American-Eurasian J. Agric. & Environ. Sci., 2 (3): 204-212, 2007
ISSN 1818-6769

Dispersion and Deposition of Heavy Metals Around Two Municipal Solid Waste (MSW) Dumpsites, Alexandria, Egypt

[1]Mohamed Rashad and [2]Elsayed A. Shalaby

[1]Arid Lands Cultivation and Development Research Institute,
Mubarak City for Scientific Research and Technology Applications,
New Borg El-Aral, Alexandria, Egypt
[2]Institute of Graduate Studies and Research, Alexandria University, Egypt

Abstract: The levels of heavy metals were measured at different sites with different distances and directions from two dumpsites in Alexandria for the ambient air, soil and vegetation. The results indicated a steady decrease in the concentrations of total Cd, Cu, Ni, Cr and Zn in the ambient air at Abis area with distance from the municipal solid waste (MSW) dumpsite. The mean maximum recorded levels were 1.35, 3.17, 2.85, 3.05 and 2.40 µg m^{-3} for Cd, Cu, Ni, Cr and Zn respectively, while the minimum levels were 0.20, 0.35, 0.31, 0.35 and 2.10 µg m^{-3} respectively in Abis area. Similar trends were found at El-Montaza district. Levels of heavy metals in soil were measured in 19 sites near and around the old (MSW) dumpsite at four directions. It was found that the sites located in the southeast direction from (MSW) dumpsite had the highest levels of total metals in soils. The soil of site close to the (MSW) dumpsite at Abis contained the highest levels of total metals which were 5.10, 97.10, 12.20, 11.20 and 110.0 µg g^{-1} for Cd, Cu, Ni, Cr and Zn respectively. Similar trend was found at El-Montaza district. The concentrations of metals in leaves and roots of tomatoes, carrots and potatoes plants were higher in plants grown at the site close to Abis (MSW) dumpsite and decreased with increasing distance. The results obtained in this study clearly showed that heavy metals are dispersed with the aerosol in the ambient air and transported by wind then deposited onto the surrounding environment.

Key words: Aerosol % heavy metals % municipal solid waste % soil % vegetation

INTRODUCTION

Atmospheric pollution is of a major public health concern in many large cities world wide. However, in many cases only a little attention has been given to this issue in developing countries. Example is the case of Alexandria city in Egypt where two municipal solid waste (MSW) dumpsites were located at the east and west directions of the city. One of the main activities leading to this problem includes deposition of compost and incineration of MSW, which contain high levels of heavy metals. Such activities tend to increase the elemental background levels in the surrounding agricultural land driving to adverse temporal and/or spatial variations of heavy metals levels in soils.

Atmospheric deposition of anthropogenic derived chemicals is an important source of environmental pollution. It contributes to the load of pollutants in urban runoff [1, 2]. In some areas, the atmospheric deposition of pollutants has reached levels which are toxic to human and organisms. Therefore, the measurements of the fluxes of pollutants from the atmosphere in urban and non urban environments can aid in the assessment of air quality and can be used to determine spatial, temporal and seasonal variability of pollution sources [3].

Soil constitutes part of a vital environmental, ecological and agricultural resources that have to be protected from further degradation as an adequate supply of healthy food needed for the world's increasing population. Heavy metals can affect both the yield of crops and their composition. Thus determination of the elemental status of a cultivated land has to be made in order to identify yield-limiting deficiencies of essential micronutrients of plants grown on polluted soils [4, 5].

Some heavy metals are essential in trace amounts, namely Zn, Cu and Mn for plants and in addition Co and Ni for animals. On the other side, Cd, has not been known to have any function for either plants or animals [6]. High

Corresponding Author: Dr. Mohamed Rashad, Arid Lands, Cultivation and Development Research Institute, Mubarak City for Scientific Research and Technology Applications, New Borg El-Aral, P.O. Box 21934, Alexandria, Egypt

concentrations of metals become toxic to plants and possibly are dangerous to human health. A number of cases of health problems related to environmental Cd poisoning have been reported [7]. Some of the metals are phytotoxic and some are toxic to both plants and animals through their entry into the food chain [8].

Baseline data for the occurrence of heavy metals as contaminants are needed as one of the criteria for assessment of critical heavy metals levels in agricultural soils. Over the last two decades, the study of the sources, fluxes and pathways of heavy metals on both national and international research communities is a response of a great concern about pollution and possible health impacts [9, 10].

Environmental pollution data tend to vary extensively and to be subjected to various types of uncertainties due to several factors such as distance from pollution sources and pathways, natural background variation, pollution buildup or degradation over time. Environmental variability depicts the exact variant in pollution levels between population units [11].

The objectives of this study were to, (i) assessing the levels of heavy metals in air, soil and vegetables distributed in the surrounding environment of two old MSW dumpsites at Alexandria city in Egypt, (ii) comparing these levels at both MSW dumpsites in west and east of Alexandria, (iii) assessing the relationship between heavy metals in soils and corresponding vegetations and (iv) defining the contribution of air pollution on soil pollution.

MATERIALS AND METHODS

Studied areas: There are two main dumpsites for Municipal solid waste MSW at Alexandria city: (i) Abis dumpsite and (ii) El-Montaza dumpsite. Both are surrounded by an agricultural area as shown in Fig. 1 and 2. (i) Abis dump site has an area approximately 100.000 m^2 and is surrounded by Maryout Lake from the northwest and northeast. The agricultural area lies to the south, southwest and southeast of the dumpsite. Some private Mixer and Project Company are located on the main road leading to the dumpsite. Alexandria-Cairo desert road is located about one km to the north of the dumpsite. The maximum height above the ground of municipal solid on site is about 5 meters. The waste is usually subjected to primitive and random sorting by Scavengers. Self ignition has been frequently occurred and a lot of pollutants were dispersed near by the surroundings as shown in (Fig. 3). (ii) El-Montaza dumpsite is located to the east of Alexandria city as shown in (Fig. 2). It is surrounded by the agricultural area from most directions except some scattered buildings and schools to the north. An old compost plant is located close to the dumpsite. Yearly average wind roses showed that the dominant wind directions in Alexandria City is Northwest, so the anticipated affected area at the two dumpsites is the southeast as, shown in Fig. 1.

Sampling program

Ambient air sampling: This was carried out as follows: (i) five sites have been selected close to the dumpsite, south and southeast the dumpsite in Abis as shown in Fig. 1 and (ii) four sites have been selected at El-Montaza dumpsite close to the dumpsite at different distances southeast direction from the dumpsite as shown in Fig 2. The air sampling method was designed to collect atmospheric particles in a form suitable for heavy metals analysis. Aerosol samples were collected using a volume samplers type L-2SF. MK3 from Rotheroe & Michael, with a fiber glass filter paper (47 mm in diameter) at a flow rate 100 l/min for 24 hrs. The inlet manifold of volume sampler was two meters height of the ground surface. Suspended particulate matter in the ambient air is sampled at standard temperature and pressure [12]. Sampling period was approximately 24 hrs and the flow was measured at the beginning and at the end of each sampling to obtain an average flow rate. Average flows ranged from 70 to 100 m^3 hrG^1. Each site was sampled four times (Four successive days) and all samples have been conducted in summer (2004).

Soil sampling: Surface soil samples (0–10 cm) from Abis area have been collected from 19 sites from the agricultural area as shown in Fig. 1. The sampling sites covered the following directions: west, east, south, southwest and southeast. The samples were collected at different distances from the dump site, the longest distance was 2000 m southwest the dumpsite, in addition to one site very close to the dumpsite. Six sites have been selected for soil sampling at south El-Montaza downwind the dumpsite. Four sites were selected at the southeast, one close to the dumpsite and the last one was to the north (upwind) for the comparison as shown in (Fig. 2). The collected soil samples were air dried in a clean room to avoid contamination and ground to pass through 2 mm sieve and stored in polyethylene bags for analysis.

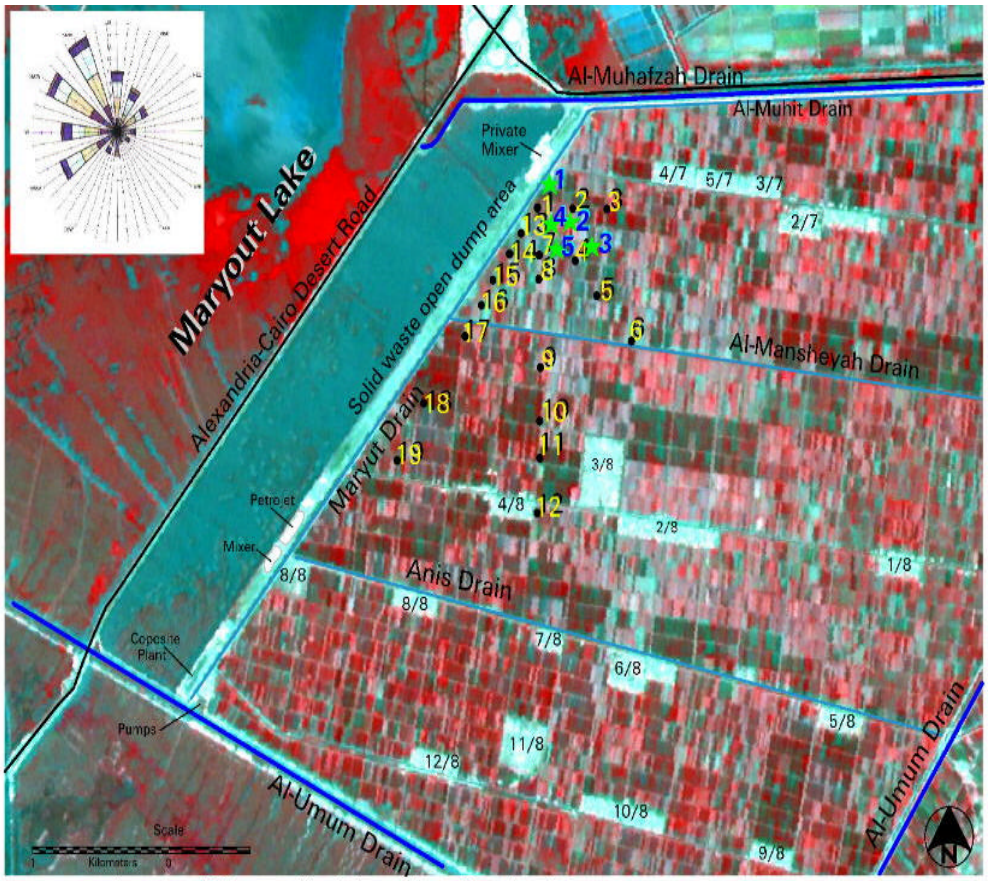

Fig. 1: Location of diffrent soil and air samples collected at Abis area near and around the municipal soil wast dumpsite, Alexandria, Egypt

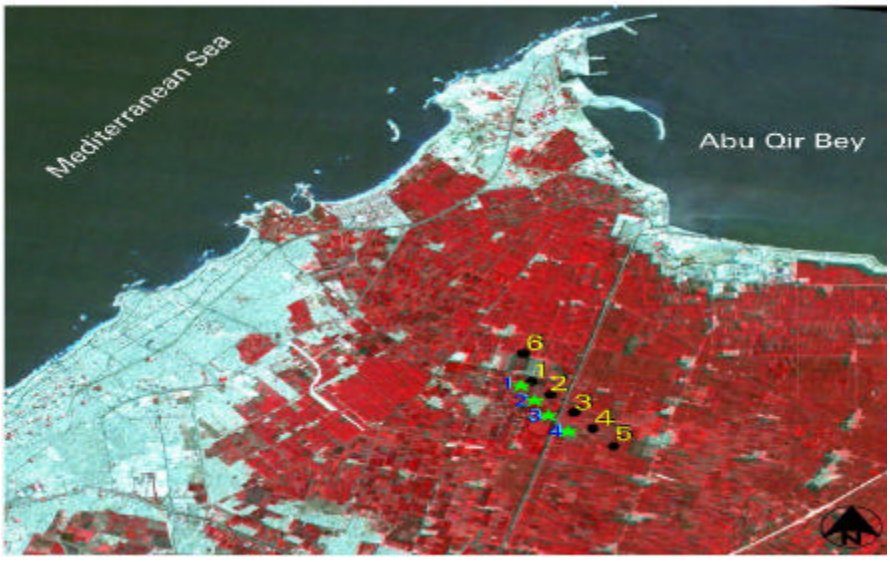

Fig. 2: Location of diffrent soil and air samples collected at Elmontaza area near and around the municipal solid wast dumpsite, Alexandria, Egypt

Fig. 3: The self ignetion at the municipal solid wast dumpsite in Abis area Alexandria, Egypt and its impact on the surrounding Environmental

Vegetables sampling: Tomato leaves and roots, carrot roots and potatoes roots were collected from sites No. 1 and 18 at Abis area, washed with tap water then with distilled water. The plant materials were air dried in a dust free room then in an oven at 70°C for 48 hrs. The plant samples were ground in a stainless steel mill and passed through a 0.5 mm sieve and stored in polyethylene bags for analysis.

Analytical procedures

Aerosol: The fiber glass filter paper was placed in a desecrator for 48 hrs then its weight was measured. For the determination of the concentration of total Cd, Pb, Ni, Cr and Zn, the pre-weighed filter paper was treated with one ml concentrated Hydrofluoric acid then 10 ml concentrated nitric acid and 5 ml perchloric acid and heated (80-120°C) for 5 hrs. To complete the digestion process, the matrix was digested three times and the sample was evaporated to dryness. The residues were dissolved in 1% nitric acid, cooled, filtered and made to 50 ml in a volumetric flask with glass double distilled water. A blank filter paper was similarly digested and the same procedure was carried out. The concentrations of heavy metals were measured by, Perkin-Elmer model 5000, an atomic absorption spectrophotometer, AAS, [13].

Soil: The main chemical characteristics of the soils: EC, pH, total carbonate and the distribution of the particle size (sand, silt and clay) were determined according to standard methods [14]. The amounts of total heavy metals in soils were determined by the same method used for digesting the aerosol samples.

Plant leaves: The same procedure, carried out for digesting the soil and aerosol samples, has been used for digesting the plant material of the different vegetables. The concentrations of Cd, Pb, Ni, Cr and Zn in plant material were measured by AAS.

RESULTS AND DISCUSSION

Heavy metals in the ambient air: The average concentrations of heavy metals (µg m^{3}) in atmospheric particulate matter near and around the two MSW are shown in Tables 1 and 2. The results indicated that the highest concentration levels were recorded for the site close to the dumpsite at Abis and El-Montaza. The mean maximum recorded levels were 1.35, 3.17, 2.85, 3.05 and 2.4 µg m^{3} for Cd, Cu, Ni, Cr and Zn, respectively in Abis area and were 0.65, 1.92, 1.83, 2.13 and 2.4 µg m^{3} respectively, for the same metals in El-Montaza area. These levels are high and could be originated from anthropogenic and industrial activities [15, 16]. These high recorded levels found in the present in study are hundred times higher than the levels of these metals in an unpolluted remote area and reached 76 times in the case

Table 1: The average values of total heavy metals concentration (µg m^{3}) in the suspended particulate matter (aerosol) at Abis in air samples collected at different sites downwind direction of the soil municipal solid waste dumpsite

Site description	Cd	Cu	Ni	Cr	Zn
Close to dumpsite	1.35±0.10	3.17±0.12	2.85±0.20	3.05±0.27	2.40±0.18
200 m, southeast the dumpsite	1.20±0.08	2.50±0.08	2.25±0.09	1.95±0.20	2.75±0.17
500 m, southeast the dumpsite	0.40±0.07	0.85±0.01	0.63±0.015	0.85±0.12	2.20±0.19
200 m, south the dumpsite	0.50±0.07	1.65±0.04	1.25±0.09	1.35±0.08	2.30±0.10
300 m, south the dumpsite	0.20±0.03	0.35±0.01	0.31±0.01	0.35±0.02	2.10±0.11

Table 2: The average values of total heavy metals concentration (µg\m^{3}) in the suspended particulate matter (aerosol) at El-Montaza in air samples collected at different sites at the municipal solid waste dumpsite

Site description	Cd	Cu	Ni	Cr	Zn
Close to dumpsite	0.65±0.08	1.92±0.12	1.83±0.10	2.13±0.19	2.40±0.15
200 m, southeast the dumpsite	0.42±0.07	1.35±0.10	1.45±0.09	1.52±0.12	2.35±0.12
300 m, southeast the dumpsite	0.20±0.04	0.85±0.09	0.92±0.09	1.10±.08	2.10±0.09
500 m, southeast the dumpsite	0.07±0.01	0.20±0.01	0.25±0.01	0.27±0.01	0.57±0.08

Table 3: The ratios of heavy metal between that of Abis and that of El-Montaza at site close to the dumpsite and at 500m southeast downwind direction

Metal	Close to dumpsite	500 m downwind site
Cd	2.07	5.70
Cu	1.65	4.25
Ni	1.55	2.52
Cr	1.43	3.14
Zn	1.14	1.28

of Cr in the rural area. A steady decrease in the concentrations of Cd, Cu, Ni, Cr and Zn were found with distance from the MSW dumpsite. The highest concentrations were found close to the MSW dumpsites for all the measured metals, while the lowest levels were recorded for the sites located far away from the dumpsites. It is clear that the MSW dumpsite is the main source of these heavy metals in this area. The suspended particles and the self ignited products with its contents of metals are transported and deposited on soil with the distance. There are two possible pathways for metals to be suspended in the aerosol. The first one is the transport of the fine material enriched with metals from MSW dumpsite. The second is the emission of heavy metals from the uncontrolled self ignition and the incineration products from the MSW dumpsite. The incineration residue including metals is suspended to the aerosol and transported by winds. The MSW consists of a wide variety of organic (combustible) and inorganic (non-combustible) products ranging in size and composition from dust particles to old furniture and appliances [17]. The percentage of combustible material in MSW reaches about 75% of the total. It is obvious that the main air pollutants from municipals solid waste are acid gases, dioxins and heavy metals. Although a great deal of these pollutants are released in the form of fly ash as a product of incineration, there is a minor contribution from the other scattered sources such as the Petrojet activity and the Mixers at Abis. It is therefore, expected to find these metals enriched in the atmosphere at these two areas; (Abis and El-Montaza) as a result of the presence of the MSW dumpsites.

It should be mention that the levels of heavy metals in the aerosol of Abis were higher than in those recorded of El-Montaza. A ratio between the levels of heavy metals in the aerosol of the site close to the dumpsite and at 500 m downwind the dumpsite, of Abis and El-Montaza, are shown in Table 3. Abis had Cd level two times higher than El-Montaza at the site close to the dumpsite and was the highest among the other metals while Zn was the least (1.14). The ratios of Cu, Ni and Cr metals varied from 1.14 to 1.65. The same trend occurred at the site 500 m downwind the dumpsite, but the ratios were much higher and reached 5.7 times for Cd in Abis compared to El-Montaza. The ratios of Cu, Ni, Cu and Zn metals varied between 1.28 to 4.25 times. The increase in the ratio between the levels of heavy metals of both areas at 500 m downwind the dumpsite revealed that there may be another sources contributing at Abis area. The obtained results showed that the aerosol which originated from the municipal solid waste were deposited close to the dumpsite while which are transported to longer distances are originated from the residue of the self incineration and from the other activities found near by the dumpsite at Abis. The differences in the levels of heavy metals, at both areas, were attributed to other sources found around

Tale 4: Average values of the main chemical and physical properties of the cultivated soils at Abis area

			Ca^{2+}	Mg^{2+}	Na^{+}	SO^{4--}	ClG		Sand	Silt	Clay	
		EC**	----------	----------	----------	----------	----------	Total	----------	----------	----------	
Plant type	pH*	dsmG^{1}			meq/1			$CaCO_3$ %		%		Soil texture
Tomato	8.1	1.38	3.7	2	7.7	6.3	5.4	24.2	5.5	19	26	Sandy Clay Loam
Carrot	8.1	2.00	4.5	3	11.8	0.5	7.3	23.3	60	16	24	
Potato	8	2.78	7.7	4.2	15	15	11	25.1	52	18	30	

*Measured in 1:2.5 soil water suspension **Measured in 1:1 soil water extrac.

Table 5: Average values of the amounts of total heavy metals in soils (µg gG^{1}) collected at different sites downwind old MSW dumpsite in Abis

Site No.	Site description	Cd	Cu	Ni	Cr	Zn
1	Close to dumpsite	5.1	97.1	12.2	11.2	110
2	200 m, east of the dumpsite	4.6	82.5	9.3	9.0	98
3	500 m, east of the dumpsite	4.3	74.8	8.4	8.2	90
4	500 m, southeast of the dumpsite	4.5	82.8	8.4	9.0	89
5	700 m, southeast of the dumpsite	3.4	60.0	7.9	8.3	87
6	1000 m, southeast of the dumpsite	2.7	55.6	7.5	8.0	86
7	300 m, south dumpsite	4.2	80.2	8.2	8.9	91
8	500 m, south dumpsite	4.1	73.5	7.9	8.7	87
9	1200 m, south dumpsite	1.2	49.5	7.2	8.6	80
10	1500 m, south dumpsite	1.5	45.2	7.2	8.4	80
11	1700 m, south dumpsite	1.2	43.4	7	8.2	80
12	2000 m, south dumpsite	0.6	41.2	7	8.0	78
13	200 m, southwest dumpsite	4.2	80.5	8.8	9.9	89
14	300 m, southwest dumpsite	3.9	78.0	8.2	4.0	87
15	500 m, southwest dumpsite	3.8	74.0	7.7	8.6	82
16	700 m, southwest dumpsite	2.8	74.1	7.6	8.1	80
17	1000 m, southwest dumpsite	1.45	61.2	7.2	7.8	72
18	1500 m, southwest dumpsite	1.0	49.0	7.2	7.6	70
19	2000 m, southwest dumpsite	0.25	43.0	6.9	7.5	70

the dumpsite at Abis area where is the Petrojet Company and the Mixers are existing active. However, the MSW dumpsites still the main sources and main contributor of heavy metals load especially for the sites close to the dumpsite.

Levels of metals in soil

Abis: The main characteristics of Abis soil are presented in Table 4. Levels of heavy metals in soils collected from 19 sites near and around the old MSW dumpsite are presented in Table 5. The samples were taken along four directions: south, southeast, southwest and east from the dumpsite in addition to one sample very close to the dumpsite. The results indicated that this area is highly polluted by heavy metals and is exposed to serious sources of pollution. The results also indicated that there is a decrease in heavy metals concentrations with increasing distance from the dumpsite. It is clear that the sites located at the southeast from the dumpsite had the highest levels of metals as compared with the sites located at the other directions. Site No. 1, which is close to the dumpsite, had the highest levels of metals relative to all other sites and is heavily polluted. These results are highly correlated with the meteorological parameters and with the wind roses which indicated that the dominant wind direction is the northwest, as a result, the affected direction will be the southeast. However, the other two directions are subjected to pollution by this source most of the year as indicated from the current wind roses. This result agreed with other studies, which reported that the concentrations of total heavy metals in soil decreased with increasing distance from the disposal sites of the tannery and the textile industries in Dkaka city, Bangladesh [18]. Similarly, another study showed that surface accumulation of heavy metals in soils may result from atmospheric input in the southwestern region being exposed to air pollution from Great Britain and central Europe [19]. In this respect, it was argued that the soils of southwest France have been received a comparable annual inputs of metals since the dawn of industrialization [20]. Moreover, monitoring of heavy metals deposition onto soils in two locations in UK showed that large amount of metals are entering the soil annually [21]. The results of our study indicted that the lowest recorded levels were found in soils at Site No. 19 (2000 m southwest the dumpsite) while the highest recorded levels were found in soils at Site No. 1 (close to the dumpsite). This indicated that the main source is the dumpsite. Comparing these levels with the background levels of heavy metals of unpolluted soils in Egypt and other soils around the world indicated that Cd, for instance, was ten times higher than the background level [4]. In addition, the levels of all other metals were higher than the background levels except for zinc, which was very close to the background levels in the Egyptian soil [4, 9].

Table 6: Avearage values of the main chemical and physical properties of El-Montaza soils

Parameters	Value
pH*	7.9±0.2
EC ds mG¹**	4.8±1.2
O.M. %	2.8±0.3
Total carbonate	6.8±1.4
Sand %	36.0±9.0
Silt %	34.0±5.0
Clay %	30.0±7.0

*Measured in 1:2.5 soil water suspension

** Measured in 1:1 soil water extract

Table 7: Average values of heavy metals in soils (µg gG¹) collected at different sites downwind El-Montaza-solid waste dumpsite

Site No.	Site description	Cd	Cu	Ni	Cr	Zn
1.	Close to the dumpsite	4.52	73.70	12.40	10.80	108.50
2.	200 m southeast dumpsite	4.10	65.20	9.40	8.50	95.00
3.	500 m southeast dumpsite	3.74	60.50	8.40	8.00	86.00
4.	700 m southeast dumpsite	2.95	52.50	8.00	8.00	81.00
5.	1000 m southeast dumpsite	1.20	40.80	7.00	7.20	78.00
6.	200 m north dumpsite	0.35	38.20	6.70	7.10	75.00

Table 8: Average values of heavy metals (µg gG¹) in root and leaves of tomato potato and carrots grown in Abis area

Type of plant	Site No.	Cd	Cu	Ni	Cr	Zn
Tomato, roots	(1)	0.18	21.60	1.80	1.88	22.60
Tomato, leaves	(1)	0.12	12.17	0.81	0.90	11.30
Carrot, roots	(1)	0.32	15.65	1.00	0.95	16.50
Potatoes, roots	(1)	0.73	42.35	0.35	6.50	43.50
Tomato, roots	(18)	0.09	3.05	0.10	0.12	18.25
Tomato, leaves	(18)	0.08	2.35	0.09	0.09	8.20
Carrot, roots	(18)	0.09	0.30	0.02	0.01	4.50
Potatoes, roots	(18)	0.15	3.50	0.18	2.20	6.50

Table 9: Values of heavy metals contents (µg gG¹) in plants [22]

Metals	Sufficient or Normal	Excess or Toxic
Cd	0.05-0.2	5-30
Co	0.02-1.0	15-50
Cr	0.1-0.5	5-30
Cu	5-30	20-100
Mn	30-300	400-1000
Ni	0.1-5.0	10-100
Pb	5-10	30-300
Zn	27-10	100-400

El-Montaza: The main characteristics of El-Montaza soil are presented in Table 6. Six sites have been selected for soil sampling and the obtained levels of heavy metals are shown in Table 7. The highest levels were recorded in soils of the site No. 1 close to the dumpsite and the lowest levels were found in soils of site No. 6, (200 m north the dumpsite). In general, there is a tendency for decreasing the levels of heavy metals with increasing distance from the dumpsite as shown in Table 7. Comparing the obtained results with those obtained with Abis area, showed similar patterns where the highest level was found close to the dumpsite and there is a continuous decrease, of the levels of metals, with increasing distance from the dumpsite at both areas. The recorded levels of Cd, Cu, Ni and Cr were higher than the background levels in the Egyptian soils taking the same trend at Abis area [4, 9]. Zinc levels still similar to that obtained at Abis area and there was no high increase within this area. The only difference between Abis and El-Montaza is that the recorded levels of heavy metals at Abis area were higher than obtained at El-Montaza area. This could be due to the other pollution sources found at Abis area, including the cement company and other petroleum companies near Abis area which is a serious source of there metals.

Levels of heavy metals in vegetables: Two sites were selected for the measurements of total heavy metals in vegetables; one site very close to Abis dumpsite (site No. 6) and the other site (18) located about 1700 m southwest of the dumpsite. The results shown in Table 8 indicate that the distance of the dumpsite is the controlling factor for the distribution of the concentration of metals. Differences were found in the concentrations of these metals at the two sites, where the cadmium levels in the leaves and roots of tomatoes decreased by 50% at site No. 18. The differences were very high in the case of carrot and potato roots where the levels increased several times higher at site No. 1 compared with site No. 18. In all cases, the recorded levels were high when compared to other studies. As reported in previous studies the concentrations of heavy metals were high in the vegetation of tannery area in the vicinity of industries around Dkaka in Bangladesh [17]. As shown in Table 9, the toxic level of Cd, Cu, Ni, Cr and Zn ranged from 5-30, 20-100, 10-100, 5-30 and 100-400 ppm, respectively [22]. In our study, all the results did not reach the toxic levels except in the case of potatoes roots regarding Cu and Cr concentrations at site No. 1 which imply that this soil is containing high amounts of these metals. There is a general tendency for higher metal concentrations in the southern part of Norway compared to central part. The more volatile elements, such as cadmium, which are commonly associated with air pollution, are generally more concentrated in the plant grown on south western

region which receives the most rainfall and being more exposed to air pollution from Great Britain and central Europe [19].

CONCLUSIONS

- The uncontrolled burning of municipal solid waste of the two opened MSW dumpsites in Alexandria City creates heavy metals in the ambient air.
- The environmental components air and soil as well as vegetables surrounding the municipal solid waste dumpsites in Abis and El-Montaza districts are highly polluted with heavy metals.
- The magnitude of pollution by metals decreased with increasing distance from the dumpsite.
- Abis area is receiving higher amounts of atmospheric deposited heavy metals than south El Montaza district as a result of the presence of other air pollution sources.
- The levels of heavy metals in tomatoes, potatoes and carrots grown in Abis area were higher than the normal, but did not reach the toxic levels except for Cu and Cr in potatoes roots at the planted area close to the dumpsite.

According to these results, the recommendations urgently required are:

- Solid waste should be carefully incinerated using special facilities and designed to prevent contamination of the soil and plants otherwise burning can result in emissions of hazardous substances such as heavy metals.
- Rehabilitation of the old dumpsites should be started as soon as possible to prevent deteriorations of the surrounding environment.

REFERENCES

1. James, S.L., G. Hoffman, J.G. Hoffman, J.L. Fasching and G. James, 1990. Sources of petroleum hydrocarbons in uban rnoff. Water, Air and Soil Pollut., 52: 1-22.
2. Jaffe, R., A. Cabrera, H. Carrero and J. Alvarado, 1993. Organic compounds and Heavy metals in the atmosphere of the city of Caracas, Venezuela. Atmospheric Deposition. Water, Air and Soil Pollut, 71: 315-330.
3. Howard, B.R., 1987. Trace metals precipitation in swedem. Water, Air and Soil Pollut, 36: 349-364.
4. Elsokkary, I.H. and J. Lag, 1980. Status of some trace elements in Egyptian soils and in wheat grains. Beitrage trop. Landwirtsch. Veterinarmed. 18:35-47.
5. Alloway, B.J., 1990. Heavy Metals in Soils, John Wiley and Sons, Glasgow: Blackie, 339.
6. Greenland, D.J. and M.H.B. Hayes, 1981. The Chemistry of Soil Processes. John Wiley and Sons Ltd., 593-619.
7. Singh, B.R., E. Steinnes, I.R. Lal and B. Stevart, 1994. Soil processes and water quality, Lewis Publishers, Chelea, Mich, pp: 233-271.
8. Roads, F.M., S.M. Olson and A. Manning, 1989. Copper toxicity in tomato plants. J. Environ. Qual., 18: 159.
9. Elsokkary, I.H., 1996. Synopsis of contamination of agricultural ecosystem by trace elements: An Emerging environmental problem. Egypt. J. Soil Sci., 36: 1-22.
10. Chrysanthus, C.S.R., 1996. Evaluating baseline data for trace elements pH, organic matter content and bulk density in agricultural Soils in Nigeria. Water, Air and Soil Pollut., 86:13-34.
11. Gilbert, R.O., 1987. In statistical methods for environmental pollution monitoring, van Nostrand. Reinhold Company, New York, 10.
12. Garland, J.A. and K.W. Nickolson, 1991. A review of methods for sampling large airborne particles and associated radioactivity. J. Aerosol. Sci., 22: 479-499.
13. Tripathi, A., 1994. Air borne lead Pollution in the city of Varanasi, India. Atmos. Environ., 28: 2317-2323.
14. Black, C.A., 1965. Methods of Soil Analysis, Parts1 and 2, No.9. in the Series of Agron. Am. Soc. Agron. Inc., Medison, Wisconsin, USA.
15. Molnar, A. and E. Meszaros, 1993. Elemental Composition of atmospheric aerosol particles under different conditions in Hungary. Atmosph. Environ., 27: 2457-2461.
16. Fildago, M.R., J. Meteos and J. Garmendia, 1988. The origin of some elements contained in the aerosols of solamanco (Spain). Atmosph. Environ., 22: 1495-1498.
17. Desnuson, R.A. and E.K. Silbergeld 1988. Risks of MSW Incineration: An Environmental Perspective. Risk Analysis, 8: 3.
18. Abul Kashem, M.D. and B.R. Singh, 1999. Heavy metals concentration of soil and Vegetation in the vicinity of industries in Bangladesh Water. Air and Soil Pollut, 115: 347-361.

19. Esser, K.B., 1996. Reference concentrations for heavy metals in Mineral soils, oat and orchard grass *(Dactylis glomerata)* from three agricultural regions in Norway. Water, Air and Soil Pollut., 89: 375-397.
20. Saur, E. and C. Juste, 1994. Enrichment of trace elements from long-range aerosol transport in sandy podzolic soils of south waste France. Water, Air and Soil Pollut., 73: 235-246.
21. Merrington, G. and B.J. Alloway, 1994. The flux of Cd, Cu, Pb and Zn in Mining polluted soils. Water, Air and Soil Pollut. 73: 333-344.
22. Kabata-Pendias, A. and H. Pendias, 1992. Trace Elements in Soils and Plants. CRC press Florida, USA.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 213-219, 2007
ISSN 1818-6769

Decisive Factors of Clay Dispersion in Alluvial Soils of the Nile River Delta – A Study on Surface Charge Properties

[1]Mohamed Rashad and [2]Stefan Dultz

[1]Arid Lands Cultivation and Development Research Institute, Mubarak City for Scientific Research and Technology Applications, New Borg El-Arab, P.O. Box 21934, Alexandria, Egypt
[2]Institute of Soil Science, Hannover University, Herrenhäuser Str. 2, D-30419 Hannover, Germany

Abstract: Clay dispersion in soils can result in reduced water infiltration and increased surface runoff. In order to improve the understanding of the decisive factors of clay dispersion of soil clays in alluvial soils of the Nile River Delta, the surface charge of the clay fraction of a typical Fluvisol was determined on its dispersion properties in dependence of pH, organic matter content, Na and Ca concentration. The surface charge was quantified by combining the electrokinetic signal of a Particle Charge Detector (PCD) with polyelectrolyte titration. The results revealed that at low pH the surface charge of both clay soil samples (original clay and the organic matter removed clay soil) had low negative values, which is due to the protonation of variable charge. With increasing pH, where deprotonation of functional groups occurs, the surface charge becomes more negative. This is most pronounced for the sample after organic matter removal. Here, surfaces of the clay minerals are not covered with organic matter and negatively charged silicate layers are detected better. On the other hand, this might be also due to the increase of the specific surface area due to the H_2O_2 treatment.

Key words: Surface charge % particle charge detector % clay dispersion % alluvial soils

INTRODUCTION

In the Nile Delta, fluvisols are the most common soil type. Fluvisols are relatively young soils developed on recently deposited stratified material, mainly fluviatile but also lacustrine, or marine sediments and on some of the coastal plains. The carbonate content is usually less than 4%. Organic matter content decreases irregularly with depth (although it remains above 0.35 % in the upper 1.25 m) and the soils contain sulfides in the Gr horizon. Generally fluvisols exhibit little horizonation, except for a weakly developed A-horizon and peaty horizons. They are the most intensively farmed soils in Egypt and have a high development potential due to the ease of irrigation and their ability to be double-cropped.

The delta ecosystem no longer receives a yearly input of sediments and nutrients from upstream due to the High Dam impact. Consequently, the soils of the floodplains are poor and large amounts of fertilizers are applied to the land each year. Run-off of fertilizers and dumping of wastewater and sewage sludge is leading to the accumulation of trace elements and salts in the sediments of the delta [1]. Fertilizers, along with salt-water intrusion, have also caused the upper delta to become more saline. In the Nile Delta, salinity may continue to increase by the infiltration of seawaters as the delta face erodes and as erosion opens the existing lagoons to the sea. Rising sea levels of a half-meter due to changing global climatic conditions would be inundating the Nile River Estuary [2].

With high Na saturation of the exchange sites, Alluvisols of the Nile River Delta undergo degradation when used for agriculture. By irrigation clay leaching might be very intensive and often leads to subsoil compaction and pan formation, secondary salinization and gleying. Also the water erosion potential might increase. There are also potential wind erosion problems in silt-rich areas if the topsoil is allowed to dry out. Flocculation and dispersion of the clay affects many properties of the soil. Clay dispersion can result in surface crushing. As a consequence water infiltration might be reduced, which can increase surface runoff and erosion and as a result the fertility of the top soil will be reduced. Clay colloids that remain suspend in surface

Corresponding Author: Dr. Mohamed Rashad Abd El-Fattah, Arid Lands Cultivation and Development Research Institute, Mubarak City for Scientific Research and Technology Applications, New Borg El-Arab, P.O. Box 21934, Alexandria, Egypt

runoff or in water infiltrating into the soil can also enhance the translocation of adsorbed contaminants.

Beneath the different methods for characterizing the charge properties of particles the technique of the Particle Charge Detector (PCD) was selected. Here, the electrokinetic signal of the PCD is combined with polyelectrolyte titration, which allows the quantification of surface charge. Usually, surface charge of clay minerals is determined by using three different approaches: Ion adsorption, potentiometric titration and Electrokinetic's technique. Ion adsorption is time consuming. Potentiometric titration overestimates the surface charges. And the surface charge calculated by using electrokinetic's technique is also approximated due to the defect in the double layer theories and their assumptions.

The determination of clay dispersion characteristics, including surface charge properties is important to evaluate an appropriate soil management system. The dispersion characteristics are governed by many factors [3]. Therefore the effect of organic matter, pH, electrolyte concentration on surface charge and dispersion of typical soil clay fractions from the Nile River Delta was determined.

MATERIALS AND METHODS

Sample origin, preparation and characteristics: The A-horizon of a typical Fluvisol, the characteristic soil prevalent in the Nile River Delta, was sampled from the A-horizon in the agricultural road, close to Tanta city. The air dried sample was 2 mm sieved. The clay fraction (<2 µm) was separated by sedimentation/decantation after shaking and ultrasonic treatment (20 s) without further pretreatment. For comparison surface charge properties were also determined for the clay fraction where the organic matter was removed by wet oxidation (H_2O_2). The suspensions were flocculated with NaCl and washed until salt-free. The electrical conductivity of the suspensions was between 0.6 and 0.9 dSmG^{1}. The clay fractions were dried at 70°C and afterwards gently pounded in a mortar. The degree of dispersion of the dried sample was determined by electron microscopy (Fei, Quanta 200). According to X-ray diffraction and FT-IR-spectroscopy, the clay fraction contains of high amounts of smectite and also kaolinite. Traces of quartz were detected. The specific surface area, determined by N_2-adsorption (Quantasorb, Quantachrome), is 31 m² gG^{1} for the original clay and 46 m² gG^{1} for the one where organic matter was removed.

Quantification of surface charge: A particle charge detector (Mütek, PCD 03) was used by employing a titration with charge compensating polyelectrolytes [4]. This method is already well established for the determination of metal complexation capacities of aquatic humic substances [5], surface charge properties of soil clay fractions [6] and latex particles [7]. The endpoint of titration was at zero potential. For negative surface charge the cationic polyelectrolyte poly-DADMAC (poly-Dially-dimethyl-ammonium chloride) and for positive surface charge the anionic polyelectrolyte PES-Na (Sodium-Polyethylen-sulfonate) was used. For each titration 20 mg of the sample was mixed with 10 ml of distilled water, which was adjusted with 0.1 N HCl and 0.1 N NaOH to pH 5, 8 and 10. For the determination of surface charge at different Na- and Ca-concentrations (0-10 mmol LG^{1}) the chloridic salts were used. The pH of these solutions was adjusted to pH 5, 8, and 10. After dispersion by an ultrasonic treatment for 15 seconds, the sample was transferred into the titration cell. In a separate experiment, the Na- and Ca-concentration in the "equilibrium solutions" were determined by flame photometer (Cole Parmer 2655-10) and atomic adsorption spectroscopy (Perkin Elmer PE 3300), respectively.

Determination of the dispersion degree: For the determination of the dispersion properties at different ionic strength a determination in test tubes according to Lagaly *et al*.[8] was performed. Ten ml of clay suspension (20 mg clay fraction, 10 ml solution) was put in the test tube and dispersed by ultrasonic treatment for 15 seconds. After 2 hours, 2 ml of the suspension were sampled from the surface and the transmission was determined using UV-visible spectrophotometer (Varian Cary 50 scan) at 600 nm wavelength.

Microstructure of individual and aggregated particles: The microstructure of the particles as affected by Na- and Ca-saturation was determined by using an environmental scanning electron microscope (Fei, Quanta 200). Suspensions of Na- and Ca-saturated clay fraction were prepared on glass slides, air dried and sputtered with Au.

RESULTS AND DISCUSSION

Effect of pH on surface charge and clay dispersion: At pH 3 the surface charge of both samples has low negative values (Fig.1), which is due to the protonation of variable charge. With increasing pH, where deprotonation of functional groups occurs, the surface charge becomes

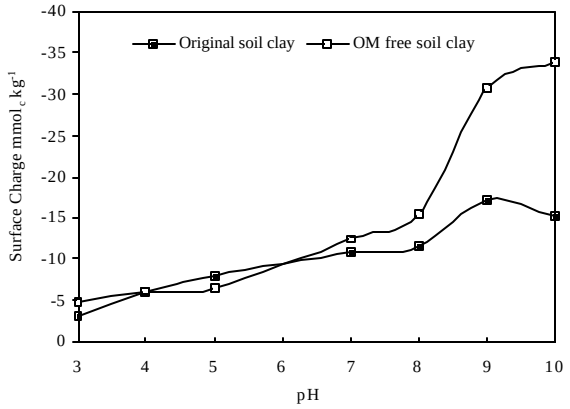

Fig. 1: Surface charge of the <2 µm fraction at pH 3, 4, 5, 7, 8, 9 and 10 before and after OM removal. Na-saturation of the exchange sites. The surface charge was determined in duplicate

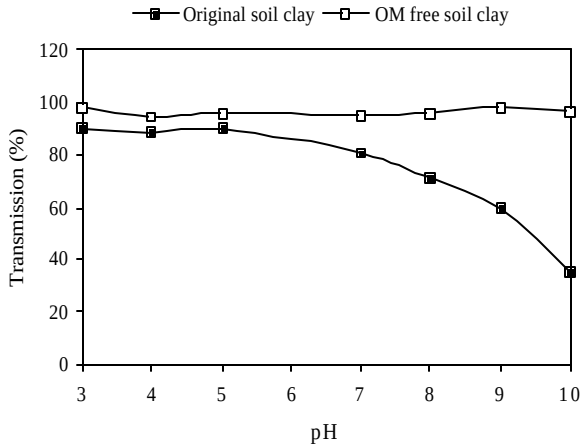

Fig. 2: Effect of pH on clay dispersion (measure: transmission) of the original sample and after OM removal

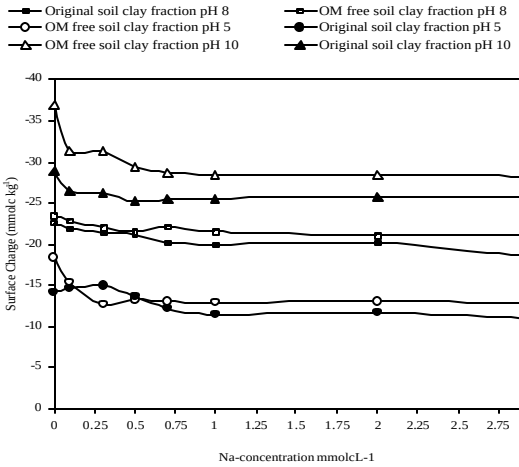

Fig.3: Surface charge as a function of Na-concentration at pH 5, 8 and 10 of the suspension of the original clay fraction and after OM removal

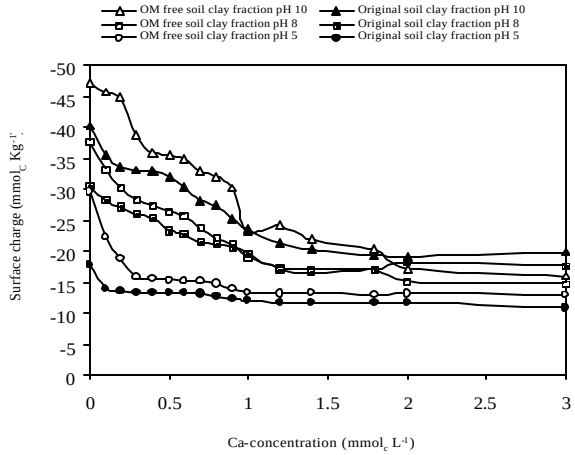

Fig. 4: Surface charge as a function of Ca-concentration at pH 5, 8 and 10 of the suspension of the original clay fraction and after OM removal.

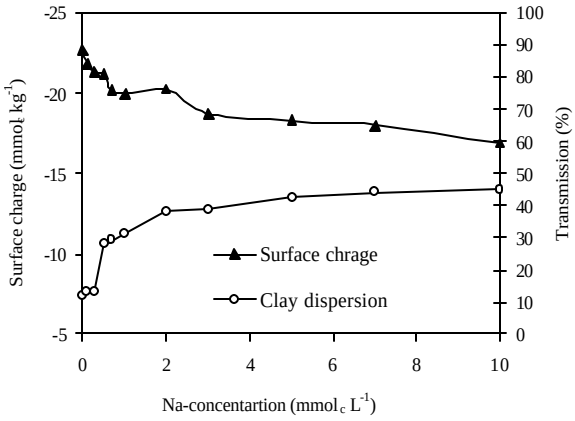

Fig. 5: Surface charge and clay dispersion as a function of Na-concentration for the original clay. Determinations at pH 8.

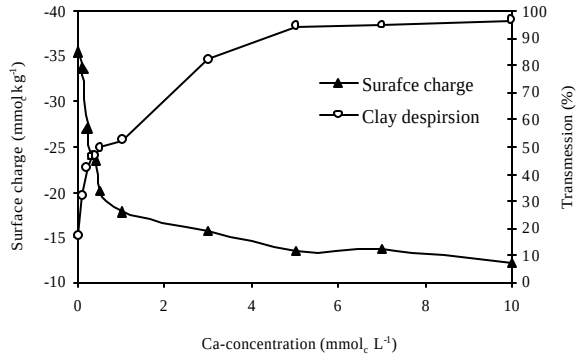

Fig. 6: Surface charge and clay dispersion as a function of Ca-concentration for the original clay. Determinations at pH 8.

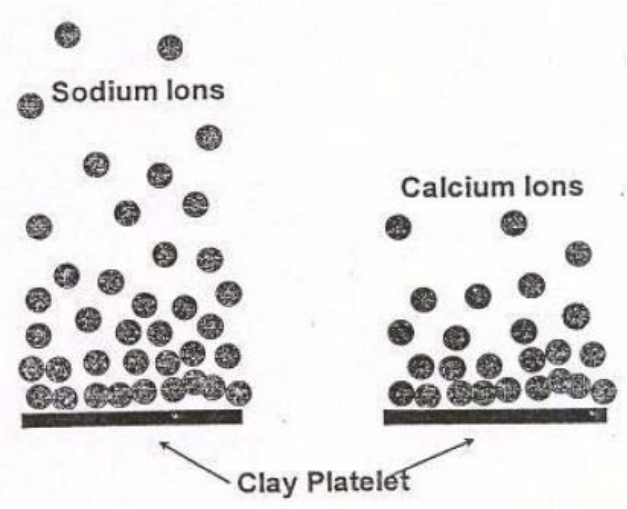

Fig. 7: Behavior of sodium and calcium ions attached to a clay platelet. (Source: [20])

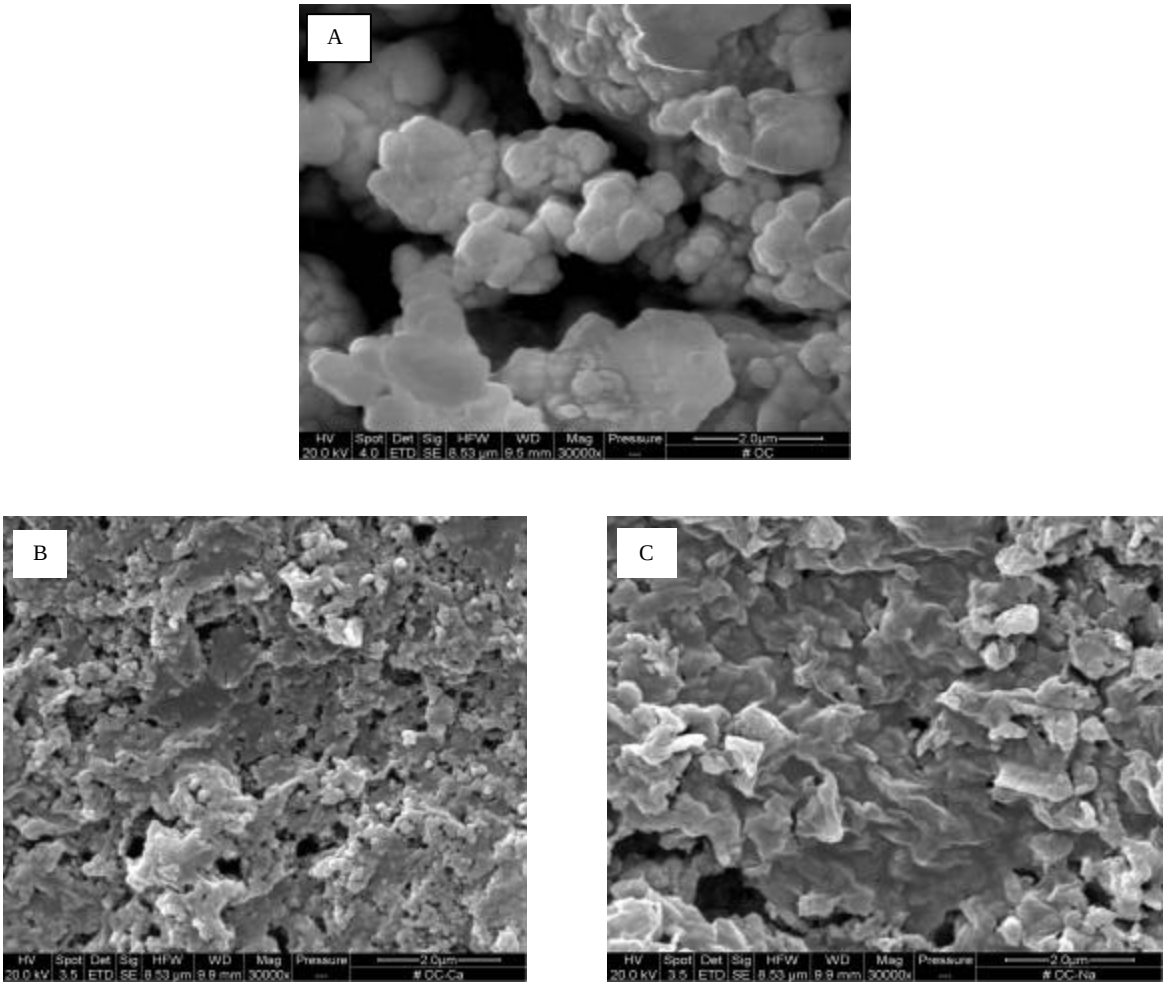

Fig. 8: Back scattered electron image of the clay fraction, original clay (A #OC) original clay with calcium (B #OC-Ca) and original clay with sodium (C #OC-Na) prepared at 0.4 mmol L^{-1} Ca and Na-concentrations

more negative i.e., dissociation of functional groups at pH>5 increases the number of negatively charged sites [9, 10]. This is most pronounced for the sample after removal of organic matter. Here, surfaces of the clay minerals are not covered with organic matter and negatively charged silicate layers are detected better. On the other hand, this might be also due to the increase of the specific surface area due to the H_2O_2 treatment. Also, increasing pH leads to make the charge on the edges of clay layers become more negative, that means this soil clay fraction is pH dependent charge.

Role of organic matter (OM): OM contributes mostly to an increase in the variable-charge; functional groups (e.g. carboxylic acids) of OM are believed to be one of the main contributors to provide negatively charged sites [10]. While charge development in OM is predominantly negative, as it is provided by functional groups (mainly carboxylic and phenolic acids), positive charge can occur through the protonation of amino groups but this is considered to be relatively small [11]. The results showed that the surface charges increased in soil clay fractions after organic matter removal by H_2O_2 suggesting that the permanent charges of the clay had been partially blocked by OM [10].

Dependency of Na- and Ca-concentration on surface charge: The data of PCD showed that at low Na^+ and Ca^{2+} concentrations the charges increased as Na ions made the double layer more diffused comparing with Ca ions (Fig. 3 and 4). By increasing Na^+ and Ca^{2+} concentrations, this part of charges decreased due to the effect of salt concentration in reducing the electrokinetic potential of the Double Layer. At low pH, there is a replacement of adsorbed ions (Na^+ and Ca^{2+}) by H^+ which has two effects: one is to increase the concentration of Na^+ and Ca^{2+} in the solution and thus to increase the electrical conductivity of the suspension and the other is to increase the concentration of H^+ on the surface. However, H^+ ions on the clay surface may slowly penetrate into lattice [12]. This attack by protons causes the clay to decompose and releases cations such as Al^{3+} and Mg^{2+}. The presence of di-or trivalent cations in the electric double layer can reduce the net negative charge due to the inner sphere complexation of these ions with clay surfaces [13]. At high pH, OH^- ions interact with the edges of the clay particles making them neutral or negatively charged. Laboratory studies have shown that the rate of dissolution of silicate minerals increases with increasing pH above 8 [14]. In spite of increasing EC at high pHs, the clay dispersed because of the development of strong negative charge.

Effect of Ca- and Na-concentration on clay dispersion: Sodium ions have a single positive charge and therefore their clay-binding ability is poor. In a dispersive soil with a large exchangeable sodium percent ESP and small concentrations of water soluble salts, the weak bonding of the clay particles by sodium ions can be broken. As water enters between the clay particles it hydrates the sodium ions. This in turn forces the plates away from the ions and lowers the attractive force between the clay particles and the ions. The plates may move far enough apart for attraction forces to be overcome. The result is dispersion (Fig. 5) soil clay dispersion is the primary physical process associated with high sodium concentrations [15-22].

Calcium ions have a double positive charge and therefore their clay-binding ability is good. In addition calcium is not as strongly hydrated as sodium; therefore, the calcium ions are held closer to the surface with consequently greater attraction, the result is flocculation or aggregation (Fig. 6). This combination of conditions does not cause the disruption to soil structure that sodium does [22, 23]. Figure 7 illustrates this difference in physical arrangement of sodium and calcium molecules on the clay surface. Basically, attractive forces which bind clay particles together are disrupted when too many sodium ions get between the clay particles. When such separation occurs, repulsive forces begin to dominate and the soil disperses [18-22, 24, 25].

Microstructure in dependence of Ca and Na-concentration: Scanning electron microscopy (Fig. 8) of original clay (A) original clay with calcium (B) and original clay with sodium (C) shows the difference between aggregation and dispersion to be present and is related to the treatment given. The aggregation is obvious in the Ca treated sample, while dispersion is pronounced in Na treated sample in addition to large surface undulations, but these are due to the shrinkage of the clay as it dried and not due to aggregation.

CONCLUSIONS

This study clearly shows that pH primarily affects dispersion and flocculation of clay by changing the amount of surface negative charge on clay particles i.e., the clay dispersion and flocculation were related to the net negative charge on clay particles. In general, while

increasing pH increase the negative charge, increasing electrolyte concentration at constant pH induces charge reduction, probably because there are more cations were tend to be specifically adsorbed in the Stern layer.

The present study has clearly demonstrated that surface charge of clay particles is the common factor affecting clay dispersion under different conditions of pH, ionic strength and cation type.

ACKNOWLEDGMENTS

This study was supported by the German Academic Exchange Service (DAAD) through their fellowship program.

REFERENCES

1. Elsokkary, I.H., 1996. Synopsis on contamination of the agricultural ecosystem by trace elements. Egypt. J. Soil Sci., 36: 1-22.
2. El-Raey, M., Y. Fouda and S. Nasr, 1997. GIS assessment of the vulnerability of the Rosetta area, Egypt, to impacts of sea rise. Environmental Monitoring and Assessment, 47: 59-77.
3. Chorom, M. and P. Rengasamy, 1995. Dispersion and zeta potential of pure clays as related to net particle charge under varying pH, electrolyte concentration and cation type. Eur. J. Soil Sci., 46: 657-665.
4. Müller, R.H., 1996. Zetapotential und Partikelladung in der Laborpraxis. Wissenschaftliche Verlagsgesellschaft, pp: 254.
5. Weiss, M., F.S. Valera and F.H. Frimmel 1989. Streaming current detection for determination of metal complexation capacities of aquatic humic substances. Z. Wasser-Abwasser-Forsch, 22:253-257.
6. Böckenhoff, K., S. Gall and W.R. Fischer 1997. Surface charge of clay-humus fractions from Chernozems as a function of pH and Ca-concentration. Z. Pflanzenernähr. Bodenk. 160: 341-346.
7. Böckenhoff, K. and W.R. Fischer, 2001. Determination of electrokinetic charge with a particle-charge detector and its relationship to the total charge. J. Anal. Chem., 371: 670-674.
8. Lagaly, G., O. Schulz and R. Zimehl 1997. Dispersionen und Emulsionen, Steinkopff, pp: 560.
9. Parfitt, R.L., 1992. Surface-Charge in some New Zealand Soils measured at typical ionic-strength. Aust. J. Soil Res., 30: 331-341.
10. Evelyn, S. K., O. S. Jan and A. B. Jeffrey 2004. Functions of soil organic matter and the effect on soil properties. Grains Research and Development corporation (GRDC) Project No. CSO 00029 Residue Management, Soil Organic Carbon and Crop Performance. http://www.grdc.com.au/growers/res_summ/cso00029/contents.htm
11. Duxbury, J.M., M.S. Smith and J.W. Doran, 1989. Soil organic matter as a source and a sink of plant nutrients. In 'Dynamics of soil organic matter in tropical ecosystems. (Eds., D.C. Coleman, J.M. Oades and G. Uehara.). (University of Hawaii Press: Honolulu.), pp: 33-67.
12. Chorom, M. and P. Rengasamy, 1995. Dispersion and zeta potential of pure clays as related to net particle charge under varying pH, electrolyte concentration and cation type. Eur. J. Soil Sci., 46: 657-665.
13. Sposito, G., 1989. The Chemistry of Soils. Oxford University Press, New York.
14. Kohut, C.K. and M.J. Dudas, 1994. Characteristics of clay minerals in saline alkaline soils in Alberta, Canada. Soil Sci. Soc. Am. J., 58: 1260-1269.
15. Miller, R.W. and R.L. Donahue, 1995. Soils in Our Environment, Seventh Edition. Prudence Hall, Englewood, Cliffs, NJ., pp: 323.
16. Ayers, R.S. and D.W. Westcot, 1976. Water Quality for Agriculture. FAO Irrigation and Drainage Paper No, 29 (Rev 1), Food and Agriculture Organization of the United Nations.
17. Bauder, J.W. and T.A. Brock, 2001. Irrigation water quality, soil amendment and crop effects on sodium leaching. Arid Land Research and Management, 15: 101-113.
18. Falstad, J., 2000. Soil Condition. Transplant Status in Burger Draw. Billings Gazette. Prepared by D.G. Steward Page. Burger Draw Comments and Recommendations. 6/06/00.
19. Frenkel, H., J.O. Goertzen and J.D. Rhoades, 1978. Effect of clay type and content, exchangeable sodium percentage and electrolyte concentration on clay dispersion and soil hydraulic conductivity. Soil Sci. Soc. Am. J., 142: 32-39.
20. Hanson, B., S.R. Grattan and A. Fulton, 1999. Agricultural Salinity and Drainage. University of California Irrigation Program. University of California, Davis.
21. Hardy, N., I. Shainberg, M. Gal and R. Keren, 1983. The effect of water quality and storm sequence upon infiltration rate and crust formation. J. Soil Sci., 34: 665-676.

22. van de Graaff, R. and R. Patterson 2001. Explaining the Mysteries of Salinity, SAR and ESP in on-site practice."on-site 01. Available at http://www.lanfaxlabs.com.au/papers/P47-mysteries.PDF
23. Shainberg, I., J.D. Rhoades and R.J. Prather, 1981. Effect of low electrolyte concentration on clay dispersion and hydraulic conductivity of a sodic soil. Soil Sci. Soc. Am. J., 45: 273-277.
24. Saskatchewan Water Corporation, 1987. Irrigation Water Quality-Soil Compatibility: Guidelines for Irrigation in Saskatchewan. Saskatchewan Water Corporation, pp: 60.
25. Western Fertilizer Handbook, 1995. Produced by the Soil Improvement Committee of the California Fertilizer Association. Interstate Publishers, Inc., Sacramento, California.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 220-226, 2007
ISSN 1818-6769

Factors Influencing Adoption of Improved Farm Practices among Women Farmers in Northern Jordan

Laith M. Rousan

Department of Plant Production, Faculty of Agriculture, Extension and Transfer of Technology, Jordan University of Science and Technology, Irbid 22110 - Jordan

Abstract: The study assesses the factors influencing adoption of improved farm practices among women farmers in three agricultural rejoins in Northern Jordan. A total of 160 women farmers were randomly selected and information was collected through a pre-tested structured interview schedule. Descriptive statistical techniques like frequency counts mean and percentages were used to analyze the data. For inferential statistics correlation was used to determine the relationship between the variables. The study showed that the majority (81.75%) of the women farmers are in the age range between 21-50 years. About 83.75 percent are married while 10 percent are illiterate. Majority of the women farmers are small scale with mean farm size 15 donums. The data showed that credibility (r = 0.469), cost (r = 0.359), land tenure (r = 0.319), divisibility (r = 0.277), communication ability (r = 0.254) and relative advantage (r = 0.247) had positive and significant relationship with adoption of innovation. Furthermore; the study concluded that innovations which are costly and complex for the farmers to apply will not receive the good will of the farmers hence their rejection. Therefore; the extension agent or agencies of agriculture should make sure that the innovations taking to farmers must be relatively affordable so that it would be within the economic reach of the farmers. It should also be simple for the farmer to understand and use by themselves without much external assistance. Also innovations to be introduced must conform to norms and the belief of the people.

Key words: Adoption of innovation % improved farm practices % rural women % women farmers

INTRODUCTION

Rural women have been suffering serious problems all over the world. The situation has been worse in the developing countries generally, despite the existence of plans and policies for integrating rural women in to the development process [1]. Women living in rural areas, which are still home to 22 percent of the population deserve special attention, as their living conditions differ in many ways from those of urban women.To begin with, the living standards of their families are lower and they live in slightly larger but significantly poorer families which in comparison to urban families have less access to clean water, sanitation and sewage disposal and are less frequently connected to electricity supply systems. This, of course, reflects negatively on the quality of life of the women, who are usually the main household managers. Rural women are also disadvantaged with regard to education and health: 30.3 percent of rural women are still illiterate, as compared to 17.8 percent of women living in urban settlements. Although their rate of participation in the basic education cycle does not differ, significantly, less rural women than urban women acquire secondary school and higher education. This is partly due to the general lack of secondary schools and colleges outside the main cities, but it is greatly exacerbated by the fact that those fewer available facilities cater first and foremost to male students. The comparatively small numbers of rural women with intermediate diplomas or with bachelor, masters or higher studies degrees have very restricted employment opportunities [2].

Rural women, play a significant role in many agricultural activities in many countries [3]. Women activities include plant and animal production activities such as production of food for the household, planting and weeding, harvesting and post harvest activities, livestock care and commercial farming. Specific tasks

Corresponding Author: Dr. Laith M. Rousan, Department of Plant Production, Faculty of Agriculture, Extension and Transfer of Technology, Jordan University of Science and Technology, Irbid 22110 - Jordan

and activities are regarded in some societies as predominately female work. They are generally tedious and time consuming tasks and considered as household duties rather than work. Women time and mobility are constrained by their multiple domestic, reproductive and agricultural roles. Besides, there are more barriers that prevent women from improving their agricultural productivity than men. However; the role of women in agriculture and in rural development is increasingly recognized both at national and international levels. Women play a significant role in many agricultural activities; they produce over half of the world's food [4] and account for 50 percent of the total labor force engaged in agriculture [5, 6].

Rural women have a much reduced access to agricultural extension services worldwide compared to men and technology is rarely designed specifically to address their gender-based needs. In Africa only 7 percent of all agricultural extension resources were allocated to women farmers and home economic extension received only 1 percent of the resources. In the Sudan, for example in the Gezira irrigation scheme out of 120,000 farmers targeted by the agricultural extension services only 11 percent were women. The main constraints limiting women's access to extension services were related to cultural restriction, domestic responsibilities, mobility limitations and even language barriers [7].

Inadequate attention has been paid to the role of women in technology, while technology plays a decisive role in the process of agricultural development. Women rarely have access to labor saving gender-specific technologies for farm and home activities [8]. Moreover; women are under-served also by the private input supply system as women were found to constitute only 3 percent of target group [9]. However, women farmers are under-served worldwide. Average percentage of time and resources allocated to women farmers' worldwide was 5 percent and the percentages in different regions of the world by extension organizations in 1989 ranged between 1 to 9 percent. Lowest percentage was observed in North America and highest percentage was found in the Near East region [10].

Studies of Jordanian agriculture have focused on labor use and the division of labor on farms. Several studies documented that Arab rural women provided up to 70 percent of the agricultural labor in many Arab countries, either as owners of land or as hired laborers [11]. According to a report on status of women in Jordan [12], the economic activity rate is estimated to be 11.7 percent for women and 65.5 percent for men. Female economic activity is only 9 percent in rural areas. The lowest economic activity rate is in Zarka (8.3%), while the highest is found in Karak (15.9%). Only 4.1 percent of the total employed population (15+ years of age) works in agriculture, hunting and forestry (4.2% male and 2.9% female). According to the field survey (MOA, 2004), the percentage of working females in agriculture is around 25 percent of the number of male workers. The highest rate is found in Ajloun (31%), followed by Aghwar (30%) and Badia (17%) [13], suggested that the main constraints facing women working in agriculture are: a) Norms and traditions that stop women from working outside the family farm unit, b) National statistics neglect to record the role of working women in the family and c) Lack of job opportunities for women, as compared to men.

In a study in north of Jordan in Irbid found that the farm household contributed 19 percent of the total labor requirements of cereals and legumes under rain-fed conditions. Females' contribution was found to be quite limited as it amounted to about 3 percent of the total labor, but it represented 16.7 percent of the household labor. Females' contribution was relatively high in planting and fertilizing, medium in threshing, manual harvesting and low in weeding, cleaning and transport. Weeding is the most important activity of women in cereal production (56% of total wives work) planting (23%) and manual harvesting (13%). Weeding is the most important activity of women in legume production (54% of total wives work), manual harvesting (36%) and transport (7%). Contribution of hired female labor was more significant in cereal production than legumes (17% against 0.4%). Highest contribution in cereals was in winnowing and cleaning, threshing and manual harvesting, while contribution in legumes was limited to winnowing and cleaning (26% of the total labor of this activity). One explanation for the minor contribution of females was the introduction of mechanical harvesting and the adoption of herbicides has displaced women from agricultural work. Another reason was related to social consideration that is the wish of farmers for not to allow their wives or daughters to be involved on farm work off the house. A further explanation would be that farmers refrain from disclosing farm work of female's family members [14].

In a survey in Al-Azraq area in Zarqa Governorate found that women's contribution in agricultural work was restricted to home gardening. The motives for all respondents were to improve the standard of living for the family. Growing vegetables and fruit trees were the main plant production activities. Ninety two percent of the sample was found to be raising few animals (i.e. 20 birds,

1-3 sheep or goat) and few have two cows. Thirty percent were found to be working as wage labor off the house. Thirteen percent of women were found to own the land and 9 percent were found to be able to take independent decision with regard to agricultural work. None was found to use any machinery. Seventy one percent were found to be spending 1-2 hours in farm work. Farm inputs were found to be secures through the husbands. Twenty percent of women were found to be getting credits from commercial bank, which was found to be used by the husbands. Women contribution was highest in caring for domestic animals, except shepherding and wool shearing, weeding, harvesting, transportation and storage (75%). Medium contribution was observed in planting (45%) and marketing (40%). Low contribution was observed in plaguing (20%) and minor contribution in pruning trees (5%). Food processing (using traditional methods) was found to be exclusively female work such as bread making for sale, pickling, tomato paste, drying vegetables and dairy products. It was concluded that extension services should be enhanced for home gardening and home economics [15].

It becomes imperative that women have significant roles to play in increasing agricultural productivity in the country. On the other hand, this realization of the high potentials of women have made government to shift ground and focused them in the development, especially in agricultural sector. Programs of development were focused on them: Participatory Support and Land Development Project (1997-2001), Income Resources Diversity Project (1995-2001), Agricultural Resources Management Project in Yarmouk Basin River (2000-2006), Agricultural Exhibition Project (2001), Project Designed to Increase of the Income of Rural Woman in the Eastern Region (1999-2001), Laying Poultry Production Project (2002), Permanent Exhibition For Rural Products Project (2001-2002) and Establishment of Dairy Units Project in Jordan's Badia. However, it was reported that the projects partly succeeded in achieving the following among the agricultural environments [16].

- Increasing income-generating capabilities of rural women.
- Increasing women farmers' involvement in production activities by applying modern methods for soil/water conservation and planting fruit trees.
- Improving living conditions of targeted women's groups.
- Help the rural families in marketing their products.
- Increasing communication and networking among production associations in different municipalities through the agricultural departments.
- Establishing a permanent exhibition for rural products
- Raising and improving rural women's skills in dairy product manufacturing.
- Training women in targeted categories.
- Promoting the development and use of appropriate agricultural technologies among women.

Despite all these that were done among women farmers, agricultural production still remain subsistence and the food production can not cope with the teaming population of the country. Therefore this study found out what are the factors that could still be responsible for the low productivity of agricultural output among women farmers.

Objectives of the study: The main objective of the study is to investigate the factors influencing adoption of improved farm practices among women farmers in Northern Jordan.

The specific objectives are to:

- Identify the socio-economic characteristics of the women farmers.
- Determine the improved farm practices passed to farmers.
- Examine sources of information of improved farm practices.
- Determine the adoption of improved farm practices.
- Investigate the factors influencing adoption of farm practices.
- Determine the characteristics of the improved farm practices.

Hypothesis of the study: There is no significant relationship between factors affecting innovation and adoption of improved farm practices.

Methodology: This study was carried out in the three agricultural areas of Northern Jordan (Badia region, Bani Kinana District and Ajloun governorate). A multistage sampling technique was employed to select the blocks, cells and villages used for the study. Simple random sampling techniques were used to select 160 women farmers in all study area. A well structured pre-tested and validated interview schedule was used to collect information from the women farmers during the year 2005 and 2006. Information was collected on the

demographic characteristics of the farmers, various sources of information available to them, factors influencing adoption and adoption of improved farm practices.

Measurement of variables: The dependent variable is the adoption of improved farm practices among women farmers which was measured by using the 5 point scale stages of adoption. Awareness 1 point, Interest (2 points), Evaluation (3 points), Trial (4 points) and Adoption (5 points). The minimum score for adoption was 11 points while the maximum score was 55 points. The independent variables are demographic characteristics of the women farmers, sources of information and factors affecting adoption of improved farm practices.

RESULTS AND DISCUSSION

Socio-economic characteristics of the women farmers: Data in Table 1 show the distribution of women farmers by demographic characteristics. The data showed that majority (81.25%) of the women were in the age range of 21-50 years, 12.5 percent were less than 20 years old while 6.25 percent were 50 years and above. About 83.75 percent were married, 6.25 percent were single and widowed respectively and 2.5 percent were divorced while 1.25 percent was separated.

About 48.75 percent of the women farmers had primary school completed, 15 percent had secondary school education while 13.75 percent of the women had adult literacy education. Also 12.5 percent had community college degree education but 10 percent of the women farmers had no education at all. Majority (87.5%) had their farm size between 1 and 10 donum. About 6.25 percent had farm size between 21-30 donum while 5 percent had between 11-20 donum but only 1.25 percent had farm size of 31 donum and above.

Majority (73.75%) of the women farmers had years of experience between 6-20 years, 22.5 percent had experience between 1-5 years while 3.75 percent had experience over 21 years.

Improved farm practices: Data in Table 2 show the distribution of improved farm practices passed across to women farmers. A hundred percent each identified application of fertilizers, use of crop residue, planting spineless cactus, milk processing techniques, planting of improved vegetable varieties, incorporate vetch in the crop rotation and using of the whole package of barley planting. About 93.75 percent identified feed blocks, while 75 percent identified spraying of herbicides. About 56.25 percent identified the use of uterus synchronization sponges and 50 percent identified the addition or and injecting vitamin (AD3E).

Table 1: Distribution of women farmers by demographic characteristics

Characteristics	Frequency	Percentage
Age		
Less than 20 years	20	12.50
21-30 years	30	18.75
31-40 years	70	43.75
41-50 years	30	18.75
51-and over	10	6.25
Marital Status		
Single	10	6.25
Married	134	83.75
Divorced	4	2.50
Separated	2	1.25
Widowed	10	6.25
Education Level		
Illiterate	16	10.00
Adult literacy	22	13.75
Primary school	78	48.75
Secondary school	24	15.00
Community college Degree	20	12.50
Farm Size (donum = 1000 m^2)		
1-10	140	87.50
11-20	8	5.00
21-30	10	6.25
31-and over	2	1.25
Farming Experience		
1-5 years	36	22.50
6-10 years	64	40.00
11-15 years	40	25.00
16-20 years	14	8.75
21- and over	6	3.75

Table 2: Improved farm practices

Improved technologies	Frequency	Percentage
Application of fertilizers	160	100.00
Use of crop residue	160	100.00
Use of the whole package of barley planting	160	100.00
Milk processing techniques	160	100.00
Planting of improved vegetable varieties	160	100.00
Spraying of herbicides	120	75.00
Use of uterus synchronization sponges	90	56.25
Feed blocks	150	93.75
Incorporating vetch in the crop rotation	160	100.00
Planting spineless cactus	160	100.00
Adding or and injecting vitamin (AD3E)	80	50.00

Table 3: Distribution of women by sources of information

Sources of Information	Frequency	Percentage
Ministry of Agriculture Extension agents, (NCARTT) agents and the Badia Development Center agents	160	100.00
Farmers (NGOs) organization meeting	160	100.00
Contact farmers	140	87.50
Friends and neighbors	120	75.00
Private sector salesman	90	56.25
Agricultural shows and Exhibitions	70	43.75
Demonstration plot	150	93.75
Farmers leaders at local community	160	100.00
Mass media	160	100.00
Bulletins	120	75.00

Sources of Information: The data in Table 3 show the distribution of respondents by sources of information available to them. A hundred percent each of the women farmers acknowledge the Ministry of Agricultural Extension Agents, National Center of Agriculture Research and Technology Transfer (NCARTT) agents and the Badia Development Center agents, farmers (NGOs) organization meeting, mass media and farmer leaders at the local community respectively as the source of information to them. About 93.75 percent identified demonstration plot, 87.5 percent mentioned contact farmers. About 75 percent each identified bulleting and friends and neighbors respectively. About 56.25 percent identified private sector salesman while 43.75 acknowledged agricultural shows and exhibitions as their source of information.

Adoption of improved farm practices: Data in Table 4 show the distribution of women farmers by adoption of improved farm practices. A hundred percent each have adopted application of fertilizer, milk processing techniques, planting spineless cactus and use of crop residue respectively. About 93.75 percent each adopted planting of improved vegetable varieties and incorporating vetch in the crop rotation and 83.75 percent adopted feed blocks for animal feed. About 56.25 percent adopted the use of the whole package of barley planting, while 37.5 percent adopted spraying of herbicides Only 25 percent adopted the use of uterus synchronization sponges and 18.75 percent were found to have adopted adding or and injecting vitamin (AD3E).

Factors influencing adoption of improved farm practices: The data in Table 5 shows the distribution of respondents by factors influencing adoption of improved farm practices. The data is classified into following groups:

Table 4: Distribution of women farmers by adoption of improved farm practices

Improved technologies	Frequency	Percentage
Application of fertilizers	160	100.00
Use of crop residue	160	100.00
Use of the whole package of barley planting	90	56.25
Milk processing techniques	160	100.00
Planting of improved vegetable varieties	150	93.75
Spraying of herbicides	60	37.50
Use of uterus synchronization sponges	30	18.75
Feed blocks	134	83.75
Incorporating vetch in the crop rotation	150	93.75
Planting spineless cactus	160	100.00
Adding or and injecting vitamin (AD3E)	40	25.00

Table 5: Distribution of women farmers by factors influencing adoption of improved farm practices

Factors affecting Adoption	Frequency	Percentage
A. Characteristics of Innovation		
1. Cost	160	100.00
2. Relative advantage	160	100.00
3. Technical appropriateness	150	93.75
4. Simplicity of application (i.e. complexity)	160	100.00
5. Divisibility	140	87.50
B. Characteristics of Adopters		
1. Technical skill	160	100.00
2. Attitude towards change	160	100.00
3. Attitude towards taking risk	160	100.00
4. Income level	160	100.00
5. Farmers exposure	150	93.75
6. Land tenure system	160	100.00
7. Years of farming experience	120	75.00
8. Educational level	160	100.00
9. labor availability	160	100.00
C. Cultural Factors		
1. Belief	160	100.00
2. Norms	160	100.00
3. Taboo	160	100.00
D. Characteristics of Change Agents		
1. Communication ability	130	81.25
2. Competency	160	100.00
3. Credibility	160	100.00
4. Confidence	150	93.75
E. Government Policy	160	100.00
F. Environmental factors (Weather condition)	160	100.00

characteristics of the innovation, characteristics of the adopters, cultural factors and characteristics of the change agent, government policy and environmental factor.

Characteristics of Innovation: A hundred percent each identified cost relative advantage and complexity about

Table 6: Relationship between factors influencing adoption of innovation and adoption

Factors affecting Adoption	Percentage
A. Characteristics of Innovation	
1. Cost	-0.359*
2. Relative advantage	0.247*
3. Technical appropriateness	-0.399*
4. Simplicity of application (i.e. complexity)	0.368*
5. Divisibility	0.277
B. Characteristics of Adopters	
1. Technical skill	0.073
2. Attitude towards change	0.134
3. Attitude towards taking risk	0.123
4. Income level	0.172
5. Farmers exposure	0.115
6. Land tenure system	0.319*
7. Years of farming experience	0.091
8. Educational level	0.113
9. labor availability	0.119
C. Cultural Factors	
1. Belief	-0.269*
2. Norms	-0.316*
3. Taboo	-0.131
D. Characteristics of Change Agents	
1. Communication ability	0.254*
2. Competency	0.059
3. Credibility	0.469*
4. Confidence	0.179
E. Government Policy	0.082
F. Environmental factors (Weather condition)	0.109

*Statistically significant

93.75 percent identified technical appropriateness, while 87.75 percent picked divisibility.

Characteristics of adopters: A hundred percent each of the women farmers identifies technical skill, attitude towards change, attitude towards taking risk, income level, land tenure, educational level and labor respectively. About 93.75 percent identified farmer's exposure, while 75 percent identified years of farming experience.

Cultural factors: A hundred percent each identified belief, norms and taboos respectively.

Characteristics of change agents: A hundred percent each identified competency and credibility as factors of change agents that influence adoption of innovation. About 93.75 percent identified confidence, while 81.25 percent identified communication ability of the agent as one of the factors.

Other factors: A hundred percent each acknowledged government policy and weather condition respectively as factors influencing adoption of improved farm practices among women farmers.

Relationship between factors influencing adoption of innovation and adoption rate: The data in Table 6 show the relationship between factors influencing adoption of innovation and adoption rate. The data showed that credibility (r = 0.469), cost (r = 0.359), land tenure (r = 0.319), divisibility (r = 0.277), communication ability (r = 0.254) and relative advantage (r = 0.247) had positive and significant relationship with adoption of innovation. However, technical appropriateness (r = -0.399) and belief (r = -0.269) had a negative but significant relationship with adoption. Other factors with positive but insignificant relationship are confidence (r = 0.179), weather condition (r = 0.109), attitude towards change (r = 0.134), farmer exposure (r = 0.115), income level (r = 0.172), level of education (r = 0.113), competence (r = 0.059), technical skill (r = 0.073), government policy (r = 0.082) and years of farming experience (r = 0.091). Only Taboo (r = -0.131) had a negative but insignificant relationship with adoption.

CONCLUSIONS

Majority (81.75%) of the women farmers are in the age range between 21-50 years. About 83.75 percent are married while 10 percent are illiterate. Majority of the women farmers are small scale with mean farm size 15 donums. Many of the farmers had years of farming experience ranging from 6-20 years. A number of factors influenced adoption of improved farm practices hence the extension agent should critically look at all these factors especially those that had significant relationship with adoption and make sure that those variables were used to the advantage of the farmers.

Innovations which are costly and complex for the farmers to apply will not receive the good will of the farmers hence their rejection. Therefore; the extension agent or agencies of agriculture should make sure that the innovations taking to farmers must be relatively affordable so that it would be within the economic reach of the farmers. It should also be simple for the farmer to understand and use by themselves without much external assistance. Also innovations to be introduced must conform to norms and the belief of the people.

RECOMMENDATIONS

Based on the result of the findings, the following recommendations are made.

- The characteristics of the extension agents goes a long way to affect the decision of the adopters hence they must be given adequate training before and on the job to improve upon their characteristics such as communication ability and credibility.
- The innovations to be passed on to the farmers must have good relative advantage and should not be expensive for the farmers to afford.
- Agencies of agricultural development should be very conscious of the existing culture when designing innovation for development.

ACKNOWLEDGEMENTS

The author would like to acknowledge the support and encouragement of Jordan Badia Research and Development Center, grant number 56/97.

REFERENCES

1. Chizari, M., J.R. Lindner and M. Zoghie, 1999. Perceptions of extension agents regarding sustainable agriculture in the khorasan province, Iran. Journal of International Agricultural and Extension Education, 6: 13-21.
2. M.O.A., 2004. Ministry of Agriculture. Report on Status of Women in Jordan. Amman. Jordan.
3. Chizari, M., J.R. Lindner and R. Bashardoost, 1997. Participation of rural women in rice production activities and extension education programs in the Gilan Province, Iran. Journal of International Agricultural and Extension Education, 4: 19-26.
4. Johnson, M.A., 1998. Women's contribution to sustainable agriculture worldwide. A paper presented to sharing the lessons of organic farming University of Guelph, Ontario, Canada.
5. Das, M.D., 1995. Improving the relevance and effectiveness of agricultural extension activities for women farmers. Food and Agriculture Organization of the United Nations, Rome.
6. F.A.O., 1995. Women, agriculture and rural development: A synthesis report of the Near East Region. Rome. Author.
7. F.A.O., 1989. Guidelines on Communication for Rural Development. A Brief for Development Planners and Project Formulators. FAO, Rome.
8. Satio, K. and D. Spurling, 1992. Developing agricultural extension for women farmers. World Bank Discussion Paper No. 156, Washington USA.
9. Rimawi, A., 1996. The private extension systems in Jordan: Issues and Policy Implications. German Technical Cooperation, Ministry of Agriculture, Amman, Jordan.
10. Swanson, B.E., B.J. Farner and R. Bahal, 1990. The current status of agricultural extension worldwide. In: The Report of the global consultation on agricultural extension, FAO, Rome.
11. Abid-Alhamid, A., 1997. Waomen and Rural Development, Center for Agricultural Studies, Institute For Agricultural Studies and Rural Development, Jordan, (Arabic)
12. M.O.A., 2001. Ministry of Agriculture. Report on Status of Women in Jordan. Amman. Jordan.
13. Al-Saraf, R.H., 1996. The Role of Women in Rural Development. Paper presented at the National Conference on Women's Role in Rural Development. Arab Institute for Rural Development, Jordan.
14. Karablieh, E. and M. Salem, 1990. The Impact of Technology on Employment in the Rain- Fed Farming Areas of Irbid District, Jordan. In: Labor, Employment and Agricultural Development in West Asia and North Africa.
15. Himour, K.H., 1994. Women role in rural development in Azrak area. Unpublished M.Sc dissertation, University of Jordan, Jordan.
16. Rousan, L.M., 2005. Women in Agriculture in Jordan. In Women in Agriculture in the Middle East, Ashgate Publishing Limited, Hants, England, pp: 13-46.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 227-230, 2007
ISSN 1818-6769

Effect of Chemical Scarification, Salinity and Preheating on Seed Germination of *Prosopis farcta* (Banks & Soland.) Macbr.

Emad Ali Al-Sherif

Department of Botany, Faculty of Sciences, Beni-Suef 62511, Egypt

Abstract: The effect of chemical scarification, salinity and preheating on the germination of *P. farcta* as a primary step for its propagation in the newly reclaimed lands in Egyptian desert, were studuied. Thermal pretreatment showed no germination without chemical scarification, similar to those of untreated seeds. Moderate salinity, 75 and 100 mM NaCl did not affect the final germination percent, while the high salinity levels (150 and 200 mM NaCl), decreased it by about 30% and 70%, respectively. Germination percentage and the vigour value were increased with increasing time exposure periods of sulphoric acid, it reached 100% after 15 min and 20 min exposure respectively. The present study confirm the ability of *P. farcta* to grow in salt affected soil but its seeds needs scarification.

Key words: *Prosopis* % germination % salinity % scarification % Egypt

INTRODUCTION

The genus *Prosopis* with about 44 species widespread in arid and semiarid regions, Asia, America and Africa [1]. *P. farcta*, an invasive weed, distributed from India to Iran and spread more to the Middle East and occurs in Cyprus, Turkey, Ukraine and along the north African coast as far as Algeria. It is recorded recently that it causes a problem in agriculture in Jordan [2]. On the other hand, species of *Prosopis* are merit candidates for erosion control, stabilizing shifting desert or coastal sand dunes, windbreaks and for shelter belts. Many *Prosopis* species have been included in afforestation programmes and agroforstry-silvopastoral system [3]. Villargra *et al*. [4] recorded that the gradual deterioration of *Prosopis* increase soil erosion, favors desertification processes and reduces ecosystem productivity. Egypt is perhaps the most arid country in North Africa, desert ecosystems covers almost all of Egypt and extends south to Sudan. The desert areas represent more than 97% of the total area [5, 6]. Only one species, *P. farcta* has been cited for the Egyptian flora [7]. Germination and seedling stages are the most critical periods in the life cycle of xerophytes [8, 9]. Salt concentration in soils is an important factor affecting germination [10, 11]. *P. farcta*, present in Beni Suef Governorate-Egypt (along road sides of arable land), characterized by rapidly spreading, due to its easy propagation and remarkable ability to withstand both adverse conditions that reduce the competitiveness of neighboring plants and heavy grazing. Because of the previous character, induced fires by farmers are common to overcome its spreading. So the effect of temperature on seed germination of the studied species will be helpful, to predict the effect of fire on seed germination. No data are available on the economic impact or control of *P. farcta* in Egypt and information on this species in general are very limited worldwide. Therefore, the aim of this work is to study the effect of scarification, salinity and preheating on *P. farcta* germination to understand population dynamics of the species and the management possibilities of it.

MTERIALS AND METHODS

Ripe pods of the leguminous plant *P. farcta* were collected from their natural habitats, Beni Suef Governorate, along road sides of arable land. The chemical and physical soil analysis at the root zone of *P. farcta* are shown in Table 1 [12]. Seeds were removed from pods and stored in opaque paper bags at room temperature. For the germinability tests, the seeds were sown in sterilized Petri dishes on a double layer of filter paper moistened with 5 ml of the treatment solution. Three replicates of 20 seeds were used in each treatment; germination was under conditions of natural light and room temperature (during August 2005). Seeds were

Corresponding Author: Dr. Emad Ali Al-Sherif, Department of Botany, Faculty of Sciences, Beni-Suef 62511, Egypt

considered to be germinated after the radicle emerged from the testa. Germination speed was also calculated. It is a very important parameterfrom the ecological point of view [13]. It may be calculatedby different ways, however, the Vigour Value (V) has been chosen for the present study.It can be calculated using the following formula [14]:

$$V= (a/1 + b/2 + c/3+d/4 +\ldots\ldots\ldots+ x/n) \times 100/S$$

where; a, b, c….., respectively, represent the number of seeds which germinated after 1, 2, 3 days of imbibition, x is the number after n days and S is the total number of germinated seeds. The different treatments were done as follow:

- *Salinity treatment*: The treatment solutions for salinity test were distilled water (control), 75 mM, 100 mM, 150 mM and 200 mM NaCl.

- *Preheating treatment*: Seeds were heated to a range of temperature similar to those registered during wildfires in the upper layer of soil (0-5 cm), where the majority of seed banks are usually concentrated [15, 16], ranged between 50-150°C, with variable heat exposure periods depending on depth and fire intensity. In this study was decided to test the treatment temperatures of 90, 120 and 150°C for duration of 1, 5 and 10 min. The preheating was carried out on dry seeds spread on glass dishes in a muffle furnace and the temperatures were maintained stable within a range of±2°C.

- Scarification methods were applied as follow: (a)-*Chemical scarification*: Seeds were scarified by putting in sulphoric acid (98%) for 5, 10, 15 and 20 min, then washed by running water many times (b)-*Thermal*: seeds were dipped in boiling water until water reached room temperature. Analysis of variance of data was done on an IBM compatible computer programmed and the least significant differences between the mean value were calculated as recommended by Bailey [17].

RESULTS AND DISCUSSION

Results showed no germination in control treatment (without scarification), unlike the finding of El-Keblawy and Al-Rawai [18] for *P. juliflora*, they found a high germination percentage for seeds did not recive any pre-treatment. The studied species, *P. farcta* with hard seeds require external stimuli for promotion the seed- coat rupture as recommended by Vilela & Ravetta [3]. This physical dormancy of the studied species helps it in germination over years. Thermal scarification by boiling water slightly increased germination and vigour value (20 and 9.8%, respectively). Germination percentage and the vigour value were increased with increasing time exposure periods of sulphoric acid, it reached 100% after 15 min and 20 min exposure respectively (Table 2).

Table 1: Some Chemical (a) and physical (b) analysis of soil samples collected from the root zones of *P. farcta*

(a)

Na (mg kg^{-1})	363.40±12.30
K (mg kg^{-1})	1123.20±23.10
P (mg kg^{-1})	5.01±0.01
Zn (mg kg^{-1})	1.50±0.30
Mn (mg kg^{-1})	4.05±0.60
Fe (mg kg^{-1})	22.55±2.10
Cu (mg kg^{-1})	5.81±2.11
Ni (mg kg^{-1})	0.51±0.01
Mo (mg kg^{-1})	Traces
Ca	196.40±2.300
Mg (mg kg^{-1})	677.30±63.100
PH	7.91±3.220
E.C (mS cm^{-1})	0.65±0.010
Organic C%	1.82±0.310
$SO4^{-}$ %	0.022±0.001
Cl^{-} %	0.023±0.001
HCO_3^{-} %	0.061±0.001

(b)

Coarse sand %	Fine sand %	Silt %	Clay %	Soil texture
3.80±0.20	9.70±0.2	38.8±0.6	47.7±3.0	Clay

Table 2: Effect of chemical and thermal scarifications on the germination percent and vigour value of *P. farcta.* (values are mean of five replicates±S.E.)

Scarification time (min.)	Germination %	Vigour value
0	zero	zero
5	40±2.0*	27±2.1
10	90±1.3	52±3.1
15	100±0.0	65±1.6
20	100±0.0	90±1.3
30	100±0.0	90±2.1
Boiling water	20±2.2	9.8±1.1
LSD 5%	20.311	10.041
1%	28.47	14.078

* Mean±SE

Table 3: Effect of salinity (NaCl), after scarification, on germination percent and vigour value of *P. farcta* (values are mean of five replicates±S.E.)

	Control (mM)					LSD (%)	
	0	75	100	150	200	5	1
Germination %	100±0.0	100±0.0	100±0.0	70±2.2	30±3.1	8.176	11.629
Vigour value	90±2.2	75±2.0	65±1.7	38±1.9	20±1.3	9.487	13.494

* Mean±S.E.

Table 4: Effect of temperature on the germination percent and vigour value of *P. farcta* (values are mean of five replicates±S.E.)

Temp. (°C)	90			120			150			LSD	
Exposure time (min)	1	5	10	1	5	10	1	5	10	5%	1%
Germination %	60±1.5*	100±0.0	zero	55±2.3	90±2.4	zero	60±2.3	zero	zero	30.392	41.632
Vigour value	70±1.4	115±1.5	zero	62±3.1	80±2.2	zero	60±1.6	zero	Zero	13.102	17.947

* Mean±S.E.

Germination percentages and vigour values of *P. fartca* were decreased with high salinity levels (150 and 200 mM NaCl), germination percentages were decreased by about 30 and 70%, respectively, while the vigoure values decreased by about 62 and 80%, respectively (Table 3). Moderate salinity, 75 and 100 mM NaCl did not affect the final germination percent but decreased the vigour value by about 25 and 35%, respectively. Thermal pretreatment showed no germination without chemical scarification, similar to those of untreated seeds (Table 4). The different effect of chemical scarification and thermal pretreatment on germination rates may explain as a result of the different effect of this scarification on seed coat structures in species with hard coat seeds. Thanos & Georghiou [19], considered the slow germination of softened seeds by heat as an obvious ecological advantage in the summer-dry and fire-porne Mediterranean climatic conditions. At the same time after chemical scarification there was a total absence of germination recorded during long exposure times (10 min. at all temperature levels and at 5 min at 150°C). This result can be discussed by the fatal effect on embryo, as has been suggested by Tarrega *et al*. [20] for *Cytisus scoporius* and *Genista florida*. According to Kigel [21], extreme fluctuations of diurnal superficial soil temperature occurring in arid environment can break the hardness of seminal coats and allow germination. In nature there are many mechanisms producing the crack of the tegumentary barrier in legumes, as temperature oscillation and the alternance of dry and wet periods [22], bacteria and other microorganism's action and the chemical scarification induced by the herbivore digestive system [23]. Tarrega *et al*. [19], recorded the importance factor generated by wild fires. It can be concluded that seeds of *P. fracta* must be scarified before establishment in the new reclaimed lands and excluded its establishment in saline habitats.

REFERENCES

1. Ortega Baes, P. and M.l. de Viana, Sühring, 2002. Germination in *Prosopis ferox* Seeds: Effects of Mechanical, Chemical and Biological Scarifications. Journal of Arid Environments, 48: 171-184.
2. Qasem, J.R., 2007. Chemical Control of *Prosopis farcta* (Banks and Sol.) Macbride in the Jordan Valley. Crop Protection, 26: 572-575.
3. Vilela, A.E. and D.A. Ravetta, 2001. The Effect of Seed Scarification and Soil-media on Germination, Growth, Storage and Survival of Seedling of Five Species of *Prosopis* L. (Mimosaceae). Journal of Arid Environments, 48: 171-184.
4. Villagra, P.E., R. Villalba and Boninsegra, 2005. Structure and Growth Rate of *Prosopis flexusa* Woodlands in Two Contrasting Environments of the Central Monte desert. Journal of Arid Environments, 60: 187-199.
5. Abdel-Ghaffar, A.S., 1989. Aspects of Microbial Activities and Dinitrogen Fixation in Egyptian Desert Soils. Arid Soil Research and Rehabilitation, 3:281-294.
6. Zahran, M.A. and A.J., Willis, 1992. The Vegetation of Egypt. Chapman and Hall, London.
7. Boulos, L., 1999. Flora of Egypt. Al Hadara Publishing, Cairo, Egypt.
8. Rathcke, B. and E. Lacey, 1985. Phenological Patterns of Terrestrial Plants. Annual Review of Ecology and Systematics, 16: 179-214.

9. Sosebee, R.E. and C. Wan, 1987. Plant EcophysiologyL a Case Study of Honey Mesquite. Contribution No T-9-502.Lubbock: College of Agriculturealk sciences, Texas Tech University, pp: 103-117.
10. Mayer, A.M. and A. Poljakoff-Mayber, 1982. The Germination of Seeds. Oxford: Pergamon Press, pp: 211.
11. Ungar, I.A., 1995. Seed Germination and Seed-Bank Ecology of Halophytes. In: Kigel, J. and G. Galili (Eds.), Seed Development and Germination. Marcel Dekker Inc., New York, pp: 599-629.
12. Al Sherif, E.A., 2002. Effect of some ecological factors on the distribution, growth and nitrogen fixation of wild herb legumes under the prevailing environmental conditions at Beni-Suef Governorate, Ph.D. Thesis, Cairo Univ., Egypt.
13. Thomson, A. J. and Y. A. El-Kassaby, 1993. Interpretation of Seed Germination Parameters. New Forests, 7: 123-132.
14. Bradbeer, J.W., 1988. Seed Dormancy and Germination. Chapman & hall, New York, pp: 146.
15. Bradstock, R.A. and T.D. Auld, 1995. Soil Temperature during Experimental Bushfires in Relation to Fire Intensity: Consequences for Legume Germination and Fire Management in South- Eastern Australia Journal of Applied Ecology, 92: 76-84.
16. Simpson, R.L., M.A. Leck and V.T Parker, 1989. Seed banks: General Concepts and Methodological Issues. In: Leck MA, Thomas VT & Simpson RL (Eds), Ecology of soil seed banks. Academic Press, San Diego, California.
17. Bailey, N.T.J., 1994. Statistical Methods in Biology. 3th Edition, Cambridge University Press, London.
18. El-Keblawy, A.and A. Al-Rawai, 2005. Effects of Salinity, Temperature and Light on Germination of Invasive *Prosopis juliflora* (Sw.) D.C. Journal of Arid Environments, 61: 555-565.
19. Thanos, C.A. and K. Georghiou, 1988. Ecophysiology of Life-Stimulated Seed Germination in *Cistus incanus* subsp. *Creticus* (L.) Heywood and *C. salvifolius* L. plant. Cell and Environment, 11: 841-849.
20. Tarrega, R., L. Calvo and L. Trabaud, 1992. Effect of High Temperature on Seed Germination of Two Woody Leguminoseae. Vegetatio, 102: 139-396.
21. Kiegel, J., 1995. Seed Germination in Arid and Semiarid Regions. In Kiegel & galili G. (Eds.). Seed Development and Germination. New York: Marcel Dekker. New York, pp: 645-699.
22. Roslton, M.P., 1978. Water Impermeable Seed Dormancy. Botanical Reviws, 44: 365-396.
23. Pereiras, J., M.A. Puentes and M. Casal, 1985. Effecto de las Altas Temperatures sobre la Germinacion de las Semillas del tajo (*Ulex europeaus* L.). Studia Oecologica, 6: 125-133.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 231-239, 2007
ISSN 1818-6769

Existing Fisheries Technologies and Approaches for Dissemination in Two Maritime States of Nigeria: Effectiveness and Constraints

A.O.K. Adesehinwa and P.I. Bolorunduro

Livestock and Fisheries Technology Transfer Programme,
National Agricultural Extension and Research Liaison Services, Ahmadu Bello University, Zaria

Abstract: A study was carried out to document available traditional practices and improved technologies in the fisheries sub-sector of two maritime states in Nigeria (Lagos and Rivers states) and the effectiveness of approaches used in information dissemination of such technologies. Structured questionnaire was used through interview schedules to obtain information from respondents in two fishing villages in a local government area of each state. The respondents (consisting of fisher-folks, fish processors and fish farmers) were randomly selected. Secondary information on available improved fisheries technologies and means of dissemination was collected from the Agricultural Development Project (ADP) in each state. Data collected were analyzed using descriptive statistics of frequencies, percentages, means and cross-tabulation. Results obtained showed that subsistence practices characterized the fisheries sub-sector in the two states. Whereas over 70% of fish farmers had less than 0.01ha land holding in Rivers State, about 53% of fish farmers in Lagos state have holdings of pond sizes above 0.5 ha. Poly-culture of different fish species under semi-intensive feeding was common in both states. Hook and line; and use of nets were the major fishing gears used. Dry smoking (by use of kilns and ovens) was the popular method of curing fish products by over 77% of respondents in the two states. Awareness and adoption levels of improved fisheries technologies were generally low among all the respondents. Group contact method was mostly used by the ADPs in information dissemination to 70.6% of respondents in Lagos and 62.5% of respondents in Rivers. While field day was rated as the most popular and most effective (41.2%) strategy used in Lagos, result and method demonstrations were the two major effective strategies (with 62.5 and 55.0% effectiveness ratings) used in Rivers. In the two states, the ADPs were rated by 95.6% of farmers as the foremost agencies in information dissemination and their extension agents as the foremost channels. Constraints to effective dissemination of information on improved technologies include lack of vehicles for field work by extension agencies, high cost of adoption inputs, dilapidating demonstration infrastructures and non release of on-shelf technologies by research institutes. However, prompt release of on-shelf fisheries technologies by Research Institutes, development of sustainable and farmer friendly technologies, empowerment of extension agencies and resuscitation of dilapidated training structures and sites were recommendations proffered to enhance technology adoption by fisher-folks.

Key words: Fisheries technologies % extension approaches % fish farmers % maritime states % Nigeria

INTRODUCTION

Subsistence in the level of operation characterizes most agricultural enterprises in developing countries. This has led to marginal output in all the component sub-sectors. Fisheries as a sub sector of agriculture, is basically operated as a small-scale enterprise by most fisher folks in sub-Saharan Africa. However; this sub sector has the potential of enhanced generation of income and thereby transforming the productivity and output of operators in the sub sector. Indigenous fishermen and processors have their practices in fishing and post-harvest handlings that have been acquired either through tradition or developed by the circumstances of their environment. In most cases; as efficient, as these practices might be, a lot of limitations and shortcomings inherent in the, prevent the realization of maximum benefits for, the level of efforts put into it. Fish protein

Corresponding Author: A.O.K. Adesehinwa, Livestock and Fisheries Technology Transfer Programme, National Agricultural Extension and Research Liaison Services, Ahmadu Bello University, Zaria

contributes significantly to the protein intake of an average Nigerian (25 kg caput/day) [1]. Government has been making efforts in funding research institutions to improve on the efficiency of existing fisheries technologies and also develop new technologies and innovations that can be disseminated by extension agencies to the technologies must be adoptable by fisher-folks and sustainable; leading to enhanced productivity; more availability of fish protein to the populace and better income to fisher-folks. Innovations and recommendations that would be readily adopted by farmers must be cheap to acquire (low cost); simple to handle, operate and maintain; available (in terms of input and spare parts); portable; durable; labour saving; energy efficient and gender friendly [2-4]. The success or likely acceptability of technologies in fisheries by fisher-folks depends on the extent to which the benefit of recommendation is high; the cost of recommendation is low; the benefit is immediate and the recommended practice is simple [5].

Lagos and Rivers States are situated in the Nigerian coastline and the Peasant natives are mostly fisher-folks characterized with subsistence production. The gears and vessels used in fishing; the traditional kilns used in processing and the indigenous packaging materials for marketing the fish products all combine to place limitations on the efficiency of the sub-sector. Notable projects that have been promoted by various administrations in Nigeria to transform the sub sector in times past include the Coastal Artisanal Fisheries Canoe Mechanization Scheme in 1962, Improved Fish Smoking Project in 1963 and the Coastal Artisanal Fisheries Development Project in 1995 [6].

Specifically; various projects have been implanted by the authorities in charge of fisheries development in the two states-Lagos and Rivers. More over the grass root extension agencies in the two states (Rivers State Agricultural Development Programme and Lagos State Agricultural Development Authority) have fisheries as their main focus in agricultural technology transfer to the rural populace in their project areas. This is understandable since fishing is the main occupation among artisans in each. There is therefore a need to document the existing traditional practices improved technologies available in the two states. It is therefore necessary to conduct a study to enable a proper establishment of data bank for fisheries technologies and evaluation of the present approaches for the dissemination of the technologies with possible improvement and re-designing.

The general objective for this work was to document the existing fisher-folks' practices and improved technologies available in the fisheries sub sector of the two states and approaches used by extension agencies in their dissemination. The specific objectives were:

- Identify improved fisheries technologies in the study areas,
- Identify sources of information of the technologies to fisher-folks,
- Assess the effectiveness of approaches used for dissemination of the technologies and
- Identify constraints to effective dissemination by research and extension agencies.

MATERIALS AND METHODS

Lagos and Rivers states were purposively selected for the study in 2003. Rivers state, located in the South-South agro-ecological zone is a maritime state, just like Lagos, which is situated in the Southwest zone of Nigeria. Both states are located within the mandate area of the Nigerian Institute for Oceanography and Marine Research (NIOMR). While Lagos hosts the NIOMR headquarters, Rivers state host an outstation of NIOMR and the African Regional Aquaculture Center (ARAC). This obviously makes the states advantageous in directly benefiting from improved technologies developed by the Institute and other Institutions (especially the Universities around the zones).

Selection of these states was based on their significance in artisanal fisheries production. One fishing village was purposively selected from a Local Government Area known for fishing activities in each state. Forty (40) fisher-folks were randomly selected for interview in each of the chosen villages. Data on available improved technologies and the approaches used for their dissemination were sourced from the records of Agricultural Development Projects (ADP) in the two states. The ADPs assisted in identification of the selected villages and the fisher-folks interviewed for the study.

Secondary data were collected from universities, research institutes and extension agencies in the two states. Data was analyzed using descriptive statistics such as frequencies, percentages and means. Cross tabulation statistics was used to measure the effectiveness of extension approaches.

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents: The socio-economic characteristics of fisher-folks in the two states are presented in Fig. 1-5. The economically active age groups consist of 31-50 years with 57.5% in Lagos and 57.5% in Rivers, with the mean age being 38.0 and 30.0years respectively in the two states (Fig. 1).

Studies have shown that middle age farmers are more inclined to adoption of innovations [7, 8]. Males dominated the fisher-folks population in both states with a proportion of 70% (Fig. 2).

The remaining 30% of the fisher-folks population in both states were women, indicating that fishing and fish farming are not exclusively male occupation. Dominant household sizes in both states were 6-10 members per household (55.0% of respondents in Lagos and 47.5% in Rivers state) (Fig. 3).

Most of the fisher-folks were literate with primary, secondary or tertiary educational attainment (Fig. 4). The implication of this is that adoption of modern technologies can be accelerated, since level of education is known to be influential in the adoption decision of farmers [9]. About 67.5% of the fisher-folks in Lagos state had between 1-10 years fishing business experience, while, only 35% of respondents in Rivers state had same (Fig. 5). On the average, 51.3% of respondents in both states had between 1-10 years fishing business experience. It was also discovered, that even though

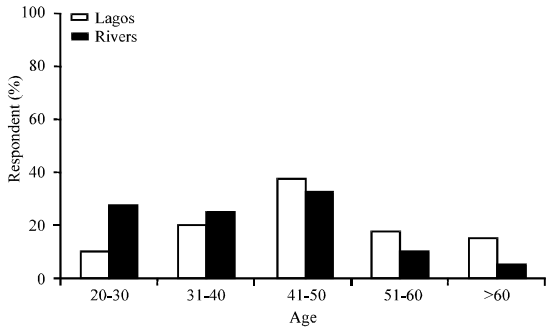

Fig. 1: Age of respondents

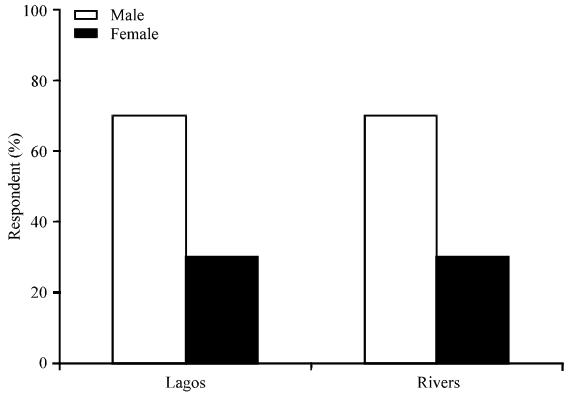

Fig. 2: Sex of respondents

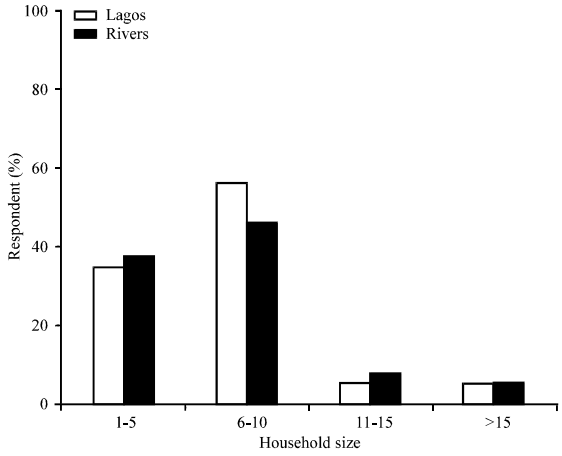

Fig. 3: Household size of respondents

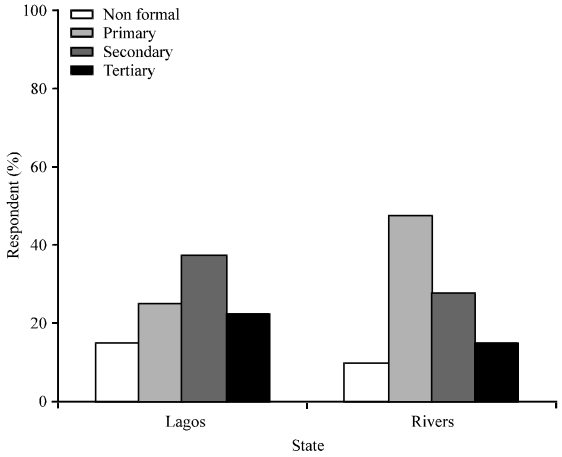

Fig. 4: Highest Education of respondents

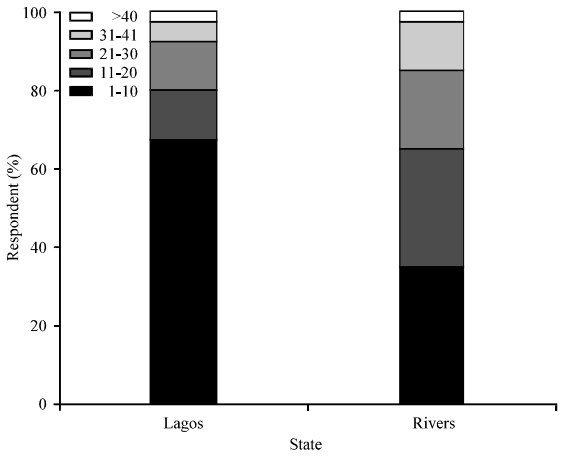

Fig. 5: Years of experience of respondents

57.5 and 62.5% of the fisher-folks in Lagos and Rivers states respectively belong to cooperative societies (with an average of 60% in both states) (Table 1), personal savings (i.e. internally generated fund) was the source of finance for business for majority of them (81.3% of respondents) (Fig. 6). The implication of this is that the fisher-folks would continue to operate at mere subsistence level without adequate credit sources.

Table 1: Membership of cooperative societies

Membership of coop.	Lagos States Freq.	Lagos States %	Rivers States Freq.	Rivers States %	Average (%)
Yes	23	57.5	25	62.5	60.0
No	17	42.5	15	37.5	40.0

Source: Survey, 2003

Table 2: Fish feeding practices of respondents

Feeding practices	Lagos States Freq.	Lagos States %	Rivers States Freq.	Rivers States %	Average (%)
Extensive	5	14.7	3	30.0	22.4
Semi-intensive	15	44.1	7	70.0	57.1
Intensive	14	41.2	-	-	20.6

Source: Survey, 2003

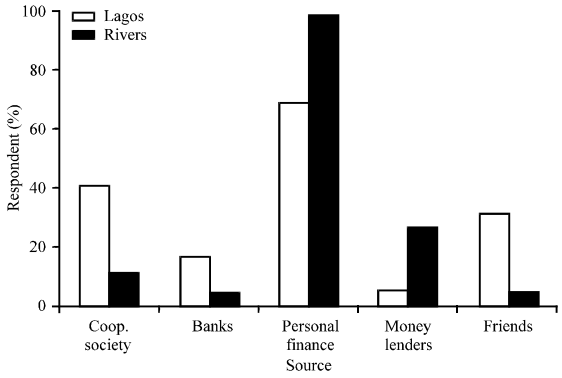

Fig. 6: Sources of credit for Business

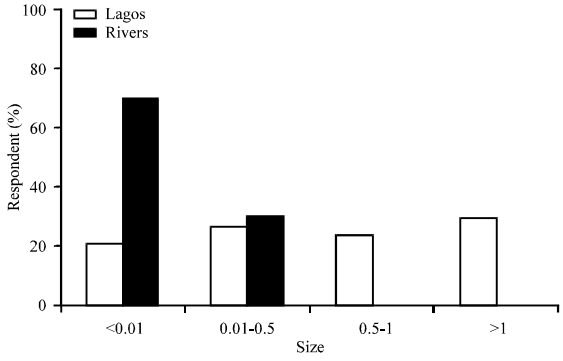

Fig. 7: Size of ponds in Aquaculture practice in Lagos and Rivers states

Traditional practices in aquaculture: Subsistence practices characterized the level of operation of the fish culture of farmers in Rivers state, with small-size fish ponds (<0.01ha) dominating the holdings of 70% (Fig. 7). Poly-culture of different species of fish was common (70%) in the two states (Fig. 8) with semi-intensive system of feeding being the common practice in Rivers state (70%) and to a lesser extent (44% of respondents) in Lagos (Table 2).

The commonly cultured fish species were *Clarias gariepinus*, *Heterotis niloticus*, *Oreochromis niloticus* and to some extent, *Gymnarchus niloticus* in Lagos State with a stocking duration, in most cases 2-3 years. *Clarias* fingerling were stocked at densities ranging from 3000-5000fish per hectare and *Heterotis* at 1000-2500 ha^{-1}. *Gymnarchus* attracted the highest price of 700-800 naira N kg^{-1}, while Tilapia was the least priced (100-180 N kg^{-1} depending on the sizes ($1.00 is approximately N140.00-Nigerian Naira).

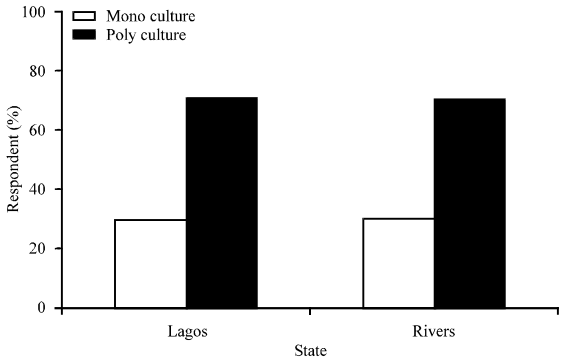

Fig. 8: Culture systems in practice in Lagos and Rivers states

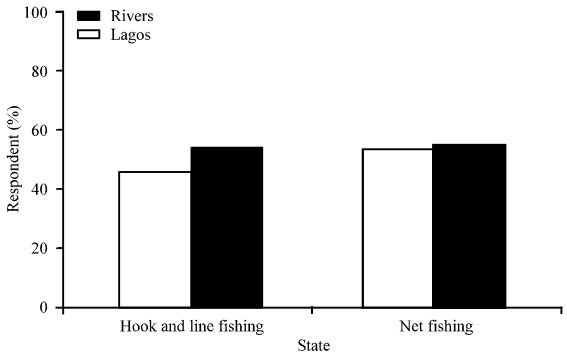

Fig. 9: Respondents distribution by type of Fishing gears

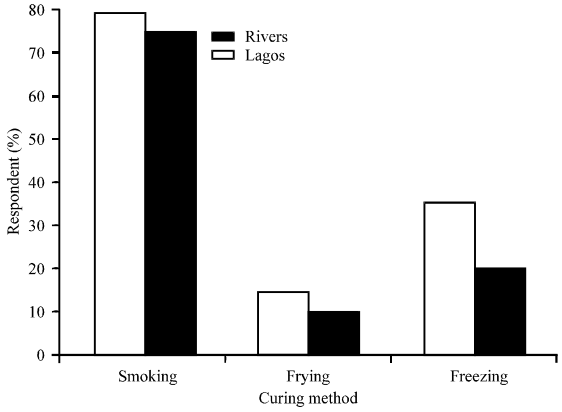

Fig. 10: Post-Havest Curing practices

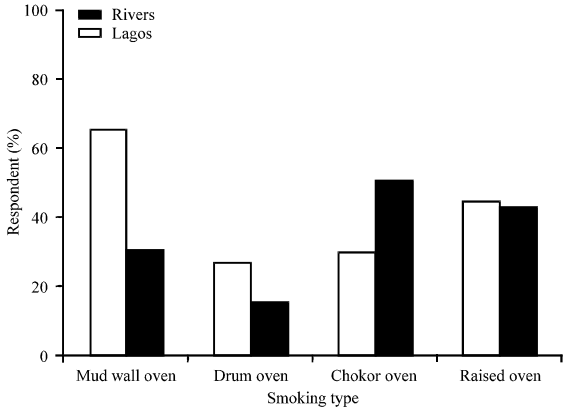

Fig. 11: Smoking methods practiced in the States

Traditional fishing methods and post-harvest practices: The locations of Lagos and Rivers states in the marine environment restrict the fisher-folks to use of nets in fishing and to some extent, hook and line. Nets commonly used include gill nets, cast net, beach seining and drift net. Respondents distribution in the two states by type of fishing gears used are shown in Fig. 9.

Smoking of fish was the most preferred curing method employed by an average of 77.5% of the respondents in the two states surveyed compared to frying and freezing as shown in Fig. 10. The most popular smoking methods include the use of Mud wall oven in Lagos and Chokor oven in Rivers state, while the use of Raised Altar ranked second with an average of 43.3% for both states (Fig. 11).

Methods and approaches for information dissemination: Extension methods used for information dissemination from the respondents view point on production recommendations by extension agencies are through individual contact and group contact methods (Fig. 12).

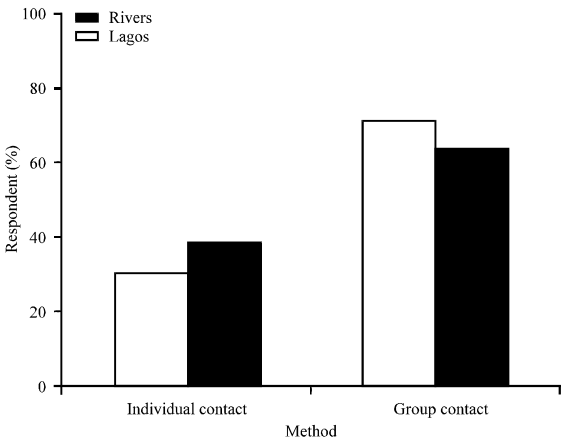

Fig. 12: Extension method used to disseminate information from respondent view point

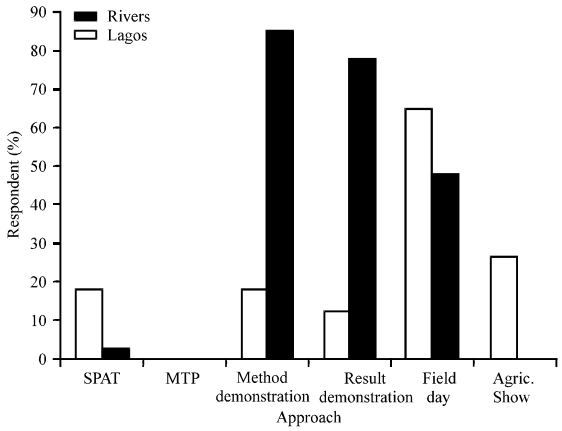

Fig. 13: Extension approaches used to disseminate information from respondent view point

The survey revealed that group contact method was mostly used to disseminate information to fisher-folks in the two states, i.e. 70.6% for Lagos and 62.5% of the respondents in Rivers state, as shown on Fig. 12. Extension approaches/strategies used to enhance farmer's skill in the gradual adoption stage or convince them on the long-term benefits of a technology include the use of Small Plot Adoption Techniques (SPAT), Management Training Plot (MTP), method demonstration, result demonstration, field days and agricultural shows (Fig. 13). According to Adams [10], the choice of extension method will depend on the number of clienteles to be reached, the nature of practices to be taught, characteristics of the method to be used, the stage of adoption of a technology, the competence of extension agents in the use of the method and the cost of procurement (of the method).

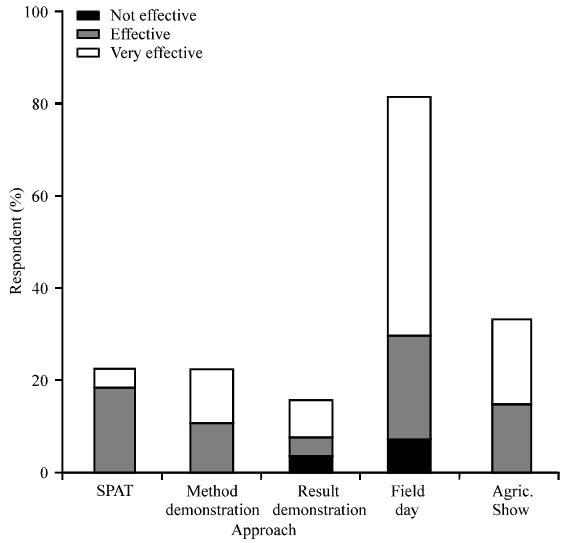

Fig. 14: Percieved effectiveness Assessment of extension approaches by respondent in Lagos state

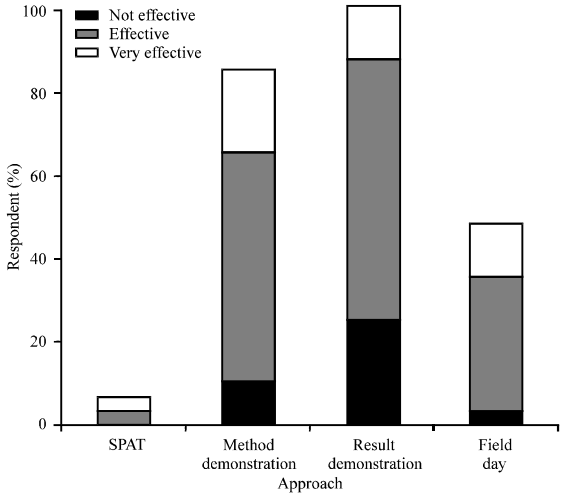

Fig. 15: Percieved effectiveness Assessment of extension approaches by respondent in Rivers state

For strategies used to further create awareness and promote adoption, field day was acclaimed by fisher-folks to be the most popular with 64.7% in Lagos and 47.5% in Rivers state. However, result and method demonstrations were popularly used in Rivers sate with 77.5% and 85% respectively. SPAT application seems to be limited to EAs' contact farmers with only 17.6% in Lagos and 2.5% in Rivers. MTP was completely unknown by fisher-folks in the 2 states. This calls for the availability of fisheries technologies demonstration centers in the two states. Agricultural show seems not to be in popular use in Rivers state perhaps due to costs and logistics.

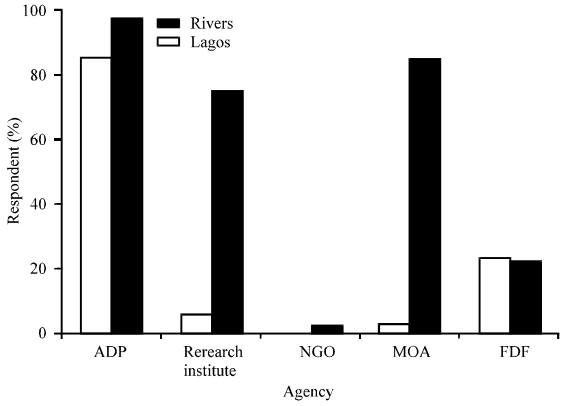

Fig. 16: Agencies of information dissemination on fisheries

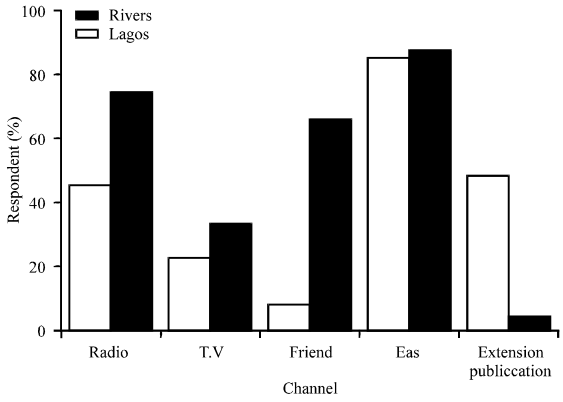

Fig. 17: Channels of information dissemination on fisheries technologies

Effectiveness of extension approaches: The effectiveness of an extension approach as perceived by fisher-folks would determine to a great extent the adoption of production recommendations. The criteria for rating the perceived effectiveness of the approaches were subjective. These were 'not effective', 'effective', or 'very effective'. For SPAT, 14.7% of respondents in Lagos state believed it is effective while the only respondent familiar with it in Rivers state claims it is also effective (Fig. 14 and 15).

Method demonstration had 55% effectiveness rating and 20% very effective rating in Rivers, whereas 62.5% rated result demonstration as effective in the same State. In Lagos, both extension approaches had low ratings. Field day was rated by 17.6% as effective and 41.2% as very effective in Lagos state with 32.5% effective and 12.5% very effective rating in Rivers state. 11.8% and14.7% of respondents in Lagos state considered agricultural show as effective and very effective respectively (Fig. 14 and 15).

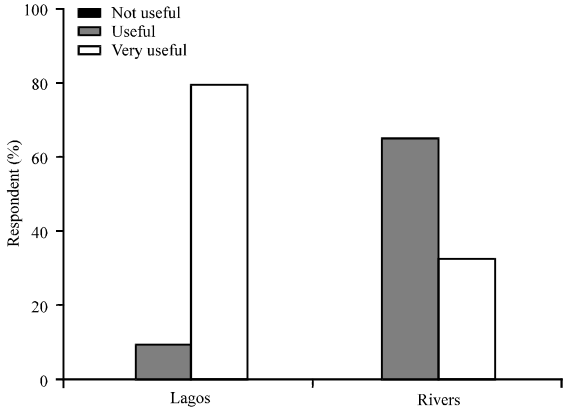

Fig. 18: Assessment of VEAs recommendations by respondents

Agencies and channels for information dissemination: The Agricultural Development Project (ADP) is the major agency for information dissemination in Lagos state as attested to by 85.3% respondents while in Rivers state, the ADP, Research Institute and the Ministry of Agriculture (MOA) were classified as major agencies by 97.5, 75.0 and 85.0% of the respondents respectively (Fig. 16). The extension agents (EAs) were also known by fisher-folks in the two states as their foremost channel of information dissemination, with 91.2% in Lagos and 100% in Rivers state. As well, radio broadcast (82.5%) and information through fellow fisher-folks (75.0%) were also important channels in Rivers state while, Extension publication (52.9%) and radio broadcast (47.1%) were also regarded as additional important channels by respondents in Lagos state (Fig. 17).

The 'contact farmers' approach in the training and visit extension (T & V) is a system of passing recommendations through Village Extension Agents (VEAs) to contact farmers, with the hope that when such farmers adopt the technologies with foreseeable benefits, other farmers will be encouraged to adopt same. In Lagos, 32.4% of the fisher-folks are contact farmers, while Rivers has 40% contact farmers among respondents. Those percentages were considered adequate for effective spread of recommendations among non-contact farmers. Reasonable percentages of non-contact farmers were aware and received production advices from contact farmers in the two states (Table 3).

Majority of the respondent interviewed in Lagos state (79.4%) assessed the recommendations given by the VEAs as very useful while it was rated by majority (65.0%) in Rivers state as just useful (Fig. 18). However, there was evidence of close interaction between the fisher-folks and

Table 3: Assessment of VEAs Recommendation and Fisher-folk Interaction with VEAs and contact farmers

	States				
	Lagos		Rivers		
Assessment of rec.	Freq.	%	Freq.	%	Average (%)
Not useful	-	-	-	-	
Useful	3	8.8	26	65.0	36.9
Very useful	27	79.4	13	32.5	56.0
Interactions					
Aware of VEAs	30	88.2	38	95.0	91.6
Aware of contact farmers	16	47.1	17	42.5	44.8
Contact farmers	11	32.4	16	40.0	36.2
Receive advance from	14	41.2	16	40.0	40.6

Source: Survey, 2003

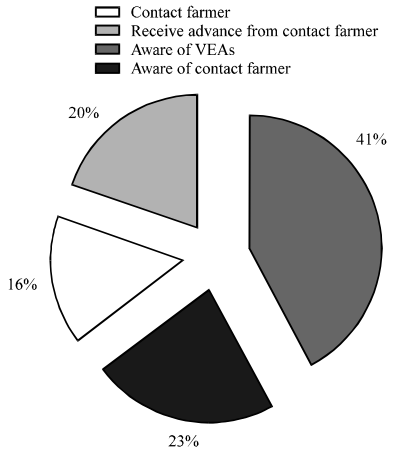

Fig. 19a: Fisher folk interaction with VEAs and contact farmers in Logos

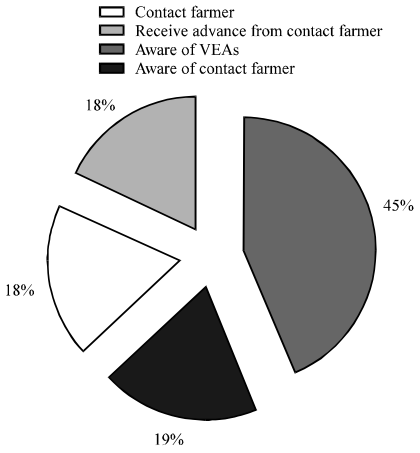

Fig. 19b: Fisher folk interaction with VEAs and contact farmers in Rivers

the VEAs on one hand and the contact farmers on the other, in both states (Fig. 19a and b).

Constraints to effective dissemination of fisheries technologies: From the records of Lagos (11) and Rivers (12) states ADP, the following were major factors affecting efforts at disseminating fisheries technologies.

- Non-availability of relevant research results on fisheries from research institutes.
- Cold attitude of fisher-folks towards disseminated technologies especially due to cost of the technologies and lack of inputs to back up adoption.
- Inadequate research work on extension delivery methods to know lapses and areas needing improvement.
- Lack of reliable field vehicles.
- Lack of field equipments to promote awareness creation like mobile cinema vans
- Lack of technology demonstration centers to serve as venue for MTPs.

CONCLUSION AND RECOMMENDATIONS

The fisheries extension situation in Nigeria is that of a commodity that is gradually being integrated into the farming systems of the farmers. This is particularly the case with Aquaculture. The study has shown that only very few technologies were available on fisheries in the two maritime states studied. This is a reflection of the entire Nigerian scenario. The constraints to effective dissemination of available technologies and recommendations on fisheries need to be given serious attention by policy makers and existing agencies in order to harness the potentials of the fisheries sub-sector as the major source of animal protein for the Nigerian populace. In view of the findings, the following recommended measures would go a long way in promoting the development of the fisheries sub-sector of the Nigerian economy.

Research institutions should be mandated to release most research results on fisheries that are on-shelf. This should pass through the technology release process of on-station trials and farmer's field trials in order to validate such as proven and relevant to the fisher-folks field situation.

Technologies and recommendations meant for fisher-folks consideration and adoption should be sustainable and user friendly. This is in terms of cost of acquisition, ease of maintenance, technical efficiency (especially of ovens), durability, portability and profitability.

Extension agencies should be equipped with functional vehicles and audio-visual materials to aid their dissemination efforts.

Practical technology demonstration plots that have dilapidated in the ADP zones should be resuscitated as this will enhance fisher-folks adoption considerations.

REFERENCES

1. FAO, 1996. Food and Agricultural Organization of the United Nations. Food Requirement and Population Growth. WFS961/TECH/10. Provisional Text FAO, Rome.
2. Baryeh, A.B., E. Ntifo-siaw and E.A. Baryeh, 1999. Transfer of fish preservation technology to women in Ghana. J. Exten. Sys., 817: 16-26.
3. Onyia, A.D., 1998. Extension services in fisheries development. Paper Presented at the 14th Conference of the Fisheries Society of Nigeria. Conference Centre, University of Ibadan.
4. Unamma, R., 1997. Evolution of research extension linkage in Nigeria. Adedipe N.O., J.S. Bakshi and A. Aliyu (Eds.). The Nigerian Agricultural Research Strategy Plan and Extension Delivery. Policy Concept and Consensus to the Year 2010. Proceedings of the Workshop on the National Agricultural Research Strategy Plan and Extension Services Input Delivery. NARP Monograph No. 7: 305-321.
5. Bolorunduro, P.I., 2004. Post-harvest loss assessment and adoption of disseminated technologies in the artisanal fisheries of North-western Nigeria. Ph.D Thesis. Department of Wildlife and Fisheries Management, University of Ibadan, pp: 317.
6. Bolorunduro, P.I., 2001. Strategies for utilizing the potentials of the Nigerian fisheries sub-sector in rural development. Nig. J. Agric. Ext., 131: 95-107.
7. Feder, G., E.J. Richard and D. Zilberman, 1985. Adoption of Agricultural Innovations in Developing Countries: A Survey. In: Economic Development and Cultural Change, Univ. Chicago, USA, 33: 86-90.
8. Bolorunduro, P.I., A.O.K Adesehinwa and J.O. Ayanda, 2005. Adoption levels and factors affecting the adoption of improved fish preservation technologies in North-western Nigeria. Tropicultura, 23: 117-123.
9. CIMMYT, 1993. The Adoption of Agricultural Technology: A Guide for survey design. CIMMYT Economics Programme, Mexico DF, pp: 88.

10. Adams, E.M., 1982. Agricultural Extension in Developing Countries. Intermediate Agriculture Series, pp: 112.
11. LASADA, 1999. Lagos State Agricultural Development Authority. Fisheries Data Collection Report, pp: 41.
12. RSADP, 2003. Rivers State Agricultural Development Programme. Report on the Fisheries Component of Rivers State ADP, pp: 16.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 240-246, 2007
ISSN 1818-6769

Effects of Rootstock on Nutrient Acquisition by Leaf, Kernel and Quality of Pistachio (*Pistacia vera* L.)

V. Tavallali and M. Rahemi

Department of Horticulture, College of Agriculture, Shiraz University, Shiraz, IR of Iran

Abstract: A research was conducted at Pistachio Research Institute in Rafsanjan, Iran, to evaluate the effects of *P. vera* L. 'Badami', *P. vera* L. 'Sarakhs' and *P. mutica* F and M. 'Beneh' rootstocks on mineral content of leaves and kernels of 'Owhadi', 'Kalleh-ghuchi' and 'Ahamd-aghaii' pistachio scion cultivars. Twenty year old trees of these combinations were used during study over 2003 and 2004. Leaves of cultivars grafted on 'Beneh' rootstock had higher K, P, Zn and lower Mg and Na content than other rootstocks. Pistachio cultivars growing on 'Badami' rootstock had higher Ca and lower Zn content in the leaves than other rootstocks. 'Ahmad-aghaii' cultivar grafted on 'Sarakhs' rootstock had higher Cu content than those on other rootstocks. Cultivars growing on 'Sarakhs' rootstock had higher Fe and Cu content than other rootstocks. The kernels of cultivars grafted on 'Sarakhs' rootstock had higher K, P, Mg, Cu, Fe and Zn than other rootstocks. The 'Sarakhs' rootstock gave the highest and 'Beneh' rootstock the lowest protein content in kernels. Type of rootstock had no significant effect on crude fat content of kernel. Crude fat content of the kernels of 'Ahmad-aghaii' was higher than other cultivars. It was concluded that, rootstock selection can be a useful management tool in poor soils.

Key words: Pistachio % rootstock % cultivar % nutrient acquisition % kernel quality

INTRODUCTION

Rootstock selection is one of the most important decisions in orchard management. In Kerman province and other pistachio growing areas in Iran, pistachio cultivars are grown on pistachio seedling rootstocks of different cultivars such as 'Badami Zarand' and 'Ghazvini'. Three wild *Pistacia* species, *P. vera* 'Sarakhs', *P. Khinjuk* Stock and *P. mutica* F and M 'Beneh' are grown in Iran. Native *P. vera* forests are located in north eastern part of Iran particularly in Sarakhs region. This native *P. vera* is the origin of cultivated pistachio trees in Iran [1]. *P. mutica* is a wild species indigenous to Iran, growing with almond, oak and other forest trees common to most Alpine regions [2, 3]. *P. khinjuk* is another wild species indigenous to Iran, growing along with *P. mutica* in Alpine area, low altitudes and warmer areas as well [4]. Native pistachio trees can tolerate temperatures between-20 to 45 °C. The main roots grow vertically through the soil 2 to 6 m or more in depth which allow the plant to absorb water deep in the soil during the periods of drought [1]. Native pistachio cultivar 'Sarakhs' is susceptible to *Phytophthora* spp. [5]. *P. mutica* has been selected as a stock resistant to root-knot nematodes [1] and salinity stress [6]. *P. mutica* and *P. khinjuk* are more susceptible to all *Phytophthora* species than *P. vera* cultivars [1].

Pistachio rootstocks differ significantly in their ability to take up nutrients from the soil. Trees grafted on 'Atlantica' rootstock are less likely to show B, Ca or Zn deficiency than other rootstocks with *P. integerrima* parentage [7]. In another study, pistachio 'Bianca' budded onto eight *in vitro*-propagated clonal rootstocks (*P. atlantica* and *P. integerrima*) and one seedling rootstock (*P. terebinthus*). Results showed that there were no particular significant differences in the foliar concentrations of N, P, Fe, Mn and Zn, whereas there were significant differences among rootstocks for Mg and K. Clone 3 of *P. atlantica* was the most efficient in using Mg and *P. terebinthus* in using K [8].

Chemical composition of pistachio nuts may vary depending upon cultivar, rootstock and maturity at harvest and moisture content. The composition of pistachio kernels of various Iranian cultivars from different response was studied. The amount of constituent in 100g kernel were within the following ranges, oil 55.2-60.5% ; protein 15.0-21.2%; carbohydrate 14.9-17.7%; Na 4.0 mg; K 1048-1142 mg; Ca 120-150 mg;

Corresponding Author: Dr. V. Tavallali, Department of Horticulture, College of Agriculture, Shiraz University, Shiraz, IR of Iran

P 494-514.5 mg; Fe 5.8-11.4 mg; Cu1.0-1.4 mg and Mg 157.5-165.0 mg [9]. In another study, pistachio nuts were collected from large cites in southern parts of turkey. They found 'Owhadi' and 'Halebi' cultivars had the highest K content. 'Halebi' had the highest Mg content. The highest Na was determined in 'Uzun' cultivar. There were significant differences among pistachio nuts regarding fatty acid contents [10].

The use of a given rootstock based on the chemical composition of kernel in pistachio is rare and has not been reported.

The purpose of the present study was to evaluate the influence of rootstock on nutrient acquisition by leaf and kernel and quality of kernel of pistachio cultivars.

MATERIALS AND METHODS

The experiment was conducted in 2003 and 2004 at the Pistachio Research Institute, in a sandy loam, located in Rafsanjan, Iran. The physical and chemical characteristics of the soil were clay 12%, silt 15% and sand 73%, pH 8.1, electrical conductivity (Ec_e) 5.5 ds mG^1, N 1-0.2% P_2O_5 9ppm and K_2O 604 ppm. The 20 to 25 year old commercial cultivars, 'Kalleh-ghuchi' 'Owhadi' and 'Ahmad-aghai' were grafted on a variety of rootstock cultivars. Three rootstock were used including: *P. Vera* L. 'Badami', *P. vera* L. 'Sarakhs' and *P. mutica* F and M 'Beneh'. Trees were trained with an open-center system and distance of trees were 4×7 m. A split plot experiment was used in a randomized complete block design with 3 replications. The 3 commercial cultivars (scion) were assigned to main plot and the 3 rootstocks were assigned to subplot within each main plot.

Minerals determination: In both years of study, from six trees of each cultivar per rootstock, samples of 10 leaflets from the mid-section of current year shoots and 400 mature fruits were collected. Leaflets were washed with mild detergent and then rinsed with distilled water, dried in a forced air drying oven at 70°C to constant weight. Leaf tissue was then ground to pass a 40 mesh screen. One g of dried ground leaf sample dry ash at 550°C for 5 h. The ash was then dissolved in 5 ml of 20% HCl. These samples were analyzed for P, K, Mg Ca, Fe, Zn and Cu by atomic absorption spectrophotometer [11].

The pericarp of fruits were removed and kernels were dried in a forced air oven at 70°C for 24 h. Mineral contents of kernels were determined as described for leaf tissues.

Kernel quality: For determination of protein content, nitrogen was determined in 0.5 g dried kernels using the micro-Kjeldahl technique as described by Tandon [11]. The protein was calculated by using the factor of N×6.25.

Samples of dried kernel used for crude fat determination, were ground to a fine powder and the crude fats extracted with ether in a Soxhlet-type extractor. The percentage of ether-extractable fat was determined according to Horwitz [12].

Data analysis: Combined data of two years (2003 and 2004) for mineral contents of leaf and kernel, percentage of kernel protein and crude fat were analyzed using SAS statistical software. Treatment means were compared using least significant differences (LSD, p = 0.05). Excel software was used for regression analysis.

RESULTS

Mineral contents of leaf and kernel: The utilization of several different combinations of scion/rootstock allow us to evaluate the nutrient efficiency of the various rootstocks. In the following, rootstocks responses are discussed in relation to each nutrient.

Phosphorous (P): Significant differences in P content of scion leaves were observed (Table 1). Cultivars grafted on 'Beneh' had higher P content than other rootstocks. 'Beneh' was the most effective rootstock in uptaking P in comparison with other rootstocks and it was significantly different at p = 0.05 (Table 1). Though P deficiency has not been identified in the cultivars, but P concentration in the leaves of 'Kalleh-ghuchi' cultivar was lower than other cultivars.

The Kernels of scion cultivars grafted on 'Sarakhs' rootstock had higher P content than other rootstocks (Table 2). 'Owhadi' fruits had higher kernel P concentration than other cultivars (Table 2).

Potassium (K): Cultivars grafted on 'Beneh' rootstock had higher K concentration in their leaves than other rootstocks (Table 1). The effect of rootstocks on uptaking K were highly significant at p = 0.05. 'Beneh' was the most effective rootstock followed by 'Badami' and 'Sarakhs' (Table 2). 'Kalleh-ghuchi' cultivar growing on three rootstocks had lower but 'Ahamd-aghiai' growing on these rootstocks showed higher K content in leaves (Table 1).

The kernels of cultivars grafted on 'Sarakhs' rootstock had significantly higher K content than other

Table 1: Effects of rootstock on micro and macro nutrients of leaves of three cultivars (Combined data of 2 years 2003 and 2004)

Rootstock	Zn	Fe	Cu	Na	K	P	Mg	Ca
'Ahmad-aghaii'(Scion)								
'Badami'	6.56c*	97.86b	7.20b	0.059b	2.13b	0.153b	1.52a	5.44a
'Sarakhs'	8.32b	128.58a	11.90a	0.083a	1.93b	0.161b	1.09b	4.03b
'Beneh'	11.49a	118.52ab	8.95b	0.031c	2.69a	0.191a	0.64c	4.47ab
'Kalleh-ghouchi'(Scion)								
'Badami'	8.92a	118.75a	5.63a	0.040b	1.74b	0.136b	1.72a	5.62a
'Sarakhs'	8.28a	133.64a	7.19a	0.064a	1.28c	0.138b	1.25b	3.95b
'Beneh'	8.95a	89.75b	4.71a	0.016c	2.20a	0.171a	0.83c	3.55b
'Owhadi'(Scion)								
'Badami'	6.56b	89.17a	4.23a	0.062a	1.72b	0.153b	1.18a	4.88a
'Sarakhs'	7.61b	101.93a	4.22a	0.069a	1.51b	0.146b	1.09ab	3.15b
'Beneh'	10.62a	89.16a	4.22a	0.008b	2.06a	0.193a	0.90b	3.39b

*Mean separation in each column by LSD at 5% level, Micro nutrient: mg/1000 g leaf, Macro nutrient: g/100 g leaf

Table 2: Effects of rootstock on micro and macro nutrients of kernels of three cultivars (Combined data of 2 years 2003 and 2004)

Rootstock	Zn	Fe	Cu	K	P	Mg	Ca
'Ahmad-aghaii'(Scion)							
'Badami'	10.79b*	7.29b	3.43b	0.54b	0.11c	0.25b	0.67b
'Sarakhs'	22.91a	17.07a	7.98a	1.05a	0.38a	0.73a	1.31a
'Beneh'	15.49ab	9.54b	4.34b	0.66b	0.22b	0.34b	0.39b
'Kalleh-ghouchi'(Scion)							
'Badami'	12.19ab	10.44ab	4.73b	0.71b	0.17b	0.32b	0.59b
'Sarakhs'	20.02a	14.00a	7.41a	1.11a	0.32a	0.70a	1.28a
'Beneh'	8.34b	7.29b	2.49c	0.70b	0.14b	0.25b	0.67b
'Owhadi'(Scion)							
'Badami'	12.33b	8.34b	3.01b	0.70b	0.15b	0.24c	0.81b
'Sarakhs'	35.82a	25.89a	9.97a	1.33a	0.46a	0.82a	1.27a
'Beneh'	14.64b	9.04b	4.14b	0.71b	0.20b	0.45b	0.64b

*Mean separation in each column by LSD at 5% level, Micro nutrient: mg/1000 g kernel, Macro nutrient: g/100 g kernel

rootstocks (Table 2), Therefore, rootstock had significant effect on kernel K content.

Magnesium (Mg): Significant differences in Mg concentration of scion leaves were observed (Table 1). Cultivars growing on 'Beneh' had lower Mg content than other growing on 'Sarakhs' and 'Badami' rootstocks. Cultivars growing on 'Badami' had higher Mg content than other rootstocks and it was significant at p = 0.05 (Table 1). The rootstock 'Beneh' had the lowest and the rootstock 'Badami' had the highest Mg uptake in this study (Table 1).

There was significant effect of rootstock on concentration of kernel. 'Sarakhs' rootstock significantly increased concentration of Mg in the kernels of scion cultivars (Table 2).

Calcium (Ca): Significant differences in Ca content of scion leaves were observed (Table 1). Pistachio cultivars growing on 'Badami' rootstock had higher Ca content in leaves than other rootstocks (Table 1). The rootstock 'Badami' took up more Ca than other rootstocks and this effect was significant at p = 0.05 (Table 1).

The concentration of Ca in kernel significantly was affected by rootstock. The rootstock 'Sarakhs' significantly increased Ca content of kernels of cultivars than other rootstocks (Table 2).

Sodium (Na): Cultivars growing on 'Beneh' rootstock had lower Na content in leaves than other rootstocks and this effect was highly significant at p = 0.05 (Table 1). Leaves of 'Kalleh-ghuchi' cultivar in comparison with other cultivars had lower Na content (Table 1).

Table 3: Effects of rootstock on protein % and fat % of kernel of three pistachio cultivars. (Combined data of 2 years 2003 and 2004)

	'Ahmad-aghaii'(Scion)		'Kalleh-ghouchi'(Scion)		'Owhadi'(Scion)	
Rootstock	% protein	% fat	% protein	% fat	% protein	% fat
'Badami'	19.50b	63.91a	21.85ab	56.25a	21.41b	55.02b
'Sarakhs'	27.51a	64.16a	26.63a	58.81a	28.74a	62.06a
'Beneh'	20.06b	64.24a	19.97b	58.01a	18.30b	59.76ab

*Mean separation in each column by LSD at 5% level

Copper (Cu): our data showed that 'Ahmad-aghai' cultivar had higher Cu content than other cultivars. Leaves of this cultivar are growing on 'Sarakhs' rootstock had higher Cu content than other rootstocks. The rootstock 'Badami' took up lower Cu than other rootstocks (Table 1).

The rootstock 'Sarakhs' significantly increased Cu content of kernels. Kernels of 'Owhadi' cultivar was grafted on 'Sarakhs' rootstock took up more Cu than other rootstocks (Table 2).

Iron (Fe): Leaves of 'Ahmad-aghai' and 'Kaleh-ghuchi' had lower Fe content than 'Owhadi' cultivar (Table 1). Cultivars growing on 'Sarakhs' rootstock had higher Fe content than other rootstocks (Table 1).

The rootstock 'Sarakhs' was found to be efficient in increasing Fe content of kernels of cultivars (Table 2). Kernels of 'Owhadi' cultivar is growing on 'Sarakhs' rootstock had higher Fe content than other cultivars.

Zinc (Zn): Our data showed that Zn content of leaves of cultivars of 'Ahamd-aghaii' and 'Owhadi' growing on 'Beneh' rootstock significantly was higher than other rootstocks (Table 1). Leaves of cultivars grafted on 'Badami' rootstock had lower Zn concentration than other rootstocks.

The kernels of cultivars growing on 'Sarakhs' rootstock had higher Zn content than other rootstocks and this effect was significant at $p = 0.05$ (Table 2). Kernels of 'Owhadi' cultivar was grafted on 'Sarakhs' rootstock had the highest Zn content. Cultivars growing on 'Badami' rootstock had the lowest Zn content in kernels (Table 2).

Protein and crude fat: The present study showed that type of pistachio rootstock has significant effect on protein and crude fat content of kernels. The rootstock 'Sarakhs' gave the highest and 'Beneh' rootstock the lowest protein content in kernels (Table 3). Crude fat of the kernels was not significantly affected by rootstock (Table 3). However, the kernels of 'Owhadi' cultivar grafted on 'Sarakhs' in comparison with 'Badami' rootstock had significantly higher crude fat content. Crude fat of kernels was between 63.91 to 64.22%, 56.25 to 58.81% and 55 to 62% in 'Ahmad-aghai', 'Kelleh-ghuchi' and 'Owhadi', respectively (Table 3).

DISCUSSION

According to the extensive pistachio growing in Iran, soil salinity is a serious problem and deficiencies of micronutrients are widespread. Soils in which pistachio is grown is characterized by high pH, carbonate content and low organic matter. In these soils, deficiencies of Zn, Fe and Cu, can become severe, resulting in the development of delayed bud break, impaired growth and meristematic regions and significant yield loss [13]. Because of high complexing capacity of the leaf waxes in pistachio, the crop is notoriously inefficient at the absorption of foliar applied micronutrients [14]. Research on multiple scion-rootstock combinations has shown that the effect of salinity on growth and yield is usually determined more by rootstock than by the scion [15, 16]. Like citrus rootstocks, pistachio rootstock species differ greatly in their water relations and their ability to transport mineral nutrients [17]. The importance of the rootstock in regulating plant water relation and transport was discussed by Sinclair [18], who noted that trees on rough lemon and *P. trifoliate* had higher transpiration rates than those on 'Cleopatra' mandarin and sour orange rootstock. Therefore, water relations and mineral nutrients uptake and transport could also be altered in rootstock × scion combinations, in both normal and saline condition [17]. The rootstock 'Sarakhs' was found the most effective in terms of enhancing leaf concentration for the Cu and Fe nutrients. The nutritional efficiency of this rootstock was constant during this study for all scion cultivars.

Specific mechanism may exist for Cu and Fe uptake similar to those reported by Zhang *et al*. [19]. Idem and Gezerel [20] reported that *P. vera* L. cv Siirt and *P. Khinjuk* seedling took up more Fe and Cu than other rootstocks. They found also more micronutrients Fe and

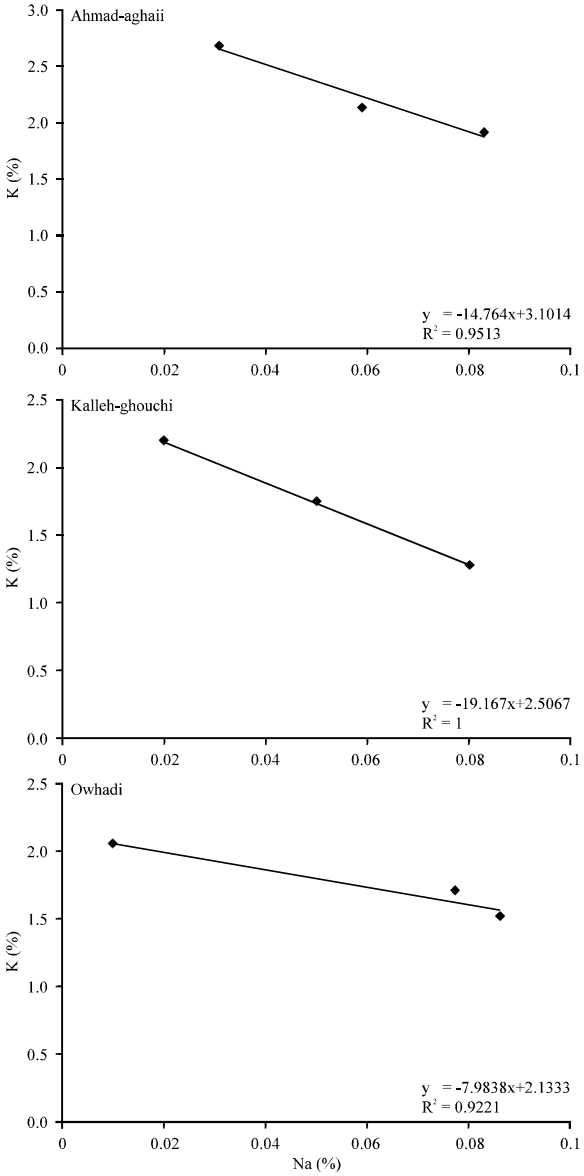

Fig. 1: Relationship between K and Na% in leaves of pistachio cultivars on three rootstocks

Cu in stems than leaves. The threshold Zn level of pistachio leaves for deficiency appears to be 7-25 ppm in mid summer [21]. In this study the Zn concentration in leaves of 3 cultivars grafted on 'Beneh' rootstock was between 9-11 ppm. The concentration of Cu in leaves of 3 cultivars grafted on 3 rootstocks was not below the threshold level, therefore, no deficiencies of Zn and Cu were observed in this study [21]. The rootstock 'Beneh' was found to be a very efficient rootstock for alkaline and dry soil [6]. The low concentration of Na in the leaves of cultivars on 'Beneh' rootstock suggests that the mechanism of Na exclusion by rootstock is similar to that of *Poncirus trifoliata* (a citrus relative) which restricts Na transport to shoots by retaining it in the main root and basal stem [22]. We did not harvest basal stem separately from the remaining stem and hence it is difficult to assess whether there was any significant accumulation of Na in the basal stem of cultivars on different rootstocks. Walker *et al.* [23] showed that *P. vera* appears to be a better Na excluder than *P. atlantica*, which in turn appears to be better than *P. terebinthus*. The leaf Zn content of the cultivars grafted on it was high. The rootstock 'Beneh' was found to be efficient in absorption lower Na and higher K than other rootstocks. Also, the correlation between K and Na was highly significant ('Ahmad-aghai' r = 0.97, 'Kalleh-ghuchii' r = 1, 'Owhadi' r = 0.96), (Fig. 1). Walker *et al.* [23] suggest that rates of uptake and root to shoot transport of K were at most only marginally different between the species of *P atlantica* and *P. vera*. On the other hand, the ratio of Na:K in leaves and stems was markedly different between these rootstocks. Therefore the deficiencies of Fe, Zn and Cu were not observed in this study [21]. Precise critical nutrient values for pistachio have not been established in Iran, but according to the mineral elements ranges in pistachio leaves exhibiting normal growth [21], the P and Mg levels in the leaves of cultivars grafted on 3 rootstocks were below the threshold level. As the pH of the soil was 8.1, the level of Ca in the leaves of cultivars was higher than the threshold level.

Pistachio nut is rich in protein, fat and minerals and is an excellent source of P, K, Mg, Ca and Fe [7]. There are a few reports dealing with chemical composition in relation to cultivar and stage of maturation. However, no detailed study has so far been reported about the effect of rootstock on chemical composition of the pistachio. These results confirm that rootstocks can have an important effect on kernel quality of pistachio. Mineral contents of pistachio kernels were highly affected by 'Sarakhs' rootstock. This rootstock significantly increased K, P, Mg, Ca, Zn, Fe and Cu contents of pistachio kernels. The present study also showed that 'Ahmad-aghai' can produce kernels with higher macro and micro nutrients content. The present study also indicated that cultivar and rootstock selection is important in pistachio production. Chloride accumulation in shoots is rootstock-dependent [24]. Salinity can affect on root and leaf K, Ca and Mg concentrations. Reductions in these nutrients in roots and leaves with increasing salinity have been observed in *Citrus* [25]. Trees with one or two grafts (rootstock/scion) have higher Cl exclusion than

non-grafted trees and can improve Ca, K and Mg absorption. High root and leaf Ca and K concentrations ameliorate the negative effect of salinity on root, shoot and fruit growth [26]. Crude fat of pistachio is the main constituents of pistachio, generally exceeding 55% in Iranian origin (based of dry weight), [9]. In the present study, it was found that type of rootstocks increased crude fat of kernel up to 64% in kernel. 'Sarakhs' had better performance in increasing crude fat in Kernel. Our data are in agreement with finding on almond [27]. Protein content ranges form 15 to 19% in Iranian pistachio origin [9]. Our data showed that protein content in kernel was between 19 to 27%. The kernel of 'Owhadi' grafted on 'Sarakhs' increased protein content up to 28.74%. Pistachio kernels with the highest oil content were found to be the highest in protein too. This data is not in agreement with those reported by Schirra [27] on almond.

CONCLUSIONS

These data show that type of rootstock has an important effect on mineral content of leaves and kernels in pistachio. Positive effects of rootstocks were found in increasing crude fat and protein contents of kernels.

REFERENCES

1. Sheibani, A., 1987. Characteristics of Iranian pistachio varieties. Iranian Pomology Seminar. Seed and Plant Improvement Institute. Rafsanjan, Iran.
2. Zohary, M., 1952. A monographic study of the genous *Pistacia*. Palestine J. Bot. Jerusalem Series, 5: 187-228.
3. Tabatabaee, M., 1966. Pistachio and its Importace in Iran. Forest Service, Ministry of Agriculture, Tehran, Iran.
4. Sheibani, A., 1995. Distribution, use and conservation of pistachio in Iran. In: Padulosi, S., T. Caruso and E. Barone (Eds.). Taxonomy, distribution, conservation and uses of *Pistacia* genetic resources. Palermo, Italy, pp: 51-56.
5. Banihashemi, Z., 1998. Assessment of *Pistacia* rootstocks to phytophthora spp. The cousal agent of pistachio. Iran J. Plant Pathol., 34: 213-224.
6. Rahemi, M. and M. Heidary, 2002. Growth and chemical composition of pistachio rootstocks in response of growth regulators under saline condition. Acta Hortic., 591: 333-340.
7. Ferguson, L., 1995. Pistachio production. Center of Fruit and Nut Crop Research and Information. University of California at Davis. Department of Pomology, 2037 Wickson Hall. Davis, CA95616 USA, pp: 160.
8. Barone, E., F. Sottile, E. Palazzolo and T. Caruso, 1997. Effect of rootstock on trunk growth and foliar mineral content in cv. 'Bianca' pistachio (*Pistacia vera* L.) trees. Acta Horticulturae, 470: 394-401.
9. Kamangar, T. and H. Farsam, 1977. Composition of pistachio kernels of various Iranian origins. J. Food Sci., 42: 1135-1136.
10. Kucukoner, E. and B. Yurt, 2003. Some chemical characteristics of *Pistacia vera* varieties produced in Turkey. Eur. Food Res. Technol., 217: 308-310.
11. Tandon, H.L.S., 1998. Methods of analysis of soil, plants, waters and fertilizers. Fertilizer Development and Consultation Organisation 204-204A Bhanot Corner, 1-2 Pamposh Enclave New Delhi-10048 (India), pp: 49-82.
12. Horwitz, W., 2000. Official Methods of Analysis of the AOAC. 17th Edn. AOAC. International. MD, USA. 49: 1-28.
13. Brown, P. M., Q.L. Zhang and L. Ferguson, 1994. Influence of rootstock on nutrient acquisition by pistachio. J. Plant Nutr., 17: 1137-1148.
14. Brown, P.M., G. Picchioni, R. Beede and R. Teranishi, 1991. Foliar nutrition of pistachio. Annaual Report of the California Pistachio Commition, Fresno, CA.
15. Nieves, M., A. Garcia and A. Cerda, 1991. Effects of salinity and rootstocks on lemon fruit quality. J. Hortic. Sci., 66: 127-130.
16. Garcia-Legaz, M.F., A. Garcia-Lidon, I. Porras-Castillo and L.M. Ortiz-Marcide, 1992. Behavior of different scion/rootstock combinations of lemons (*C. limon* (L.) Burm.F.) against Cl and Na ions. In: Proceeding of International Society Citriculture, Acireale, Italy, pp: 397-399.
17. Syvertsen, J.P. and J.H. Graham, 1985. Hydraulic conductivity of roots, mineral nutrition and leaf gas exchange of citrus rootstocks. J. Am. Soc. Hortic. Sci., 110: 865-869.
18. Sinclair, W.B., 1984. The biochemistry and physiology of the lemon and other citrus fruits. University of California, Division of Agriculture and Natural Resources.
19. Zhang, F., V. Rohmheld and N. Marschner, 1991. Release of Zink mobilizing root exudates in different plant species as affected by zinc nutritional status. J. Plant Nutr., 14: 675-686.

20. Idem, G. and O. Gezerel, 1995. The effect of sampling time, type of seedling and organs on the content of mineral elements and reducing sugar form in *Pistacia* seedling. Acta Hortic., 419: 323-327.
21. Uriu, K. and J.C. Crane, 1976. Mineral element changes in pistachio leaves. J. Am. Soc. Hort. Sci., 102: 155-158.
22. Walker, R.R., 1986. Sodium exclusion and potassium-sodium selectively in salt-treated trifoliate orange (*Poncirus trifoliate*) and Cleopatra mandarin (*Citrus reticulate*) plants. Aust. J. Plant Physiol., 13: 293-303.
23. Walker, R.R., E. Torokfalvy and M.H. Behboudian, 1987. Uptake and distribution of chloride, sodium and potassium ions and growth of salt-treated pistachio plants. Aust. J. Agric. Res., 38: 383-394.
24. Behboudian, M.H., E. Torokfalvy and R.R. Walker, 1986. Effects of salinity on ionic content, water relations and gas exchange parameters in some citrus scion-rootstock combinations. Scientia Horticulturae, 28: 105-116.
25. Garcia-Sanchez, F., J. Jifon, M. Carvajal and J.P. Syvertsen, 2002. Gas exchange, chlorophyll and nutrient contents in relation to Na and Cl accumulation in 'Sunburst' mandarin grafted on different rootstock. Plant Science, 162: 705-712.
26. Kent, L.M. and A. Lauchli, 1985. Germination and seedling growth of cotton: salinity-calcium interactions. Plant, Cell and Environment, 8: 155-159.
27. Schirra, M., 1997. Postharvest technology and utilization of almonds. Hortic. Rev., 20: 267-311.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 247-254, 2007
ISSN 1818-6769

Observations of Arbuscular Mycorrhizas on Dipterocarpaceae Grown in Tropical Rainforest in China

[1]Zhao Yong Shi, [1]Fa Yuan Wang, [2]Yan Li Wei and [3]Ying Long Chen

[1]Department of Resources and Environmental Science, College of Agriculture,
Henan University of Science and Technology, Luoyang, Henan Province, 471003, P.R. China
[2]Institute of Biology, Shandong Academy of Sciences, Key Laboratory of Applied
Microbiology of Shandong Province, Jinan, Shandong Province, 250014, P.R. China
[3]School of Earth and Geographic Sciences (M087), Faculty of Natural and Agricultural Sciences,
The University of Western Australia, Perth, WA 6009, Australia

Abstract: The mycorrhizal colonization patterns, fungal spore density, species richness, occurrence frequency and relative abundance of arbuscular mycorrhizal (AM) fungi in the rhizosphere of Dipterocarpaceae plants grown in tropic rainforest in south China were investigated. Twenty-one Dipterocarpaceae species in 54 sites of 11 regions were involved in Yunnan Province and Hainan Island, China. Arbuscular mycorrhizal typical structures were observed for the first time in roots of *Parashorea chinesis* Wang Hsie, *Vatica astrotricha* Hance, *Dipterocarpus turbinatus* Gaertn.f., *Hopea exalata* Lin, Yang et Hsue, *Shorea assamica* Dyer, *S. robusta* Gaertn. and *H. hainanensis* Merr. et Chun. Sixty-four AM fungal species belonging to 7 genera were identified. Species richness and spore density of AM fungi varied from 1.43 to 5.04 and from 3.05 to 8.26 per 20 ml rhizospheric soil, respectively. *Glomus* and *Acaulospora*, *Glomus etunicatum* Becker and Gerd., *G. claroideum* Schenck and Smith, *G. dolichosporum* Zhang and Wang, *G. macrocarpum* Gerd. and Trappe, *Acaulospora spinosa* Walker and Trappe and *A. denticulata* Sieverding and Toro were dominant genera and species, respectively in the rhizosphere of Dipterocarpaceae in tropic rainforest of China.

Key words: Arbuscular mycorrhizal fungi % Dipterocarpaceae % spore density % species richness % relative abundance

INTRODUCTION

As the symbol of tropical rain forest, trees of the Dipterocarpaceae family are the most ecologically and economically important resource in tropical forest. Besides being the main source of very valuable tropical hardwood timber much in demand throughout the world, members of the Dipterocarpaceae also yield various other minor products such as resin and gums. At present, there are about 16 genera (520 species) in this family which distribute mainly in tropical Asia [1]. South China is the north edge of the distribution of Dipterocarpaceae. There are 13 species in 5 genera native to China and they are geographically distributed in southeastern Tibet, southern Yunnan, southern Guangxi and Hainan Island [2]. Presently, 29 species of this family have been planted and maintained in tropical China thanks to the national reservation and introduction programs. However, most of these species, including exotic trees, are endangered in China and attention has been raised for their sustainable development by the governments.

Arbuscular mycorrhizas evolved concurrently with the first colonization of land by plants some 450–500 million years ago and persist in most extant plant taxa [3]. Arbuscular mycorrhizas associations are the most widespread amongst the extant flora, occurring in the roots of most angiosperms and pteridophytes, along with some gymnosperms and the gametophytes of some lower plants like mosses and lycopods [4]. In recent years, there has been increasing interest in the arbuscular mycorrhizae of tropical rain forest plants [5-10]. For a long time, Dipterocarpaceae is believed to be ectomycorrhizal species [11-14]. Only a few reports have been published on the arbuscular mycorrhizal (AM) status of *Hopea odorata* [15], *Dipterocarpus macrocarpus* [16] and other 3 *Shorea* species [6]. Unfortunately, little has been known on the mycorrhizal status of Dipterocarpaceae in China [17]. Based on a broad field survey conducted in tropical Yunnan Province (Southwest of China) and Hainan Island (South of China), this paper presents the results on the AM status of 21 Diptericarpaceae tree species in these regions.

Corresponding Author: Dr. Zhao Yong Shi, Department of Resources and Environmental Science, College of Agriculture, Henan University of Science and Technology, Luoyang, Henan Province, 471003, P.R. China

MATERIALS AND METHODS

Site location: This study was conducted at 11 locations within the tropical Yunnan Province and the whole Hainan Island of China. Hainan Island lies in the climate zones of the tropical monsoon and the tropical ocean, with annual mean temperature of 22-26°C, annual rainfall at 1,600mm and annual mean sea water temperature at 27°C. Yunnan Province is located in the southwest boundary of China, between 20°8'32"-29°15'8"N and 97°31'39"-106°11'47"E. The south part of Yunnan Province is on the belt of the Tropic of Cancer, which is dominated by a tropical rainforest climate with the average temperature of 21°C.

Collection of soil and root samples: Soil and root samples were colleted according to the procedures described by Liu and Li [18]. Twenty-one Dipterocarpaceae species were involved from 54 sites in 11 locations (Table 1). Six soil samples with fine roots were randomly collected from the plant rhizosphere per tree species. Care was taken during collection of individual plants that roots could be positively identified as belonging to a particular plant. To make sure that the roots were connected to the sampled plants, root samples of host plants were usually traced back to the stem. Samples were collected from 20-50 cm soil. Samples of plant roots were returned to the laboratory for determination of root colonization. The soil samples were then air-dried in the shade at laboratory temperature for spore extracting, counting and identification.

Measurement of AM colonization: Fresh roots were processed by washing free of soil and cleared in 10% (w/v) KOH by heating to approximate 90°C in a water bath for 30-60 min depending on the lignin degree of the root and their pigmentation. The cooled root samples were washed and cut into 0.5 to 1.0 cm segments and stained with 0.5% acid fuchsin [19]. For each samples, eight slides with 20 root fragments each were mounted to examine vesicles, arbuscules and hyphae and colonized root tissue was evaluated as the proportion of total length of observed roots (percent root length colonized) under a microscope (BX50 Olympus microscope with Automatic Photomicrographic System). The type of arbuscular mycorrhizas and fungal structure were described.

Isolation and identification of AM fungi: Spores of AM fungi in aliquots (20 ml) of soil were extracted by wet sieving and sucrose density gradient centrifugation [20]. Morphological features of spore were described with a various treatments including water, lacto phenol, PVA and Melzer's reagent, respectively [21]. Fungal identification was based on the spore size, color, surface ornamentation and wall structure according to the procedure described by Schenck and Perez [22] and INVAM (http:// invam.caf.wvu.edu).

Measurement of species richness, spore density, frequency and relative abundance of AM fungi: Spore density, species richness, frequency and relative abundance of AM fungi were counted according to the methods described by Zhang *et al*. [23], the formulas were

Table 1: The description of species investigated in Dipterocarpaece, arbuscular mycorrhizal patterns of colonization, species richness and spores density of AM fungi in the rhizosphere of Dipterocarpaceae in tropic rainforest in China

Sample codes	Host plants	Sites	Soil types***	Tree ages (years)	Patterns of colonization**	Species richness	Spores density (Degree/ No. of samples)
D1	*Hopea hainanensis* Merr. et Chun	Puwen	LRE	28	h,v	3.17 c	3.83 f
D2	*Vatica xishuangbannaensis* G.D. Tao et J.H. Zhang	Puwen	LRE	22	h	2.66 d	4.54 ef
D3	*H. hainanensis* Merr. Et Chun	Puwen	PLRE	30	h,c	2.43 d	3.32 g
D4	*H. horgayensis* Trad-blot	Puwen	LRE	9	h,c,v	3.78 bc	3.21 g
D5	*Dipterocarpus tuberculatus* Roxb.	Puwen	LRE	20	h	2.13 de	4.87 e
D6	*H. odorata* Roxb.	Puwen	LRE	21	h,v	2.40 d	3.75 f
D7	*Shorea robusta* Gaertn.	Puwen	LRE	13	h,c,v	3.79 bc	3.80 f
D8	*H. mollissima* C.Y. Wu.	Puwen	LRE	15	h	1.97 e	7.76 ab
D9	*Parashorea chinesis* Wang Hsie	Puwen	LRE	23	ar,h,v	4.31 b	3.56 fg
D10	*D. turbinatus* Gaertn.f.	Puwen	LRE	20	ap, h	2.33 d	3.45 g
D11	*D. turbinatus* Gaertn.f.	Puwen forest farm	LRE	37	h	1.78 e	3.18 g
D12	*V. xishuangbannaensis* G.D. Tao et J.H. Zhang	Xishuangbanna	L	19	h	1.84 e	3.32 g

Table 1: Continued

Sample codes	Host plants	Sites	Soil types***	Tree ages (years)	Patterns of colonization**	Species richness	Spores density (Degree/ No. of samples)
D13	*H. hainanensis* Merr. Et Chun	Xishuangbanna	L	39	h	2.07 de	4.65 e
D14	*S. assamica* Dyer	Xishuangbanna	L	21	h	1.63 e	3.15 g
D15	*D. tuberculatus* Roxb.	Xishuangbanna	L	21	h	1.72 e	3.21 g
D16	*D. alatus* Roxb.	Xishuangbanna	L	22	h	3.03 cd	3.48 g
D17	*V. astrotricha* Hance	Xishuangbanna	L	39	h	2.52 d	3.09 g
D18	*H. hainanensis* Merr. et Chun	Xishuangbanna	L	26	h	1.81 e	3.51 g
D19	*S. robusta* Gaertn.	Xishuangbanna	L	12	h	1.77 e	3.13 g
D20	*D. intricatus* Dyer	Xishuangbanna	L	22	h	2.14 de	5.06 e
D21	*D. retusus* Bl.	Xishuangbanna	L	14	h	1.88 e	7.21 b
D22	*D. turbinatus* Gaertn.f.	Xishuangbanna	L	14	h	2.21 d	5.43 d
D23	*V. guangxiensis* S.L.Mo.	Xishuangbanna	L	11	ap,h	1.69 e	3.45 g
D24	*H. chinensis* Hand.-Mazz.	Xishuangbanna	L	11	h	1.67 e	3.44 g
D25	*D. zeylanicus* Thw.	Xishuangbanna	L	24	h	1.70 e	3.27 g
D26	*H. mollissima* C.Y.Wu.	Xishuangbanna	L	25	h	2.35 d	3.57 fg
D27	*H. horgayensis* Trad-blot	Xishuangbanna	L	36	h	3.36 c	4.06 f
D28	*Anisoptera laeris* Ridl.	Xishuangbanna	L	21	h	1.56 e	3.09 g
D29	*Shorea obtusa* Wall Teng	Xishuangbanna	L	17	h,v	1.62 e	3.43g
D30*	*P. chinesis* Wang Hsie*	Mengla	MRE	175	ap,ar,h,v,c	3.82 bc	7.83 a
D31	*D. turbinatus* Gaertn.f.	Mengla county	MRE	90	ar,h,v	3.45 c	6.46 c
D32	*V. astrotricha* Hance	Xinglong	L	8	h,v	1.58 e	3.05 g
D33*	*V. astrotricha* Hance	Wuzhi mountain	MRE	70	ap,ar,h,v,c	4.45 ab	7.87 a
D34*	*V. astrotricha* Hance	Diaoluo mountain	MRE	65	ap,ar,h,v,c	4.47 ab	7.76 ab
D35*	*V. astrotricha* Hance	Shimei bay	SS	85	ap,ar,h,v,c	4.86 a	8.26 a
D36*	*H. exalata* Lin, Yang et Hsue	Baoting	A	58	ap,ar,h,v	3.39 c	6.37 c
D37	*V. hainanensis* Chang var. parvifolia Chang var. nov.	Jianfengling forestry bureau	YS	35	h	1.49 ef	3.11 g
D38	*V. astrotricha* Hance	Jianfengling forestry bureau	YS	35	h	2.03 de	3.46 g
D39	*S. robusta* Gaertn.	Jianfengling forestry bureau	YS	35	ar,h	3.28 c	5.44 d
D40	*H. hainanensis* Merr. Et Chun	Jianfengling forestry bureau	YS	35	h	1.55 e	3.86 f
D41	*H. chinensis* Hand.-Mazz.	Jianfengling forestry bureau	YS	35	h	3.43 c	5.09 e
D42	*H. exalata* Lin, Yang et Hsue	Jianfengling forestry bureau	YS	35	ar,h	1.43 f	3.78 f
D43	*D. alatus* Roxb.	Jianfengling forestry bureau	YS	35	h	1.56 e	3.09 g
D44	*S. assamica* Dyer	Jianfengling forestry bureau	YS	35	ap,ar,h,v	3.81 bc	6.78 b
D45	*D. turbinatus* Gaertn.f.	Jianfengling forestry bureau	YS	35	ar,h,v	3.06 cd	5.67 d
D46	*H. mollissima* C.Y.Wu.	Jianfengling forestry bureau	YS	35	a,v	2.54 d	4.08 f
D47	*P. chinesis* Wang Hsie	Jianfengling forestry bureau	YS	35	ap,h	2.37 d	3.90 f
D48	*V. xishuangbannaensis* G.D. Tao et J.H. Zhang	Jianfengling forestry bureau	YS	32	h	1.98 e	3.07 g
D49	*H. horgayensis* Trad-blot	Jianfengling forestry bureau	YS	35	ap,h,v	3.36 c	5.66 d
D50	*V. astrotricha* Hance	Jianfengling mountain	CS	45	ap,h,v	4.27 b	6.39 c
D51*	*V. astrotricha* Hance	Bawangling mountain	L	70	ap,ar,h,v,c	5.04 a	8.07 a
D52*	*H. hainanensis* Merr. et Chun	Bawangling mountain	L	75	ap,ar,h,v	4.33 b	7.06 b
D53	*V. astrotricha* Hance	Danzhou	L	46	h,v	2.46 d	6.32 c
D54	*H. hainanensis* Merr. et Chun	Danzhou	L	45	h	2.09 de	4.05 f

Note: * means natural forest. **ap appressoria, ar arbuscules, h hyphea, v vesaicles, c coils. ***RE, latosolic red earths; PLRE, purple latosolic red earths; MRE, mountain red earth; YS, yellow soil; CS, coarse soil; L, latosols; SS, sandy soil; A, aquod. Different letters after each number mean significant difference between each treatment at p=0.05 level

given below. Different grades were separated in order to decrease statistical error. Five spores were stipulated as a grade, namely, the first grade includes 1 to 5 spores, the second grade includes 6 to 10 spores and the rest may be deduced by analogy.

Species richness = times number of all AM fungal species appearance/number of all soil samples (1)

Spore density = sum of all AM fungal species grades/ number of all soil samples (2)

Frequency = number of present times of a AM fungal genera or species/number of all soil samples (3)

Relative abundance = number of grade of a AM fungal genera or species/total grade number of AM fungal spores in rhizosphere of a plant species ×100% (4)

RESULTS

The arbuscular mycorrhizal pattern of 21 Dipterocarpaceae species and arbuscular mycorrhizal fungal species richness and spore density in rhizosphere soils in 54 sites of were demonstrated in Table 1. Arbuscular mycorrhizal colonization was observed in all plant roots collected. Among them, frequent AM structures including appressoria, arbuscules, hyphea, vesicles and hyphal coils were presented in roots of *Parashorea chinesis* Wang Hsie (D30) and *Vatica astrotricha* Hance (D33, D34, D35 and D51). If at least vesicles and arbuscules were presented in roots, then the plant was regarded as arbuscular mycorrhizal plant. Six Dipterocarpaceae species, i.e. *P. chinesis* Wang Hsie (D9, D30), *D. turbinatus* Gaertn. f. (D31, D45), *V. astrotricha* Hance (D33, D34, D35, D51), *H. exalata* Lin, Yang et Hsue (D36), *S. assamica* Dyer (D44) and *H. hainanensis* Merr. et Chun(D52), were able to form arbuscular mycorrhizas. As we know that AM fungi of the genera *Scutellospora* and *Gigaspora* are not able to form vesicles during colonization, root samples of *S. robusta* Gaertn. (D39) and *H. exalata* Lin, Yang et Hsue (D42) may be considered to be AM plants as fungi from these two genera were presented in other ways. Generally speaking, 7 out of 21 Dipterocarpaceae species collected from 54 sites formed arbuscular mycorrhizas. There were significant differences of species richness and spore density among different Dipterocarpaceae species and sites. The species richness varied from 1.43 (D42) to 5.04 (D51) and the spore density from 3.05 (D32) to 8.26 (D35). The difference of species richness was significant between natural forest (7.60) and planted forest (4.21).

Sixty-four species of AM fungi belonging to *Acaulospora*, *Archaeospora*, *Gigaspora*, *Glomus*, *Paraglomus*, *Scutellospora* and *Entrophospora* were

Table 2: The frequency (F) and relative abundance (RA) of AM fungi on different species of Dipterocarpaece

Arbuscular mycorrhizal fungi	F(%)	RA(%)	Codes of host plants
Acaulospora (15 species)			
A. appendicola Rothwell and Trappe	12	1.5	D1, D4-6, D7, D9-11, D13, D21-22, D30, D32-35, D41, D44, D51-53
A. denticulate Sieverding and Toro	30	3.7	D1-2,D4,D6-7,D9-10,D12,D14,D16,D18-25,D27-31,D33-36,D42-45, D48-52, D54
A. dilatata Morton	13	1.5	D2-3,D5-8,D13,D15,D23,D29-36,D44, D51
A. elegans Trappe and Gerdemann	16	1.9	D4-7,D11,D13-17,D30-31,D33-36,D39,D41,D44-45, D49,D51-52
A. excavate Ingleby and Walker	12	1.5	D3-4,D7,D9,D16-17, D20, D22, D26, D27-31, D33-36,D39,D41,D44,D51-52
A. foveata Trappe and Janos	21	2.6	D1-4,D6-7,D9-11, D15-17, D2, D23, D26, D30, D31,D33-39,D41-45,D49-52
A. lacunose Morton	16	1.9	D2, D4, D7, D9, D14, D17, D19, D21, D24, D26-30, D33-39,D46-48,D50-54
A. laevis Gerdemann and Trappe	10	1.2	D1,D4,D6-7,D9-10,D23,D29-31,D33-36,D39, D50
A. mellea Spain and Schenck	9	1.2	D4,D-8,D11-13,D16,D20-22,D37-38,D47-48,D53-54
A. morrowae Spain and Schenck	11	1.3	D1-3,D6-7,D10,D14-15,D17-19,D30-36,D41,D45,D51-52
A. rehmii Sieverding and Toro	4	1.3	D9,D30-31,D33-36,D51-52
A. rugosa Morton	9	1.2	D7,D9,D23,D27-31,D32,D36,D42-44,D45,D49,D51-54
A. scrobiculata Trappe	13	1.6	D1-4,D9,16-19,D21-25,D37-39,D44-45,D47,D51,D53
A. spinosa Walker and Trappe	32	4.0	D1-13, D16-18, D21-22, D26-28,D31,D33-36, D39,D41,D44-46,D48,D50-51
A. tuberculata Janos and Trappe	9	1.1	D1,D4,D6-7,D10,D23,D29-31,D33-36,D41,D44-45,D49,D54
Archaeospora (2 species)			
Ar. gerdemannii (Rose, Daniels and Trappe) Morton and Redecker	7	1.0	D7,D9-10,D30-31,D33-36,D39,D41,D44, D50- 52
Ar. Leptoticha (Schenck and Sm) Morton and Redecker.	9	1.3	D2, D4, D7, D9, D13-14,D16-19, D28,D37, D40-41, D47-48

Table 2: Continued

Arbuscular mycorrhizal fungi	F(%)	RA(%)	Codes of host plants
Entrophospora (1 species)			
E. infrequens (Hall) Ames and Schneider	8	1.1	D4,D7,D9-10,D30-31,D33-36,D39,D41,D44, D50-52
Gigaspora (3 species)			
Gi. albida Schenck and Smith	10	1.2	D1,D4,D6-7,D9-10,D24-25,D29-31,D33-36, D39, D52
Gi. decipiens Hall and Abbott	9	1.1	D1,D4,D6-7,D10,D21-22,D30-31,D33-36,D41,D44-45,D49,D54
Gi. margarita Becker and Hall	13	1.6	D2-4,D7, D9,D16-17,D20, D22,D26, D27-31,D33-36,D38, D42,D44, D51-52
Glomus (38 species)			
G. aggregatum Schenck and Smith emend. Koske	18	2.2	D1-4, D6-7, D9-11, D15, D21, D23, D25, D30-31, D33-39,D43-45,D49-52
G. albidum Walker and Rhodes	8	1.0	D5-6,D8-9,D11,D30-31,D33-36,D39,D41,D44, D50-53
G. ambisporum Smith and Schenk	6	0.8	D1,D4, D9-10,D13-14,D23,D27,D33-36, D39, D51
G. caledonium (Nicol. and Gerd.) Trappe and Gerd.	10	1.1	D3-4,D6-8,D11-13,D16,D20-22,D37-38,D47-48,D51-54
G. canadense (Thaxter) Trappe and Gerdemann	6	0.8	D33-35,D51,D53
G. chimonobambusa Wu and Liu	8	0.9	D9-10,D30-31,D33-36,D43,D46
G. citricolum Tang and zang	11	1.4	D3-4, D8, D9, D16-17, D21-22,D25, D27-31, D33-36,D39,D41,D44,D51-52
G. claroideum Schenck and Smith	35	4.3	D1-11,D13,D16-19,D21-22,D24,D26-28,D32,D33-36,D39,D41-42,D44-46,D48,D50-51
G. clarum Nicolson and Gerdemann	21	2.6	D1-4,D6-7,D9-11,D15,D20,D22-23,D30-31,D33-39,D41,D43-45,D49-52, D54
G. constrictum Trappe	16	2.3	D2-7, D12,D13-17,D30-31, D33-36,D39,D41, D44-45,D49-52
G. convolutum Gerdemann and Trappe	3	0.4	D30,D37,D47
G. deserticola Trappe, Bloss and Menge	9	0.9	D1,D4,D6-7,D9,D23,D29-31,D33-36,D41,D44-45,D49,D54
G. diaphanum Morton and Walker	6	0.7	D3-4, D9-10,D13-14,D23,D27,D33-36, D39, D52
G. dimorphicum Boyetchko and Tewari	5	0.8	D4, D15-16, D30-31,D33-36,D50-52
G. dolichosporum Zhang and Wang	31	3.7	D1-9, D11-22, D26, D30-31,D33-37, D40-45, D49-52
G. etunicatum Becker and Gerd.	36	4.5	D1-12, D14, D16-27,D29-36,D39,D41,D44-45, D49-53
G. fasciculatum (Thaxt.)Gerd. and Trappe	7	2	D2, D6, D7, D9, D14-15,D28-31,D33-34,D37, D51-52
G. formosanum Wu and Chen	11	1.3	D1-4, D7, D9, D17,D19,D23,D29-34,D38-39, D47-48,D53-54
G. geosporum (Nicol. and Gerd.) Walker	8	0.7	D3, D6, D16-17, D20,D26, D30-31,D33-36,D38 D50-52
G. glomerulatum Sieverding	10	1.1	D4,D6-8,D11-13,D16,D19-22,D36,D47-48,D51-54
G. hoi Berch and Trappe	6	0.5	D10,D16, D20,D30-31,D33-36,D50-52
G. intraradices Schenck and Smith	8	0.9	D7,D8-10,D23,D30-31,D33-36,D39,D41,D44, D50-52
G. liquidambaris Wu and Chen	7	0.9	D4,D7,D30-31,D33-36,D49,D53-54
G. macrocarpum Gerd. and Ttappe	33	3.9	D1-13,D16-18,D20,D22-26,D29-36,D39,D41,D44-45, D49-52
G. magnicaule Hall	6	0.6	D24,D30,33-35,D41,D46,D49-52
G. manihotis Howeler, Sieverding and Schenck	9	1.0	D3,D6-7,D9,D23,D30-31,D33-36,D41,D44-45,D49,D51-52
G. microaggregatum Koske, Gemma and Olexia	21	2.6	D2-4,D6-9,D16-18,D20,D22,D25-26,D29-36,D38-39, D41,D49,D51-52
G. microcarpum Tul. and Tul.	19	2.5	D1, D4-6, D12, D16, D19, D21, D24, D29-31, D33-36, D38-39,D41, D51-52
G. mosseae (Nicol. and Gerd.) Gerd. and Trappe	23	2.7	D1-4,D6-7,D9-11,D13-15,D20,D22-23,D30-31,D33-39,D41,D43-45, D49-52, D54
G. pansihalos Berch and Koske	18	2.4	D1-3,D5-7,D8,D10-11,D15,D21, D23, D25, D30-31, D33-39,D43-45,D49-52
G. pustulatum Koske, Friese, Walker and Dalpe	12	1.5	D1-4,D7,D9,D17,D19,D23,D29-34,D38-39,D47-48, D53-54
G. reticulatum Bhattacharjee and Mukerji	9	1.0	D4,D6-7, D9-10, D14, D23, D29,D35-36,D38- 39, D41,D51-52
G. taiwanensis Wu and Chen	9	1.1	D3, D6, D16-17, D20,D26, D30-31,D33-36,D38 D50-52

Table 2: Continued

Arbuscular mycorrhizal fungi	F(%)	RA(%)	Codes of host plants
G. tenebrosum Berch	8	0.9	D4,D7,D9-10,D30-31,D33-36,D39,D41,D44, D50-52
G. tortuosum Schenck and Smith	10	1.2	D1-3,D6-7,D11,D15-16,D18-19,D33-36,D41,D45, D48-49,D51-52
G. versiforme (Karsten) Berch	20	2.3	D4,D7,D9,D11,D14-17,D21,D23-25,D27-28,D30-31,D33-36,D38-39,D41, D44, D51-52
G. sp.1	2	0.6	D30-31,D35
G. sp.2	2	0.6	D35,D51,D53
Paraglomus (1 species)			
P. occltum (Walker) Morton et. Redecker	7	0.9	D3, D7, D9, D27, D29-31,D33-36,D44,D50-52
Scutellospora (4 species)			
Scu. aurigloba Walker and Sanders	9	1.1	D4,D6-7,D9,D23,D29-31,D33-36,D41,D44-45,D49, D50-52
Scu. calospora Walker and Sanders	6	0.6	D1,D3-4, D9-10,D13-14,D23,D27,D33-36, D39, D51
Scu. nigra (Redhead) Walker and Sanders	3	0.7	D36,D41-42
Scu. reticulata (Koske, Miller and Walker) Walker and Sanders	10	1.2	D4,D9,D11-13,D16-17,D19-22,D36,D47-48, D51-54

isolated from rhizosphere of 21 Dipterocarpacea species in 54 sites. The occurrence frequency and relative abundance of AM fungi ranged from 2 to 36 and, 0.4 to 4.5, respectively. The occurrence frequency and relative abundance of each species were listed in Table 2. *Glomus etunicatum* Becker and Gerd., *G. claroideum* Schenck and Smith, *G. macrocarpum* Gerd. and Ttappe, *Acaulospora spinosa* Walker and Trappe, *G. dolichosporum* Zhang and Wang and *A. denticulata* Sieverding and Toro were dominant species and consequently the two genera were considered to be dominant in the surveyed regions.

DISCUSSION

Most trees in tropical forest might be associated with arbuscular mycorrhizas [8-10, 24-27]. The colonization of AM fungi might be very important in increasing seedling life rate of trees. Regarding to the mycorrhizal status of Dipterocarpaceae in the literature, two early reports by Shamsudin [15] and Chalermpongse [16] and a recent publication by Tawaraya *et al*. [6] were searched while others were only targeted on ectomycorrhizas (ECM). Lee and Alexander surveyed 7-month old seedlings of *Shorea leprosula* Miq. at three sites in the West Malaysia and they found that roots had well-developed ectomycorrhizas, but no observation on the arbuscular mycorrhizas [11]. Moyersoen investigated fungal richness of ectomycorrhizas and arbuscular mycorrhizas in tropical heath forest, but he did not find any Dipterocarpaceae trees infected by AM fungi [28].

Our results indicated that Dipterocarpaceae plants were able to form arbuscular mycorrhizas. In particular, arbuscules were observed in root samples of *P. chinesis*, *D. turbinatus*, *V. astrotricha*, *H. exalata*, *S. assamica*, *H. hainanensis* and *S. robusta*. This result agreed with the previous reports [6, 15, 16]. A potential reason to explain why the previous studies on ectomycorrhizas outweigh those on arbuscular mycorrhizas of Dipterocarpaceae is that young seedlings of the family are lack of root hairs and they may have less chance to be colonized by AM fungi in a short term.

In addition, the occurrence of arbuscules was lower than vesicles (Table 1) as we believe the survey season may affect the result of the present of arbuscules. Many researches pointed out that mycorrhizal colonization including hyphal colonization, vesicular colonization and arbuscular colonization, spore density and species diversity were influenced by seasonal variation [29-31]. Brundrett and Kendrick observed a gradual collapse of the arbuscules in *Erythronium americanum* from late autumn throughout the spring [32]. Important reductions in arbuscular content were also shown in winter cereals during the summer [33]. However, we cannot rule out the possibility that decrease of arbusculars was an adaptive mechanism formed chronically between AM fungi and Dipterocarpaceae plants. Toth and Miller have suggested that arbuscules could be digested by host cells when they are no longer needed for phosphorus transfer [34].

Species richness and spore density of AM fungi in the rhizosphere of Dipterocarpaceae plants varied with the difference of sites. Species richness and spore density of AM fungi in the rhizosphere of same plants were also significantly different. Species richness and spore density of AM fungi in natural forests were higher than those in plantations. One of the possible reasons might be the disturbance in plantation areas [5].

Some AM fungi of *Acaulospora* and *Glomus* were dominant in the rhizosphere of Dipterocarpaceae plants, since 82.8% of the encountered AM fungi were within the two genera, while *Archaeospora*, *Entrophospora*, *Gigaspora*, *Paraglomus* and *Scutellospora* were 2.3, 1.1, 3.9, 0.9 and 3.6%, respectively.

ACKNOWLEDGMENT

This work was supported by Talent Foundation of Henan University of Science and Technology (06-34).

REFERENCES

1. Ashton, P.S., 1982. Dipterocarpaceae. In: van, C.G.G.J. (Ed.). Flora. Malesiana, Series I, 9: 237-552.
2. Tong, S.D. and G.D. Tao, 1990. Dipterocarpacece. In: Li, X.W., Y.H. Li, S.Q. Tong and G.D. Tao (Eds.). Flora Reipublicae Popularis Sinicae 50 (2). Science Press, Beijing, 114-131.
3. Cairney, J.W.G., 2000. Evolution of mycorrhiza systems. Naturwissenschaften, 87: 467-475.
4. Smith, S.E and D.J. Read, 1997. Mycorrhizal Symbiosis. Academic Press, London.
5. Guadarrama, P. and F.J. Alvarez-Sanchez, 1999. Abundance of arbuscular mycorrhizal fungi spores in different environments in a tropical rain forest, Veracruz, Mexico. Mycorrhiza, 8: 267-270.
6. Tawaraya, K., Y. Takaya, M. Turjaman, S.J. Tuah, S.H. Limin, Y. Tamai, J.Y. Cha and T. Wagatsuma, M. Osaki, 2003. Arbuscular mycorrhizal colonization of tree species grown in peat swamp forests of Central Kalimantan, Indonesia. Forest Ecol. Manag., 182: 381-386.
7. Zhao, Z.W., 2000. The arbuscular mycorrhizas of pteridophytes in Yunnan, southwest China: evolutionary interpretations. Mycorrhiza, 10: 145-149.
8. Muthukumar, T., L.Q. Sha, X.D. Yang, M. Cao, J.W. Tang and Z. Zheng, 2003. Mycorrhiza of plants in different vegetation types in tropical ecosystems of Xishuangbanna, southwest China. Mycorrhiza, 13: 289-297
9. Zhao, Z.W., Y.M. Xia, X.Z. Qin, X.W. Li, L.Z. Cheng, T. Sha and G.H. Wang, 2001. Arbuscular mycorrhizal status of plants and the spore density of arbuscular mycorrhizal fungi in the tropical rain forest of Xishuangbanna, southwest China. Mycorrhiza, 11: 159-162
10. Shi, Z.Y., Y.L. Chen, G. Feng, R.J. Liu, P. Christie and X.L. Li, 2006. Arbuscular mycorrhizal fungi associated with the Meliaceae on Hainan island, China. Mycorrhiza, 16: 81-87
11. Lee, S.S. and I.J Alexander, 1996. The dynamics of ectomycorrhizal infection of *Shorea leprosula* seedlings in Malaysian rain forests. New Phytol., 132: 297-305.
12. Lee, S.S. and I.J. Alexander, 1994. The response of seedlings of two dipterocarp species to nutrient additions and a forest plantation. Plant Soil, 163: 299-306.
13. Lee, S.S. and K.L. Lim, 1989. Mycorrhizal infection and foliar phosphorus content of seedlings of three dipterocarp species growing in a selectively logged forest and a forest plantation. Plant Soil, 117: 237-241.
14. Supriyanto, J., 1993. Status of mycorrhizal research in Indonesia. In: Soerianegara, I. (ed.). Supriyanto. Proceedings of 2nd Asian Conference on Mycorrhizal. March 1991, Thailand, 9-20. BIOTROP Special Publication No. 42, 11-15.
15. Shamsudin, M.N., 1979. Mycorrhiza of tropical forest trees. In: Furtado, J.I, (ed.). V International Symposium of Tropical Ecology. Kuala Lumpur, Malaysia, pp: 173.
16. Chalermpongse, A., 1987. Mycorrhizal survey of Dry-Deciduous and Semi-Evergreen Dipterocarp forest ecosystems in Thailand. In: Kostermans, A.C.J.H. (ed.). Proceedings of the Third Round Table Conference on Dipterocarps. Mulawarman University, East Kalimantan.
17. Shi, Z.Y., Y.L. Chen and R.J. Liu, 2003. Research advances on the Dipterocarpaceae mycorrhizas. Forest Res., 16(1): 104-109.
18. Liu, R.J. and X.L. Li, 2000. Arbuscular mycorrhizas and Their Application. Science Press, Beijing, 1-224.
19. Biemann, B. and R.G. Linderman, 1981. Quantifying vesicular arbuscular mycorrhizae: a proposed methods towards standardization. New Phytol., 87: 63-67.
20. Daniels, B.A. and H.D. Skipper, 1982. Methods for the recovery and quantitative estimation of propagules from soil vesicular arbuscular mycorrhizal fungi. In: Schenk, N.C. (Ed.) Methods and Principles of Mycorrhizal Research. American Phytopathological Society, St. Paul, MN., pp: 29-35.
21. Morton, J.B., 1988. Taxonomy of VA mycorrhizal fungi: classification, nomenclature and identification. Mycotaxon, 32: 267-232.

22. Schenck, N.C. and Y. Perez, 1988. Manual for Identification of Vesicular Arbuscular Mycorrhizal Fungi. Second edition. INVAM. University of Florida. Gainesville, Florida, USA.
23. Zhang, M.Q., Y.S. Wang and L.J. Xing, 1998. The ecological distribution of AM fungi community in south and east coast of China. Mycosystema, 17: 274-277.
24. Alexander, I.J., 1989. Systematics and ecology of ectomycorrhizal legumes. Monographs in Systematics Botany from the Missouri Botanical Garden, 29: 607-624.
25. Hart, T.B., 1989. Monodominant and species-rich forests of the humid tropics: causes for their co-occurrence. Am. Naturalist, 133: 613-633.
26. Bereau, M., 1997. Les symbioses des arbres de la foret tropicale humide de Guyane francaise. Can. J. Bot., 75: 711-716.
27. Henkel, T.W., 1999. New taxa and distribution recordes of *Tylopilus* from *Dicymbe* forests of Guyana. Mycologia, 91: 655-665.
28. Moyersoen, B., 2001. Are ectomycorrhizas more abundant than arbuscular mycorrhizas in tropical heath forest? New Phytol., 150: 591-599.
29. Li, L.F., A.N. Yang and Z.W. Zhao, 2005. Seasonality of arbuscular mycorrhizal symbiosis and dark septate endophytes in a grassland site in southwest China. FEMS Microbiol. Ecol., 54: 367-373.
30. Lugo, M.A. and M.N. Cabello, 2002. Native arbuscular mycorrhizal fungi (AMF) from mountain grassland (Córdoba, Argentina) I. Seasonal variation of fungal spore diversity. Mycologia, 94: 579-586.
31. Allen, E.B., E. Rincon, M.F. Allen, A. Perez-Jimenez and P. Huante, 1998. Disturbance and seasonal dynamics of mycorrhizae in a tropical deciduous forest in Mexico. Biotropica, 30: 261-274.
32. Brundrett, M. and B. Kendrick, 1990. The roots and mycorrhizas of herbaceous woodland plants?. Quantitative aspects of morphology. New Phytol., 114: 457-468.
33. Dodd, J.C. and P. Jefferies, 1986. Early development of vesiculer-arbuscular mycorrhizas in autumn-sown cereals. Soil Biol. Biochem., 18: 149-154.
34. Toth, R. and R.M. Miller, 1984. Dynamics of arbuscule development and degeneration in a *Zea Mays* mycorrhiza. Am. J. Bot., 71: 449-460.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 255-260, 2007
ISSN 1818-6769

Socioeconomic and Environmental Aspects of Women Labor in the Egyptian Agricultural Sector: Case Study of Sugar Crops

Khairy Hamed El-Eshmawiy, Laila Moustafa El-Shiraif and Ayman Ibrahim El-Khafif

Department of Agricultural Economics, National Research Centre, Cairo, Egypt

Abstract: Egyptian rural Women play an important and main vital role beside men in the agricultural production. The present study aims to recognize and assess the different economic and social aspects of women's labor in the agricultural Sector especially in sugar crops production and marketing. Results. Indicated that most of Sugar beet cultivation is concentrated in Kafr El-Shiekh Governorate "lower Egypt" and the sugarcane in Qena Governorate "upper Egypt". Data also showed that women contribute to production and marketing of sugar crops, either in decision making or agricultural practices. Women's participation was more recognized in Kafr El-Shiekh (Lower Egypt) for sugar beet production than in Qena (upper Egypt) for sugar cane production. Also data revealed that the main constraints facing women in the agricultural sector is the high physical effort needed for executing agricultural operations, which is not available for women, in addition traditional customs, especially in the Upper Egypt may also limit ate women's labor. It is recommended to present special training courses for women in the agricultural field in addition to establish a Special TV channel specified in agriculture aspects such as to increase women's experience and public awareness of the importance of woman role in integrated development.

Key words: Socioeconomic aspects % rural women % sugar crops % agricultural operations % lower and upper egypt % structural and demographic factors

INTRODUCTION

Recent interest in women's work and status has resulted in increased documentation of women's participation and agricultural experience. Women play important roles in food production, natural resources management, income increasing, house management, food and nutrition security [1]. Based on analysis of household surveys, a recent document presented eight research findings showing the key and central role of women [2].

Men and women play different roles, have different needs and face different constraints. This necessitates the need, value and potential of gender-disaggregated database as a tool for the effective formulation and monitoring of agricultural and natural resource policies [3]. Integration of gender concerns in agricultural data collection was also emphasized by Tempelman [4] and gender-disaggregated statistical data for understanding the economic and social and political differences existing between men and women, ensuring that such understanding is based on facts; and planning of development programs which take the specific situation of both genders into account.

Structural factors including farm size, economic viability of farm enterprise, commodities produced and region of the country affect and explain variations in women's participation in farm tasks. Also, demographic factors including age, marital status, number of children under six, percent of the life on the farm and education have also been shown to account for variation in women's farm labor. Jones and Rosenfeld [5] analyzed farm women's participation in work and decision-making among other dimensions of farm women involvement and indicated that single women are more likely to do farm tasks as are women who are younger, have fewer children under six, have lived a greater portion of their lives on farms and have higher education.

The average value of sugar crops production for 2002-2004 period was about LE 2223 million and constituted about 2.4% of the corresponding value of total agricultural production for the same period [6].

Corresponding Author: Dr. Khairy Hamed El-Eshmawiy, Department of Agricultural Economics, National Research Centre, Cairo, Egypt

Sugar Produced from sugarcane was about 996 thousand ton as an average for the period 2003-2005 and constituted about 72% of the total the volume of domestic production (1384 thousand ton). Sugar Produced from sugar beets was about 388 thousand ton as an average for the period 2003-2005 and constituted about 28% of the total local production.

Self sufficiency from sugar during 2003-2005 increased from 61.2% in 2003 to about 63.2% in 2005 with an average of about 62.3% for the mentioned period [7].

The aim of the present study is to study different social, environmental and economic aspects of women labor in the agriculture sector in lower and Upper Egypt for improving their abilities. In addition to investigate the factors affecting woman participation in agricultural production in both regions under investigation.

METHODOLOGY AND SOURCE OF DATA

Secondary data are obtained from bulletins published by the ministry of agriculture and land reclamation (MALR) and reports published by The Sugar Crops council in addition to unpublished data from different sources. Field data are obtained through rapid survey and focus groups meetings in Kafr El-Shiekh governorate (60% of sugar beets area) for data concerning women's participation in sugar beets production and in Qena governorate (48 % of sugarcane area) for data concerning women's participation in sugarcane production. For each crop three focus group meetings were held in different three villages plus three individual meetings in each village. This study depended on descriptive and quantitive statistical analyses methods.

RESULTS AND DISCUSSION

Geographic allocation for Sugar Beets and Sugarcane production: Data in Table 1 indicate that Sugar beet production is concentrated in governorates of Lower Egypt in addition to middle Egypt. Where the production of Sugar beet by Kafr El-Shiekh Governorate reached 60% of the total production at national level (2.742 million ton). Dakahleya Governorate production was 21%, followed by Gharbeya and EL-Minya 6% as a mean of (2003-2005). As for Sugar beets productivity it reached 27.43 tons/feddan, in EL-Minya Governorate, while productivity reached 22.95 ton/ feddan in Gharbeya Governorate, followed by Kafr El-Shiekh Governorate "20. ton/ feddan". The average productivity ranged between a lower limit of about 16.6 ton/ feddan in El-Nobareya area (new lands) and an upper limit of about 27.43 ton/feddan in El-Minya governorate with an average of about 18.98 ton/feddan at national level over the mentioned period.

The most cultivation of sugar cane crop was found in upper Egypt where Qena Governorate considered to be the most important and superior for production of sugarcane, nearly (48% of the total production all national level), followed by Aswan Governorate producing 24.5% and EL-Minya 11.8%. There was clear difference in 2003-2005 average productivity at regional level. The average productivity ranged between a lower limit of about 49.9 ton/ feddan in Qena governorate and an upper limit of about 52.5 ton/feddan in Luxor.

Table 1: Geographic allocation for Sugar Beets and Sugarcane production areas by Governorate During 2003-2005

Sugar Beets crop					Sugar cane crop				
Governorate	Area	Productivity	Production	%	Governorate	Area	Productivity	Production	%
Kafr El-Shiekh	80.3	20.48	1645	60.0	El-Minya	37.9	50.3	1906	11.8
Dakahleya	28.6	20.16	577	21.0	Sohag	18.8	50.7	953	5.9
Gharbeya	7.2	22.95	165	6.0	Qena	155.8	49.9	7774	48.0
Behairah	3.0	16.59	50	1.8	Luxor	22.2	52.5	1166	7.2
Sharkeya	5.8	19.37	112	4.1	Aswan	78	50.9	3970	24.5
Fayyoum	4.3	17.28	74	2.7					
El-Minya	6.0	27.43	165	6.0					
El-Nobareya	3.8	16.26	62	2.3					
National Level	144.5	18.98	2772	100.0	National Level	324.2	50.0	16194	100.0

(*)Area (thousand feddan), productivity(ton/feddan), production(thousand Ton),

Source: Ministry of Agriculture and Land Reclamation (MALR), Sugar Crops Council, Report on: "Sugar Crops and Sugar Production in Egypt", 2005.

Pattern and extent of rural women's participation in sugar crops production and marketing

Contribution of women in the agricultural sector: Data presented in Table 2 indicated that women's contribution reached 54.5% calculated from the total Labor contribution in producing and marketing Sugar beet crop in Kafr El-Shiekh Governorate which was estimated by 53 men /day during the agricultural season of 2003/2004.

Also, presented data showed that the most important operations, which women participated in were the (sowing, thinning & replanting and chemical fertilizer application) with a percentage of 85.7%, 80.0% and 75% of total labor used in the three operations respectively. The least participation of women was observed in irrigation, manure application and pest control reaching 12.5%, 18.0% and 25.0% respectively. This may due to the physical effort needed by above mentioned operations.

Studying women average wages, showed that, it ranged between a lower rate of L.E 8/day in fertilizer application and harvesting and, an upper rate of about L.E 10 in output cleaning and loading, in irrigation, hoeing and pest control operations. Average women's wage in sugar beets operations is about L.E 9/ day and constitutes about 84% of the corresponding average men's rate. As a percentage of the representing men's rate, percentage ranges between 67% in Manure and 100% in sowing with an overall average of about 84% for all operations.

For the sugarcane crop which is mainly produced in the upper Egypt lands, there is a decrease in women's contribution (28%) due to the general customs and habits of the region. This doesn't facilitate nor prefer women's labor does not field work. However Women's contribution differs among operations and ranges between a lower limit of zero in irrigation and an upper limit of about 75% in Output cleaning and loading.

The women's wage is stable for most of agricultural operations reaching L.E 8/ day which is equivalent to 80% of the men wage. In the case of harvest, sometimes green tops are used as in kind wage for both hired men and women. Hired labor has the right to use the green tops for his animals or to sell it.

These results are in coincide with those mentioned by Booth [3], Tempelman [4] and Jones and Rosenfeld [5], who found that, women participation in labor supply differed by regional, economic viability and gender-disaggregated factors. Moreover the present study found that customs and habits of the region affected the women participation in labor, aet.

Participation in decision making: Data presented in Table 3 show assessment of women's contribution in making decisions for sugar beet and sugar cane production.

As indicated in Table 3, while, woman participation in making the decision of whether to cultivate sugar beets or not was about 90%. Only about 10 % of responsibility

Table 2: Level of participation in labor (worker/feddan), and wage rate, social status for women participating in sugar beets and sugarcane farm operations in, 2003/2004 season

	Sugar beets			Sugarcane		
		Women wage rate			Women wage rate	
Operation	% of women's contribution	LE/day	% of men's rate	% of women's contribution	LE/day	% of men's rate
Land, seeds preparation	-	-	-	25	8	80
Manure	18	10	67	25	8	80
sowing	85.7	10	100	30	8	80
Irrigation	12.5	10	67	-	-	-
Fertilizer application	75	8	80	10	8	100
Thinning and replanting	80	10	100	-	-	-
Pest control	25	10	67	10	8	53
harvest	40	8	80	30	8	100
Output cleaning and loading	50	10	67	75	8	80
Burning dried leafs after harvest	-	-	-	10	8	80
Total	54.5	9	84	28	8	80

Source: Field data

Table 3: Frequency of positive responses about women's participation in making decisions related to sugar beets and sugarcane production and marketing in 2003/2004 season

	sugar beets Frequency		sugarcane Frequency	
Decision level	Number	%	Number	%
To cultivate or no	45	90	8	16
Cultivation date	10	20	15	30
Cultivation method	12	24	8	16
Timing of operations	30	60	10	20
Quantity & method of Fertilizers application	22	44	5	10
Output use and marketing	5	10	5	10
Timing for Marketing	5	10	8	16
Total	50	-	50	-

Source: Field data

Table 4: Social characteristics of Women participation in production and marketing of sugar crops, 2003/2004 season

	Sugar beets Frequency		Sugarcane Frequency	
Item	Number	%	Number	%
Educational Level				
-Illiterate	27	54	34	68
-Read and write	12	24	10	20
-Before high school	7	14	6	12
-High school	4	8	-	-
Social Status				
- married	22	44	29	58
- unmarried	24	48	18	36
- divorced	4	8	3	6
Total	50	-	50	-

Source: Field data

advocates women's participation in making decisions related to sugar beets marketing.

On the other side, 30 % of responses indicated that women participate in making decisions related to time of sugar cane cultivation. However,only 10 % of responses of women participation in making decisions related to each of the following operations: fertilizers quantity & method of application and output use & marketing.

Literature indicated that women's participation in decision making do not go hand in hand with performance of tasks [8]. Although women rarely made farm management decisions alone, they were substantially involved in joint decisions with their husbands [9]. The results agree with the mentioned above Literature.

Social characteristics of women participation in production and marketing of sugar crops

Educational status: Table 4 shows the effect of marital status and education level on women participating in sugar crops production.

Table 4 indicates that, In case of sugar beets: about 54 % were in favor of the view that participating women in sugar beets production and marketing are illiterate, 24% were able to read and write, 14% were educated up to preparatory schools; and 8% of were hold higher school degree. Meanwhile, In case of sugarcane: about 68 % were in favor of the view that participating women in sugar cane production and marketing are illiterate, 20% were able to read and write, 12% were educated up to preparatory schools; and there were no woman hold higher school degree participating in sugar cane production and marketing.

As shown previously, a higher education level leads to lower participating of woman in agriculture labor.

Social status and age category: Data in Table 4 revealed that, In case of sugar beets: Participating women in sugar beets production and marketing activities are usually married "44%" unmarried "48%" and divorced "8% ". However, In case of sugarcane Participating women in sugarcane production and marketing activities are usually married "58%" unmarried "36%" and divorced "6% ".

Unmarried woman participates more than married one because of child care responsibility. Furthermore, women's participation increases in cases of divorce and householder's death.

For hired and family women labor, age of participating women ranges between 13 year in furrowing, thinning and replanting and 45 years in manure application, cultivation and output cleaning and loading.

The result agreed with those reported by Jones and Rosenfeld [5] who investigated the demographic factors including age, marital status and education on women participation in agriculture and indicated that single women are more likely to do farm tasks as are women who are younger. However the study's results gave an opposite direction with respect to education level.

Constraints to women's participation: As indicated in Table 5, interviewed people indicated that the four major constraints for women's participation in sugar beets production and marketing were the needs of high level of physical efforts (80% of responses), Lack of women's experience in activities related to sugar beets production (20% of responses), family traditions toward women's work (about 12% of responses) and being educated in high schools or college (about 10% of responses). However, interviewed people indicated that the four major constraints for women's participation in sugar cane production and marketing were the local traditions in

Table 5: Constraints to women's participation in sugar beets and sugarcane production and marketing, 2003/2004 season

	Sugar Beets Frequency		Sugarcane Frequency	
Constraints	Number	%	Number	%
Women's work is a shame	5	10	10	20
Family and local traditions	6	12	40	80
Lack of experience in sugar crops activities	10	20	15	30
Sugar crop activities need high physical efforts	40	80	12	24
Being educated	5	10	2	4
Total interviews	50	-	50	-

Source: Field data

Table 6: Impact of women's work on children

	Sugar beets Frequency		Sugarcane Frequency	
Place to leave children	Number	%	Number	%
Alone at home	6	12	7	14
With grandmother& brothers	35	70	40	80
With neighbors & relatives	5	10	3	6
With the working woman here self to the field	4	8	-	-
Total	50	100	50	100

Source: Field data

Upper Egypt (80 % of responses), Lack of women's experience in activities related to sugar beets production (30% of responses), the needs of high level of physical efforts (24 % of responses) and Women's work is a shame (20% of responses)

Impact of women's work on children: As a family worker in the small landholdings or as an assistant to her husband as the main wage-earner and householder, women have to leave their children in one of the alternative facilities Mentioned in Table 6. Indicated that, Taking children to the field in the sugarcane plantations is no longer possible but it was positively reported by about 8 % of responses in sugar beet production. The most popular alternative is to leave children with their grandmothers or elder brothers, 70% of responses in sugar beets and about 80% of responses in sugar cane.

According to the results, establishing nursery schools in the rural area may help in increasing women participating in agriculture production and marketing.

Women's contribution in agricultural production to family income: Results of the study's sample survey showed that women contribute about 9.8% of total family agriculture income in northern regions of Egypt. Through accounting opportunity costs, about 3.9% rendered by participation in field work for crops production and almost 5.9% through house keeping and management beside farm animals breeding and marketing its products. As for the Southern regions, nearly 7.6% of family income is contributed by women, of which about 3.1%come frome field work participation and nearly 4.5%from animals breeding and products marketing beside house keeping house keeping. Such results reveal the importance of rural women role in family income increase.

Environmental issues and women's role

Residues of sugar crops at field: Responses of interviewed people regarding how farmers get red of sugar beets leaves as a residue at field after harvest indicates. plough it in land after getting dried. Women's contribution is only about 20% of utilized work "In about 60% of responses". Or to use it as animal feed. Women's contribution is about 80% of utilized work in collecting and transporting it to animals house.

Green tops as a residue of sugarcane at field constitutes about 20% of total harvested quantity and trash or dried leaves (5% of the total harvest). Green tops amounted to about 2.1 million ton in year 2005. Farmers use it as animal feed at a price of L.E. 60-70 /ton. According to field meetings, women's contribution is about 73% of total work utilized in transporting of green tops from field to animal house.The dry leaves and stems have to be left over the cane stubbles (roots) to protect it from winter frost during December, January, February and early March., After that they are burnt, this burning has a biological role in the sugarcane monoculture where it Enhances and promote the germination of the sugarcane new buds and Eliminates weed population. Women contribution is about 13% of total work utilized in burning the dried leaves.

Finally the results revealed that, women participation in agriculture sector help in increasing family income and reduce the bad environmental effects of crop residues by utilizing it as animal feed or plough it in the soil.

REFERENCES

1. Quisumbing, A.R. and R.S. Meinzen-Dick, 2001. "Empowering Women to Achieve Food Security: Overview", Focus 6, Policy Brief 1of 12, IFPRI,.
2. IFPRI, 2000 "Women the Key to Food Security", June 2000.

3. Booth, H., 1999. "Gender Data Base for Agriculture and Resource Management: Policies in the Pacific Island Countries", SD-dimensions, Sustainable Development Dept., FAO.
4. Tempelman, D., 1999. "Integration of Gender Concerns in Agricultural Data Collection: Conceptual/Methodological Issues", 16th Session of the African Commission on Agricultural Statistics.
5. Jones, C. and R.A. Rosenfeld, 1981. "American Farm Women: Findings from a National Survey", Chicago, Illinois: National Opinion Research Center, Report No.130.
6. Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agric. Economics Bulletin, different issues covering the period (2003-2005).
7. Ministry of Agriculture and Land Reclamation, Sugar Crops Council, Sugar Crops and Sugar Production in Egypt, Report of year 2005.
8. Boulding, E., 1980. 'The Labor of U.S. Farm Women: A Knowledge Gape", Sociology of Work and Occupation.
9. Bentley, S. and C. Sachs, 1984. " Farm women in the United States: An Updated Literature Review and Annotated Bibliography", Department of Agricultural Economics and Rural Sociology, Center for Rural Women, the Pennsylvania State University.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 261-267, 2007
ISSN 1818-6769

Jojoba Oil as a Novel Coating for Exported Valencia Orange Fruit Part 11: the Use of Jojoba Oil Emulsion

Dorria M.M. Ahmed

Department of Pomology, Agriculture and Biological Division,
National Research Center, Dokki, Giza, Cairo, Egypt

Abstract: Jojoba oil emulsion as a novel coating material of Valencia orange fruits (*Citrus sinensis)* as a simulation in citrus packinghouses for export, was investigated. The emulsions from Jojoba oil, prepared by wax to water method at the concentrations of 5, 10, 15, 20, 25 and 30%, were applied. Hand coated fruits were stored at 5°C for 60 days and one week at 20°C as a simulation of land and sea shipment and shelf-life. Coated orange fruits were compared with untreated ones (control) and also those treated with Exported wax (E.-wax) which was used commercially. Fruit quality characteristics (weight loss, decay percentages, respiration rate, ssc, acidity, ssc/acid ratio and ascorbic acid content) were evaluated periodically at removal from cold storage and after holding at 20°C. Jojoba oil emulsions lowered weight loss percent of Valencia orange fruits than that uncoated ones at 5°C, but with further decline weight at 20°C. Also, a noticeable significant decrease in respiration rate was observed with inversely proportional to JOE concentrations increase. Although, orange fruits withstand free from microbial decay as rot symptoms for 60 days of storage either at 5°C or 20°C, whereas, the incidence of breakdown (softening) of coated fruits (at the range of 15-30% of JOE) had lower percent relative to uncoated fruits. Soluble solids content of Valencia orange fruits increased significantly at higher emulsions JOE concentrations (20-30%), meanwhile, titratable acidity showed the opposite trend. Ascorbic acid (Vitamin C) content had significant decrease by expanding storage period with slight loss in fruits coated with highly concentrations of Jojoba oil emulsion coatings. In conclusion, the use of Jojoba oil emulsion-coatings at higher concentration (15-30%), proved to be the most capable treatments in keeping Valencia orange fruit quality for two months of storage at 5°C. This storage duration is enough periods required for land and sea shipment of exported orange fruits.

Key words: Valencia orange % coating % jojoba oil emulsion % emulsifier % cold storage % fruit quality % simulation shipment % shelf-life

INTRODUCTION

Fresh citrus have traditionally been coated with waxes to maintain fruit quality during cold storage or refrigerated shipment, by improving appearance, gloss and function as barriers to water vapor, gases, volatile, ethylene transmission [1, 2]. In addition, postharvest handling has greatly changed with the use of water-soluble wax instead of the petroleum-based wax previously used in the 1980s. [3, 4]. Surface coatings can create different levels of internal atmosphere modification depending on the chemical nature, concentration and thickness of surface cover [5, 6].

Several authors used waxes as emulsion and microemulsions in fruit-coating [7]. The formulae of edible wax coatings were made by microemulsions composed of water, fatty acids, ammonia and various combinations of many waxes [8, 9]. Meanwhile, wax microemulsions used as fruit coatings generally contain morpholine, an ingredient permitted by the U.S. Food and Drug Administration (FDA).The edible coatings are applied to the surface of fresh fruits and vegetables for its protection [10]. Moreover, the application of wax to fruit as microemulsions makes it possible to apply a very thin coating to fruits in which molten wax may not be appropriate [7, 8, 11].

Corresponding Author: Dr. Dorria M.M. Ahmed, Department of Pomology, Agriculture and Biological Division, National Research Center, Dokki, Giza, Cairo, Egypt

It is noteworthy that the use of Jojoba oil has not been used as fruit coating. Jojoba oil is commonly known as liquid wax, colorless and odorless with unique physical and chemical properties. The objective of this study was to define clearly the effect of emulsified Jojoba oil as fruit coatings on maintaining quality of Valencia orange fruit during cold storage and shelf-life

MATERIALS AND METHODS

Fruit: Valencia orange fruits (*Citrus sinensis*) were obtained from a private orchard (Dina), Giza Governorate. Orange trees were 15 years old grown in new lands of sand-loam soil, cultivated in 5 x 5 meters and were similar in growth and received common horticulture practices. Mature orange fruits, undamaged, free from apparent pathogen infection, uniform in shape, weight and color were harvested at the mid of May of 2003, 2004 and 2005 in the full color stage and average weight of 224.3 gm and transported to the laboratory. The initial quality measurements were determined as shown in (Table 1).

Jojoba oil emulsion for coatings: Jojoba oil (Iodine value, 85; saponification value, 93 and acid value, 0.2) was obtained from Egyptian Company for natural oils. The emulsions from jojoba oil were prepared by wax to water method. It is required that water was added to the jojoba oil according to Hagenmaier and Baker [1]. Typically, 5, 10, 15, 20, 25 and 30 ml of liquid Jojoba oil were used for the preparation of different concentrations of Jojoba Oil Emulsion (JOE). Tween 80 as emulsifier material was used in this investigation. A stock solution of Tween 80 was prepared by adding 90 ml of water to 10 ml of Tween 80 to introduce Tween 80 emulsifier at the concentration of 1%. Emulsions of Jojoba oil were prepared by adding the stock solution of Tween 80 to the above mentioned concentrations of Jojoba oil at variable amounts, so that the emulsion was stabilized. Afterthat, the mixtures were completed with water to 100 ml to obtain Jojoba oil emulsion-coatings (JOECs) concentrations of 5, 10, 15, 20, 25 and 30% (v/v). It is worthy to mention that the amount of Tween 80 solution is proportionally increased with Jojoba oil concentrations within the range of 4-12 ml. Emulsions at different concentrations were mixed thoroughly with vortex stirrer before fruit coatings. The stirred Jojoba mixtures (Jojoba oil emulsions) were stored in a closed dark container and were ready for the coating application.

Table 1: Valencia orange fruit characteristics at harvest (average of three seasons)

Fruit quality characteristics at harvest				
Respiration rate (ml/kg^{-1}hr^{-1})	Soluble solids content %	Titratable acidity %	SSC/TA ratio	Vitamin C (mg/100g)
3.11 ± 0.02	11.37 ± 0.14	0.78 ± 0.01	14.64 ± 0.15	46.53 ± 0.89

Fruit Coating Treatments: At the day of harvest, the selected Valencia orange fruits were washed with rotating polyethylene brushes, using only tap water with citrus washer (Tew packaging line). Coating of the selected fruits was carried out with JOE at the concentrations of (5, 10, 15, 20, 25 and 30%). Thus, the JOE mixtures were stirred thoroughly again before the coating process.

Fruits randomly subjected to the different emulsions of Jojoba oil, were hand coated (0.4 ml per fruit) with a paint pad brush at 25±1°C. The coated orange fruits were compared with commercial exported wax (E.-wax) and also with uncoated fruits (control). Export wax which used in citrus packinghouses was obtained from Egyptian company for mechanical & electrical industries. The composition of the Exported wax as water emulsion contained 22% solids materials including shellac, kalaphonia, polyethylene emulsifier and water.

Treated and untreated fruits packed in carton boxes (6 kg in two layers of fruits), were stored at 5°C±1 and relative humidity 85 - 90 % for 60 days as simulation of export shipment. At 15 days intervals, fruit sample (15 fruits for each treatment) was removed from cold storage to determine fruit quality assessments and shelf life at 20°C and 55-60% RH was also examined.

Quality assessments

Weight loss: Fruits were periodically weighed and the loss in mass weight was recorded for each replicate. Data were calculated as percentage.

Decay percent: Decayed fruits (physiological and microbial decay) were discarded in each sample and decay percent was recorded till the end of experiment.

Respiration rate: Individual fruits for each treatment were weighed and placed in 2-liter jars at 20°C. The jars were sealed for 3 hr with a cap and a rubber septum. The resulting of O_2 and CO_2 samples of the headspace were taken via septum with a syringe and then injected into Servomex Inst. Model 1450C, Food Pack Gas Analyzer to measure oxygen and carbon dioxide production. Respiration rate was calculated as ml CO_2 kg^{-1} hr^{-1} [12].

Soluble Solids Content (SSC): Individual orange fruit was ground in an electric juice extractor for preparing fresh juice. Soluble solids content was measured using a T/C hand refractometer Instrone (Model 10430 Brix-readings 0-30 ranges Bausch & Lomb Co. Calif., USA. [13].

Titratable Acidity (TA): Titratable acidity (expressed as citric acid weight %) was determined by titrating 5-ml juice with 0.1N sodium hydroxide using phenolphthalein as an indicator [13].

Ascorbic acid (Vitamin C): Ascorbic acid content was measured using 2, 5-6 dichlorophenol indophenols' method [13].

Experimental design and statistical analysis: The design for this experiment was a Completely Randomized Design (CRD) with three replicates. Data were analyzed with the Analysis of Variance (ANOVA) procedure of MSTAT-C program. When significant differences were detected; treatment means were compared by LSD range test at the 5% level of probability of the three investigated seasons [14].

RESULTS AND DISCUSSION

Weight loss and fruit breakdown percentages: The average weight loss percentage of Valencia orange fruits significantly increased as the concentration of Jojoba oil emulsion-coatings (JOECs) decreased during cold storage at 5°C up to 60 days, as well as after shelf-life for 7days at 20°C (Table2).

Utilization of JOE showed lower loss in fruit weight at the concentrations ranged between 15-30% relative to uncoated fruits (control). After 8 weeks of cold storage at 5°C, the highest JOE concentration (30%) showed the lower loss in fruit weight (6.65%) compared with control fruit value (8.73%). Meanwhile, fruits coated with exported wax (E-wax) had the lowest significant weight loss value (5.58%) of all stored orange fruits.

In marketable life at 20°C for 7 days, further significant decline weight was observed in orange fruits. The reduction at shelf-life recorded around 1/5 percent of its value after 60 days of storage at 5°C. The same trend was obtained at the three successive seasons of investigations.

In all coated and uncoated fruits, Valencia orange fruits did not show any microbial decay as rot symptoms either at cold storage at 5°C or shelf-life at 20°C. The incidence of breakdown (softening) of Valencia orange fruits coated especially with higher concentrations of JOE, had lower percentage than uncoated ones as well as at marketable period at 20°C (Table 2). It was found that better results superior to the exported wax was found by obtaining the least fruit deterioration (3.53%) occurred in JOE-coating at the concentration of 30%, followed by (3.58%) in fruits coated with exported wax (E-wax).

Table 2: The influence of Jojoba Oil Emulsion Coatings (JOECs) on weight loss and decay (breakdown) percent of Valencia orange fruits after storage at 5°C for 60 days and 7 days at 20°C (shelf-life)

Jojoba oil emulsion concentrations	Weight loss %		Decay (Breakdown) %	
	60 days storage at 5°C			
	At transfer	Plus 7 days at 20°C	At transfer	Plus 7 days at 20°C
TJO 5 %	11.00a±0.038	2.26i±0.025	7.10e±0.020	9.91a±0.046
TJO 10%	10.21b±0.046	2.04j ±0.031	6.13g±0.015	8.44b±0.027
TJO 15%	8.35d±0.041	1.69k±0.023	5.54j±0.030	7.56d±0.030
TJO 20%	7.96e±0.042	1.48l±0.021	4.84l±0.036	6.73f±0.025
TJO 25%	7.44f±0.045	1.35mn±0.025	4.30m±0.035	5.86h±0.038
TJO 30%	6.65g±0.038	1.26n±0.032	3.53n±0.025	4.98k±0.021
E-wax	5.58h±0.049	1.14o±0.010	3.58n±0.015	5.02k±0.023
Control	8.73c±0.066	1.38lm±0.015	5.73i±0.020	7.98c±0.021
LSD at µ 0.05 of storage (S)		0.037	0.026	
LSD at µ 0.05 of Coatings (C)		0.074	0.053	
LSD at µ 0.05 (S X C)		0.105	0.074	

Data are means of three replicates of 5 fruits each. (Average of three seasons)

On the other side, the highest breakdown value (7.10%) which was obtained in coated fruits with the least concentration of EJO (5%) after two months of cold storage at 5°C. In addition, during shelf-life period, it can be proved that breakdown percent showed the same trend but with more significant increase than cold storage values (Table 2). The differences between the storage period and JOE-coating concentrations were significant.

Respiration rate: Data illustrated in Figure 1, revealed that there was a noticeable significant decrease in respiration rate of Valencia orange fruits with inversely proportional to the JOE concentrations increase.

In general, all JOE-coatings showed significant lower rate of CO_2 production than control fruits, but was higher rate of fruits coated with commercial exported wax (E-wax). Moreover, the good quality of Valencia orange fruits caused by the least respiration rate was observed in E-wax coating application followed by the highest JOE concentration of 30% (4.09 and 4.23 ml kg^{-1} hr^{-1}) respectively. In addition, uncoated fruits (control) had the

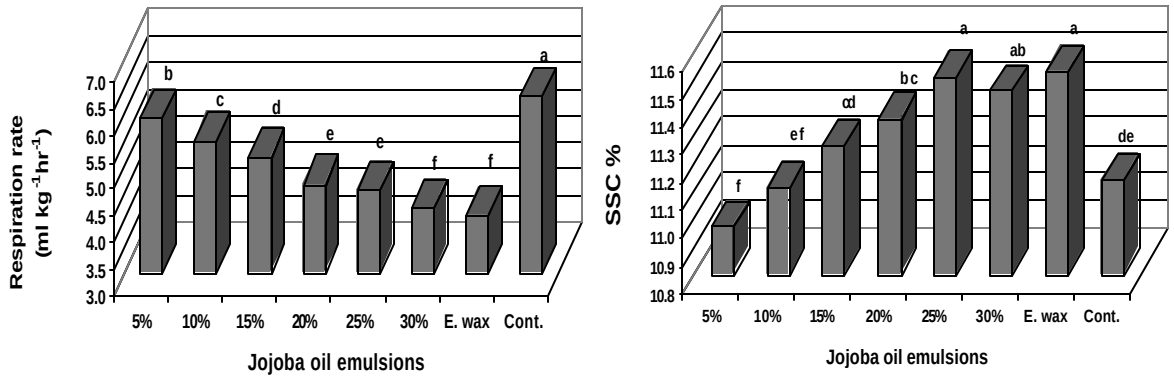

Fig. 1: Respiration rate and soluble solids content of Valencia orange fruits coated after harvest with different concentrations of Jojoba oil emulsions (JOE) and stored at 5°C for 60 days. Values are the means of 3 replicates of 5 fruits each. The letters represents LSD at 0.05 level

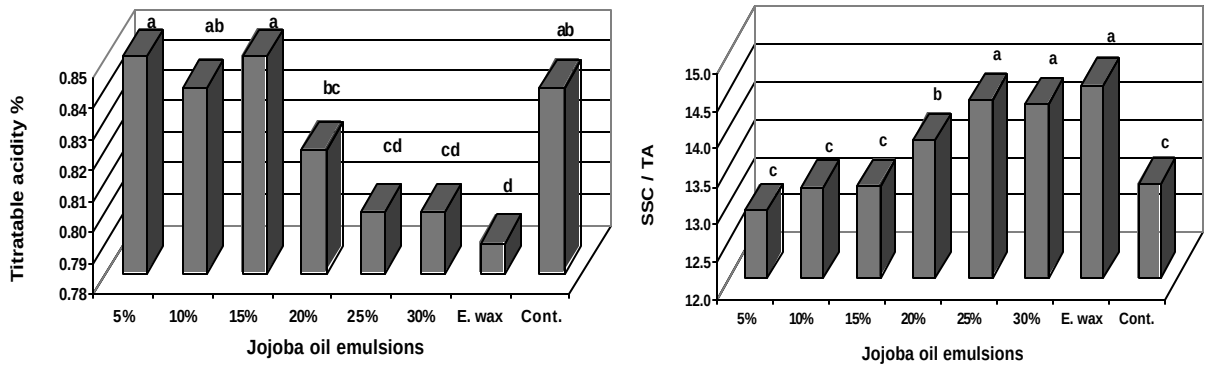

Fig. 2: Titratable acidity and soluble solids /acid ratio of Valencia orange fruits coated after harvest with different concentrations of Jojoba oil emulsions (JOE) and stored at 5°C for 60 days. Values are the means of 3 replicates fruits each. The letters represents LSD at 0.05 level

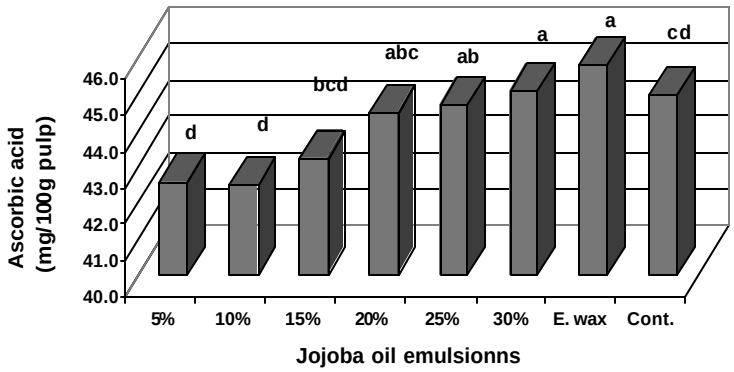

Fig. 3: Ascorbic acid content of Valencia orange fruits coated after harvest with different concentrations of Jojoba oil emulsions (JOE) and stored at 5°C for 60 days. Values are the means of 3 replicates of 5 fruits each. The letters represents LSD at 0.05 level

highest rate of respiration (6.32 ml kg^{-1} hr^{-1}) at 5°C compared with 5% of JOE coating (5.92 ml kg^{-1} hr^{-1} after 60 days).

Soluble solids content: It can be noticed from (Fig.1) that soluble solids content (SSC) of Valencia orange fruit showed a significant increase relative to the coatings of Jojoba oil emulsion concentrations up to 60 days of storage at 5°C, as well as after shelf-life at 20°C. Significant increase in SSC (11.51 and 11.46%) were obtained when using the high concentrations of JOE-coating (25 and 30%) respectively, with comparison to the initial value at harvest (11.37%). Meanwhile, control fruits had significant decline value (11.14%) which approximately equal to that fruits coated with 10% of JOE (11.11%) with insignificant difference.

Titratable acidity: It can be stated from Fig. 2 that Valencia orange fruits coated with Jojoba oil emulsions, revealed significant decrease with inversely proportional to JOE concentrations increase. Moreover, orange fruits coated with exported wax had the least significant acid content (0.79%) after 8 weeks of storage at 5°C. In addition, the highest titratable acid content (0.85%) was obtained in fruits coated with Jojoba oil emulsions at the concentrations of 5 and 15%. It was followed by fruits treated with 10% JOE and control fruits, which they have the same acid values (0.84%).

Soluble solids/acid ratio: At the end of storage period (2 months), the soluble solids/acid ratio (SSC/TA), as the organoleptic test indicator of stored Valencia orange fruit, as a result of Jojoba oil emulsion-coatings, were illustrated in (Fig. 2). SSC/TA ratio were increased as the concentrations of JOE-coatings increased, but with less significant ratio than their value at harvest (14.64%). Moreover, an equal SSC/TA ratio (13.23 and 13.25%) were noticed in fruits coated with JOE at the concentrations of 10 and 15% respectively, with significant difference. Uncoated orange fruits (control) had the same equal ratio (13.26%) after 8 weeks of cold storage at 5°C. After the marketable life at 20°C for 7 days, the same trends were observed throughout the three successive seasons of investigations.

Ascorbic acid content (Vitamin C): Vitamin C content of Valencia orange fruits at harvest was (46.53 mg/100mg). It is clear from Fig. 3 that orange fruits coated with different Jojoba oil emulsion concentrations, showed significant decrease in vitamin C content after 8 weeks of cold storage at 5°C as well as after holding at 20°C compared with its initial value.

Generally, the higher concentrations of Jojoba oil emulsion kept higher vitamin content. Moreover, orange fruit coated with exported wax (E-wax) had the highest vitamin C content, followed by fruits coated with JOE at 30% (45.77 and 45.03 mg/100g pulp) respectively. In addition, the least ascorbic acid content (42.46 mg/100g pulp) was noticed in orange fruits coated with 10% of Jojoba oil emulsion. At the end of storage period, the differences between JOE-coatings concentrations were significant. The shelf-life period for 7 days at 20°C showed the same trend, with slight changes.

DISCUSSION

The novel utilization of Jojoba oil emulsion as Valencia fruit coating had different proportional contributions to fruit quality characteristics throughout cold storage at 5°C for two months which is enough for sea and land shipment of orange fruits. Increasing the concentration of Jojoba oil emulsion resulted in a quadratic increase in the amount of coating deposit left on the fruit surface. These findings were interpreted by Amarante *et al*. [5] and Banks *et al*. [11] to be as a result of increased total solids concentrations and also by possibly increased coating viscosity rather than by reduced coating surface tension. In addition, the authors reported that, diluted coating concentrations caused very small increases in coating deposit on fruit skin.

Similarly, the results in the current study indicated that increasing the emulsion Jojoba oil concentrations showed a more substantial effect of coatings in reducing permeability of gases and water vapor than lower concentrations as supported by Ben-Yehoshua *et al*. [15] and Amarante *et al*. [5]. This led to maintain Valencia coated fruit quality up to 8 weeks of cold storage at 5°C, especially with highly JOE concentrations.

Recent reports on respiration rate have suggested that gases diffuse mainly through pores, while water moves preferentially by a different pathway, probably through a liquid aqueous phase in the cuticle where water conductance is much higher [1, 15]. Also, Banks *et al*. [11] found that the permeability of the coating film is much more important than pore blockage in reducing fruit's water loss and that the modification of fruit internal atmosphere is strongly determined by the proportion of pores blocked by the coating and not by the permeability

of the coating film. In contrast to the two views, Hagenmaier and Baker [8,16] suggested that for both CO_2 and water vapor, the skin permeance of coated fruit was mainly reduced by a coating tendency to seal pores in the fruit peel, besides the resistance of the coating film by itself.

In the present study, Valencia orange fruits coated with different concentrations of Jojoba Oil Emulsion (JOE) showed lower loss in fruit weight and respiration rate at the concentrations ranged between 15-30% in relative to uncoated fruits (Table 2 and Fig. 1). These results were in harmony with those obtained on citrus fruits by Hagenmaier and Baker [1, 7] and Porat *et al*. [17]. They reported that permeability for citrus coatings should be high for O_2, CO_2 and low for water vapor to reduce transpiration as much as possible and not overly restrict respiration. In all cases, it can be concluded that weight loss reduction was indicative to good waxing type. Waxing fruit partially or completely plugs pores, restricting mainly the transport of O_2 and CO_2 and to a less extent, water [5, 18].

With reference to the decay percentage, it was mentioned as a limiting factor for storage life of citrus fruits. The physiological breakdown was the main problem limit the long-term storage capability of Valencia orange fruit used in this investigation [2,20]. Also, Breakdown as softening appearance of coated fruits ranged between 7.10-3.53% with directly proportional to JOE concentrations during storage at 5°C as well as during marketable life at 20°C (Table 2). These results are confirmed with those suggested by Hauting [3] and Ergun *et al*. [18] which they found that Grapefruit handling at the packinghouse reduces fruit resistance to chilling injury because washing influences the fine wax structure of citrus peel. Moreover, Petracek *et al*. [19] and Brown and Miller [4] reported that the effect of waxing on peel disorders is particular interest since subsequent loss of fruit during storage is often substantial. Additionally, the postharvest pitting can be controlled by improving the gas permeability of applied wax citrus peel which caused extending the storage and marketable life.

After two months of cold storage at 5°C as well as at shelf life at 20°C, soluble solids (SSC) were affected slightly either by coatings or cold storage duration (Fig.1). Moreover, titratable acidity (TA) had a slight significant decrease with inversely proportional to EJO concentrations [2, 9]. In addition, SSC/TA ratio were increased as the concentrations of EJO-coatings increased, but with less significant ratio than their value at harvest. The present data are similar to those reported by Landaniya and Sonkar [20] and Ergun *et al*. [18] on mandarin and mamy sapote fruits respectively. Also, Burns and Echeverria [21] and Chien *et al*. [6], found that there is no effect on acidity percent and SSC values of stored 'Valencia' fruit and Murcott tangor citrus fruits due to wax application.

In all JOE coatings studied, a significant decrease of vitamin C could be observed in Valencia orange fruit between the initial value and the Vitamin C content at the end of storage period. Mahrouz *et al*. [22] and Chien *et al*. [6] had the same findings after waxing treatments of Clementine and Murcott tangor citrus fruits in this respect.

CONCLUSION

So far, coating of Valencia orange fruit with Jojoba oil emulsion (JOE) has not been utilized for such citrus fruits. It is considered as a new coating material, produced from natural source and suggested as edible and safe wax for fruit coating during postharvest handling in citrus packinghouses for exportation. Generally, the higher concentrations of Jojoba oil emulsion (15-30%) were more effective than lower ones in keeping Valencia orange fruit quality up to 60 days at 5°C as well as at 20°C. Two months of storage is enough period required for land and sea shipment of exported orange fruits.

ACKNOLEDGEMENT

The author acknowledges Dr. M. Hassan El-Mallah and Dr. Safinaz M. El-Shami in the Fats and Oils Department, Food Industry and Nutrition Division, National Research Center, for their help and criticism offered during the preparation of this work. I am also thankful for the financial support from the National Research Center (NRC). Also, I thank the members of Agricultural Development Systems project (ADS) for technical assistance.

REFERENCES

1. Hagenmaier, R.D. and R.A. Baker, 1994. Wax microemulsions and emulsions as citrus coating. J. Agric. Food Chem., 42: 899-902.
2. Kader, A.A. and M.L. Arpaia, 2002. Postharvest handling systems: subtropical fruit In: Kader, A.A. (Ed). Postharvest Technology of Horticultural Crops. Regents of the University of California. Division of Agricultural and Natural Resources, Okland, CA. pp: 375-384.

3. Huating, D., 2004. Effect of Coating Application on Chilling Injury of Grapefruit Cultivars. HortScience, 39: 558-561.
4. Brown, G.E. and W.R. Miller, 1999. Maintaining fruit health after harvest, In:L.W. Timmer and L.W. Duncan (Eds.). Citrus Health Mgt., APS Press, St. Paul. Minn., pp: 175-188.
5. Amarante, C., N.H. Banks and S. Ganesh, 2001. Relationshipbetween character of skin cover of coated pears and permeance to water vapour and gass. Postharvest Biol. Technol., 21: 291-301.
6. Chien, P.J., F. Sheu and H.R. Lin, 2007. Coating citrus (Murcott tangor) fruit with low molecular weight chitosan increases postharvest quality and shelf life. Food Chemist., 3: 1160-1164.
7. Hagenmaier, R.D. and R.A. Baker, 1996. Edible coatings from candelilla wax microemulsions. J. Food Sci., 61: 562-565.
8. Hagenmaier, R.D. and R.A. Baker, 1997. Edible coatings from morpholine-free wax microemulsions. J. Agric. Food Chem., 45: 394-352.
9. Mannheim, C.H. and T. Soffer, 1996. Permeability of different wax coatings and their effect on citrus fruit quality. J. Agric. Food Chem., 44: 919-923.
10. FDA. Code Fed. Regul. 1995. Title 21.
11. Banks, N.H., J.G.M. Cutting and S.E. Nicholson, 1997. Approaches to optimizing surface coatings for fruits. N. Z. J. Crop Hort. Sci., 25: 261-272.
12. Lurie, S. and E. Pesis, 1992. Effect of acetaldehyde and anaerobiosis as post harvest treatment on the quality ofpeaches and nectarines. Postharvest Biol.Technol., 1: 317-326.
13. A.O.A.C., 1990. Official methods of analysis. Association of Official Analytical Chemists., Washington, DC, USA.
14. Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods. 7th Edn. lowa State Univ. press Ames. Low USA.
15. Ben-Yehoshua, S., S.P. Burg and R. Young, 1985. Resistance of citrus fruit to mass transport of water vapor and other gases. Plant Physiol., 79: 1048-1053.
16. Hagenmaier, R.D. and R.A. Baker, 1993. Reduction in gas exchange of citrus fruit by wax coatings. J. Agric. Food Chem., 41: 283-287.
17. Porat, R., B. Weiss, L. Cohen, A. Daus and N. Aharouni, 2004. Reduction of postharvest rind disorders in citrus fruit by modified atmosphere packaging. Postharvest Biol. Technol., 33: 35-43.
18. Ergun, M., S.A. Sargent, A.J. Fox, J.H. Crane and D.J. Huber, 2005. Ripening and quality responses of mamy sapote fruit to postharvest wax and 1-methylcyclopropane treatments. Postharvest Biol. Technol., 36: 127-134.
19. Petracek, P.D., H. Dou and S. Pao, 1998. The influence of applied waxes on postharvest physiological behavior and pitting of grapefruit. Postharvest Biol. Technol., 14: 99-106
20. Landaniya, M.S. and R.K. Sonkar, 1997. Effect of curing, wax application and packaging on collar breakdown and quality in stored ‘Nagpur’ mandarin (*Citrus reticulate*). Indian Journal of Agricultural Sciences, 67: 500-503.
21. Burns, J.K. and E. Echeverria, 1990. Quality changes during harvesting and handling of Valencia oranges. Proceedings, Florida State Horticulture Society, 103: 225-228.
22. Mahrouz, M., M. Lacroix; G.D. Aprano, H. Oufedjikh, C. Boubekri and M. Gagnon, 2002. Effect of (- irradiation combined with washing and waxing treatment on physiochemical properties, vitamin c and organoleptic quality of citrus clemantina. Hort. Ex. Tanaka. J. Agric. Food Chem., 50: 7271-7276.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 268-270, 2007
ISSN 1818-6769

Performance Characteristics of West African Dwarf Goat Fed *Aspergillus* Treated Cassava *(Manihot esculutus)* Waste Based Diets

M.A. Belewu and O.O. Fagbcmi

Microbial Biotechnology and Dairy Science Laboratory,
Department of Animal Production, University of Ilorin, Kwara State, Nigeria

Abstract: The effect of Cassava waste incubated with *Aspergillus niger* on the performance characteristics of WAD goats (n=12) was studied in a Completely Randomized Design Model for 56 days in which the untreated cassava waste was used as the control and the fungus treated waste was included in diets B, C and D (20, 30 and 40% levels respectively). The feed intake, growth rate, weight gain, apparent digestibility and digestible nutrients parameters were monitored. The results revealed that the micro- fungus has greater affinity to dignify cassava waste and this leads to a greater decrease in the crude fibre content of the waste. The activities of the fungus on the cassava waste increased the crude protein content while the consumption of the fungus treated diets compared very well with diet A (control). Animals fed the fungus treated diets showed increasing weight gain. There was also increase in the nutrient availability from the treated cassava waste, thereby increasing the digestibility of this diet. To this effect, the inclusion of fungus treated cassava waste in the diet of WAD goat suggested that fungal treatment had improved effect on feed intake, digestibility and growth rate which holds a good promise as a converter of fibrous materials thereby enhancing it utilization by goat.

Key words: *Aspergillus niger* % cassava waste % intake % digestibility % WAD goat

INTRODUCTION

Livestock farmers in developing countries are faced with various challenges that led to a considerable fall in the production of certain livestock species like goats, cattle, swine and poultry. Most of the problems originated from high cost of production due to increase in prices of locally available feed ingredients and livestock species.

The effects of these challenges have reflected on the quality and amount of animal protein available for human consumption in the third world.

Waste agricultural residues (Tapioca or cassava waste) which constitute a nuisance to the environment can be used to greater extent if properly processed. The various processing methods include physical, mechanical, chemical and biological. The physical, mechanical and chemical methods are well documented in literature [1, 2] while the biological method is still at its infancy in Nigeria but Belewu and Afolabi, [3]. Belewu [4], Belewu, [5] reported on the efficacy of this method and/or compared to the chemical method. There were improvement in the feed intake (CP, CF, EE, NFE, ADF, NDF) of animal fed fungi treated rice husk, cotton waste, sorghum stover and saw-dust [6, 5]. The effect of feeding fungus treated cotton waste on *In vitro* dry matter enzymatic digestibility (FVDMED) are well documented [7]. Similarly, the effect of fungi on IVDMED of lemon grass and bagasse was reported [8]. The resultant effects of this method are the pre -digestion of the fibrous materials, the availability of fungal protein and the addition and release of bound minerals [9]. Hence, the objective of the work reported in this paper was to determine whether the *Aspergillus* treatment of cassava waste (Manihot) would affect the performance characteristics of growing WAD goats fed rations in which the fungus treated cassava waste was included at various levels. Previous work in this laboratory showed that, the rate of fibre degradation was high by such treatment (fungus) concomitant with increased digestibility in nitrogen and structural carbohydrate.

MATERIAL AND METHODS

Fungus and subtrate used: *Aspergillus niger* used for the experiment was isolated from soil through serial dilution method, later identified and characterized accordingly.

Corresponding Author: Dr. M.A. Belewu, Microbial Biotechnology and Dairy Science Laboratory, Department of Animal Production, University of Ilorin, Kwara State, Nigeria

Table 1: Composition of the Experimental Diets

	A	B	C	D
Ingredients (%)	Control			
Cassava waste	40.00	20.00	10.00	-
Aspergillus treated Cassava waste	-	20.00	30.00	40.00
Sorghum brewers dried grain	15.00	15.00	15.00	15.00
Wheat offals	15.00	15.00	15.00	15.00
Palm kernel cake	28.00	28.00	28.00	28.00
Common salt	1.00	1.00	1.00	1.00
Vitamin-mineral premix	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00
Proximate composition				
Dry matter	94.50	94.00	94.10	95.11
Crude Protein	14.39	16.60	16.80	17.95
Crude fibre	11.10	10.20	9.10	8.40
Ether extract	8.00	6.00	6.50	5.50
NFE	60.34	65.10	63.42	64.81
Acid detergent fibre	60.90	47.30	37.80	32.80
Lignin	53.22	48.63	39.11	33.96

* Containing per kg, Vit. A, 10000iu; Vit. D_3,1500000iu, Vit. E, 300iu; Vit. K_3, 300g; Vit. B_2 250g; Nicotinic acid, 8.00g; Calcium D-Panlhothenate, 30g; Vit. B_6 0.03g; Vit. B_{12}, 800mg; Mn 10,000g; Fe, 5.00g; Zn, 4.50g; Cu 0.20g; Iodine, 0.15g; Co, 0.02g; Selenium,0.01 g.

Stock culture of the fungus was maintained on potato dextrose agar (PDA) kept in a MacCarthy bottle and stored at room temperature till needed for inoculation.

Cassava waste used was obtained from the garri processing centers around Ilorin metropolis, Nigeria. The waste was sundried, later milled and packed into polyprothene bags. At the start of the experiment, the waste was sterilized by autoclaving at 121°C, 15 kg cmG^2 for 15 minutes. It was allowed to cool and then inoculated with *Aspergillus niger*.

Inoculation and incubation: *Aspergillus niger* was harvested with Tween 80 solution (10ml, 0.01% V/V) and adjusted to l0^7 - 10^s spores per ml with sterile water. Each bag (50g) was inoculated with 5ml of the spore suspension containing 1O^7 spore per ml of each microoganism. The inoculated substrate was covered partially with cellophane and in about 7 days the fungus covered the surface of the substrate. The fungus growth was later terminated by oven drying at 70°C for 48 hours in a laboratory air forced draught oven.

Preparation of the experimental diets: Four experimental diets were formulated in which diets B, C and D contained graded levels (20, 30 and 40% respectively) of fungus treated cassava waste while diet A (control) has untreated cassava waste (40%). Other ingredients are of similar quantities as shown in Table 1.

Animals and management: West African dwarf goals (n=12) treated against ecto and endo parasites and weighing between 2.80 and 5.4 kg were randomized against the experimental diets in a Completely Randomized Design Model for a 56 day period. Feeding and watering were given *ad libitum* while feed intake, growth rate and weight gain were monitored weekly. Digestibility study was conducted in the last week of the experiment using a total faecal collection method [10].

Chemical analysis: The experimental diets (A, B, C, D) were subjected to chemical analysis using the method of A.O.A.C [11] while fibre fractions were determined according to the method of Goering and VanSoest [12].

Statistical analysis: All data collected were subjected to analysis of variance [13] of a Completely Randomized Design Model while treatment means were separated by Duncan [14] multiple range test.

RESULTS AND DISCUSSION

Data on digestibility (Table 2) trial show that fungus treatment resulted in a substantial increase in intake and digestion of the various organic components shown ($p<0.05$). For example, dry matter and crude protein consumption were increased by 79.01 and 113.56% respectively while the dry matter and crude protein digestibilities were 19.88 and 6.73%. Thus, the data suggest that the effects of treating cassava waste with fungus are similar to those noted for other fungi treated lignocellulose materials [3, 4, 10]. The untreated cassava waste (control diet) was poorly consumed (DM, 17.01 gld; CP, 1.18 g/d). Treating the waste with *Aspergillus niger* resulted in improved ADF and lignin intake but dry matter and ether extract intake were similar in diets A and C.

In addition, there was considerably improvement in the digestibility of the fungus treated waste over the untreated waste (control diet). The fibre fraction (ADF and lignin) was higher in the control (97.9 and 53.72% respectively) than in the fungus treated diets. This is expected, since there was no treatment of the cassava waste by the fungus. The coefficient of digestibility for CP, ADF and lignin were significantly higher in the fungus treated cassava waste of diets B - D. This agreed with the results of Belewu [4] Belewu and Adenuga [10],

Table 2: Feed intake, digestibilities and weight gain of WAD goat fed fungus treated cassava waste

Parameters	A	B	C	D	±SE
Dry matter intake (g/d)	17.01 [a]	26.32 [b]	40.50 [c]	30.45 [d]	3.52*
Digestibility %	51.40 [a]	59.72[a]	86.66	81.28 [b]	5.27*
Crude protein intake (g/d)	1.18 [a]	2.13 [b]	3.34[c]	2.52 [b]	0.39*
Digestibility %	66.52[a]	85.43[b]	94.97[c]	93.25 [c]	8.23*
Crude Fibre intake (g/d)	1.99[a]	2.86[b]	3.91[c]	2.69[b]	0.40*
Digestibility %	76.93[a]	89.16[a]	96.00[b]	94.94[b]	6.12*
Ether extract intake (g/d)	1.44[a]	1.68[a]	2.79[b]	1.76[a]	0.32*
Digestibility %	83.33[a]	80.35[a]	94.62[b]	93.18[b]	7.33*
NFE intake (g/d)	10.86[a]	18.22[b]	27.27[c]	1.76[a]	0.32*
Digestibility %	50.27	51.97	83.16	76.41	5.14*
Lignin intake (g/d)	9.14	12.80	15.80	26.80	2.95[+]
% Digestibility	60.85[a]	78.82[a]	93.25[b]	96.10[b]	6.38*
Acid detergent intake (g/d)	16.01a	24.70b	38.11c	28.76bs	3.72*
% Digestibility	72.08[a]	76.60[a]	92.23[b]	90.64[b]	8.75*
Metabolizable energy	60.73	60.18	60.93	60.83	4.25NS
% TDN''	2.47[a]	33.25[b]	46.94[c]	47.95[c]	3.13*
Weight gain (kg/d)	0.75[a]	0.86[a]	1.04[b]	1.14[b]	0.02*

+ Capenter and Clegg (1956)
++Church and Champe (1980)

Belewu *et al*., [2] who noted that treatment of lignocellulose materials with fungi improved animal performance significantly. Weight gain was increased markedly when goats consumed the diets containing fungus treated waste. Animals on diet D recorded the highest weight gain followed by animals on diets C, B and A in that order. Thus, the method seems an appropriate one for evaluating digestibility of low quality waste agricultural residues. The chief advantage of the method is that a diet containing low quality waste agricultural residues fed alone is not required, so few treatments less analytical method should be done to break the bond and upgrade the material for better animal performance.

Calculated ME and TDN values (Table 2) showed that the fungus treated cassava waste based diets resulted in higher performance compared to the control diet (A). In conclusion, the results of the study show that WAD goat production performance was different on diets containing fungus treated and untreated cassava waste based diets. Diets may be more cost effective in particular circumstances. Moreover, a comparable performance at dietary concentrations up to 40% of the fungus treated waste was attained without any detrimental effect on the performance of the animals and in contrast to the previously held opinion and practice on the feeding of biological (microbes) treated materials, to livestock.

REFERENCES

1. Church, D.C. and K.A. Champe, 1980. Digestibility of untreated and hydroxide treated rye grass straw J. Anim. Sci., 1: 20-24.
2. Belewu, M.A., N.O. Muhammed and B.O. Ikuomola, 2004. Comparative nutritional evaluation of fungus treated and alkali treated rice husk by rat. Moor J. Agri. Res., 2: 129-134.
3. Belewu, M.A. and O.Y. Afolabi, 2000. Biochemical degradation of corn cobs and arborea sawdust by Oyster mushroom Pleurotus sajor caju. Proceeding, International Confon Biotechnology held at Sheraton Hotel Abuja between 24 and 26th Oct. 2000.
4. Belewu, M.A., 2001. Effect of fungus (Volvariella Volvacea) treated cotton waste as a replacement For cotton seed cake and meal by WAD goats. Trop. J. Anim. Sci., 4: 93-98.
5. Belewu, M.A., 2003. Nutritional qualities of corn cobs and waste paper incubated with mushroom (Pleurotus sajor caju) Nig. J. Anim. Prod., 30: 20-25.
6. Belewu, M.A. and A.A. Ademilola, 2002. Digestibility response of WAD goat to mushroom (Volvariella volvacea) treated cotton waste Moor J. Agric. Res., 1: 83-86.
7. Belewu, M.A., 2006. Conversion of mansonia sawdust and cotton plant by-product (*Pleurotus saior caju*). African J. Biotech., 5: 1763-1764.
8. Rolz, C., R. De-leon, M.C. De Arriola and S. De-Cabrera, 1986. Biodelignification of Lemon and citronella bagasse by white rot fungi. Applied Environ. Microbial, 4: 607-611.
9. Jacqueline, E.W., Broerse and Bert Visser, 1996. Assessing the potential in Biotechnology: Building on Farmers' knowledge. CTA Book edited by Joske, B, Bertuis, H and Wim, H.
10. Belewu, M.A. and O.S. Adenuga, 2003. Effect of treating rice husk with *Aspergillus niger* on feed intake and digestibility of WAD goat. J. Raw Material Res., 2: 19-23.
11. A.O.A.C., 1990. Official Methods of Analysis '(15th Ed). Association of Official Analytical Chemists, Washington, DC, Anim. Prod. Held between 21 and 24th March at Gateway Hotel Abeokuta, Ogun State.
12. Goering, H.K. and P.J. Vansoest, 1970. Forage fiber analysis. (Appartus, reagent procedure and some applications) Agric handbook No379. ARS USDA, Washington, DC, pp: 20.
13. Steel, R.G.D. and J.H. Torre, 1990. Principles and procedure of statistics. A Biometrical Approach, 2nd Edn. Me Graw-Hill.
14. Duncan, D.B., 1955. Multiple range test and multiple F-test. Biometrics, 1: 1-42.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 271-281, 2007
ISSN 1818-6769

Improving the Production of *Ruta graveolens* L. Plants Cultivated under Different Compost Levels and Various Sowing Distance

S.E. El-Sherbeny, M.S. Hussein and M.Y. Khalil

Departments of Cultivation and Production of Medicinal and Aromatic Plants,
National Research Centre, Dokki, Giza, Egypt

Abstract: Two field experiments were carried out during 2004/2005 and 2005/2006 seasons to study the effect of compost fertilizers at three doses of 78.54, 159.46 and 238 Kg N/hectare on growth, flower characters and active constituents of *Ruta graveolens* L. plants cultivated at three different plant distances. Compost significantly improved most vegetative growth characters as plant height, fresh and dry weight of leaves, stems and roots. The highest compost level produced highest accumulation of essential oil of leaves and flowers, rutin and coumarin percentage as well as nutrient content (N, P, K, Fe, Mn and Zn). The different sowing distance recorded various difference effects on growth characters. The narrow distance (30 cm) resulted the highest essential oil yield for both leaves and flowers, while the wider distance of 50cm produced highest accumulation of rutin, coumarin and nutrients content. Moreover, the interaction between compost doses and sowing distances indicated that the highest means values for most growth characters, rutin and coumarin were recorded with 78.54Kg N/hectare +30 cm distance between plants, while for essential oil content the applied 159.46 Kg N/hectare and sowing at 30 cm produced highest content. GC/MS analysis of rue essential oil showed that there were 32 and 31 compounds for leaves and flowers consisting about 94.54 and 96.45% of total essential oil for both organs respectively. The major constituents of rue oil were the oxygenated compounds (80.3% for leaves 83.3% for flowers). The main component was 2-undecanone which represented more the half of total essential oil. The results indicated that compost levels or sowing distances had different effects on total identified and major constituents of rue essential oil.

Key words: *Ruta graveolens* % essential oil % rutin % coumarin % compost fertilizers % sowing distances

INTRODUCTION

Ruta graveolens L. (common rue) is native to Southern Europe and Northern Africa. Rue plant is medicinal plant whose roots and aerial parts contain more than one hundred and twenty compounds of different classes of natural products such as acridone alkaloids, coumarines, essential oil, flavonoids and furoquinoline [1, 2]. Many of these compounds are physiologically active and therefore of pharmacological interest [3]. The medicinal action of common rue is abortificient, anthelmintic, antiseptic, antispasmodic, carminative, irritant and stomachic [4, 5]. The main uses of rue are to relieve gouty and rheumatic pains and to treat nervous heart problems [6, 7]. The infusion is also said to be useful in eliminating worms [8]. In addition Chiu and Fung [9] revealed that rue plants contained cardiovascular active substance that had a direct effect on the cardiovascular system. Moreover, Pathak *el al.* [10] revealed that Ruta in combination with $Co_3 (Po_4)^2$ could be used for effective treatment of brain cancers, particularly glioma.

Compost fertilizer is safety for human health and environment. It is made by recycling organic material as plant and animals waste, food scraps in a controlled process.Compost used to improve soil properties, water retention capacity, drainage, pH and better availability soil micro organism [11, 12]. Several researchers reported that adding various organic compost to the soil resulted to marked promotion on different growth characters yield and chemical constituents of various medicinal and aromatic plants i.e. on peppermint [13], *Rosmarinus officinalis* [14], *Tagetes erecta* [15] and *Sideritis montana* [16].

Corresponding Author: Dr. S.E. El-Sherbeny, Departments of Cultivation and Production of Medicinal and Aromatic Plants, National Research Centre, Dokki, Giza, Egypt

Otherwise, the distance between plants or plant density is the most important factors affect greatly on growth and chemical constituents by effecting on light and photosynthetic process, water and nutrients uptake. The suitable spacing and its affect on the productivity of different plants were reported by El-Gengaihi *et al.* [17] on *Dracocephalum moldavica*, Omar *et al.* [18] on *Silybum marianum*, El-Sherbeny *et al.* [16] on *Sideritis montana*.

Thus, this investigation was conducted to detect the optimum compost dose with suitable plant distance to produced highest vegetative and flowering growth with good quality of essential oil as well as rutin and coumarin content of *Ruta graveolens* plants.

MATERIALS AND METHODS

Plant material: Two Field experiments were conducted at the Experimental Station of National Research Centre, Shalakan, Kalubia Government during two successive seasons of 2004/2005 and 2005/2006 to study the influence of different compost levels and various plant distances on growth and chemical constituents of rue plants. Seed of common rue plants (Ruta graveolens) were sown on 25th of October, during the two successive seasons in seedbeds. When seedling reached to 12-15 on long, they were transplanted in plots $4m^2$ area (2x2m) on rows of 60 cm apart with three distance interbetween 30, 40 and 50 cm. The experimental soil was analyzed according to Black [19]. It was clay loamy having pH.7.2; EC0.5, $CaCo_3$ 1.4% Total N 540 mg kgG^1, available P(P_2O_5), 87mg kgG^1, available K(K_2O) 256 mg $kgG^1$and available Mg 2500 mg kgG^1. DTPA extractable Fe, Mn, Zn and Cu were 22.1, 3.8 and 2.65 mg kgG^1, respectively.

Methods: The different treatments were arranged in 4 replication using a split plot design having the compost in the main plots, while the different plant distance were distributed at random in the sub plots. Each sub plot contained 10 plants. Compost levels were added during soil preparation at three levels, 78.54, 159.46 and 238.6 kg N/hect.Compost was produced by Green Valley for Organic Products Co., S.A.E. Physical-chemical properties of organic compost are shown in Table 1.

The experiment was included the following treatments:

1. Control (0 compost) + 30 cm distance between plants
2. Control (0 compost) + 40 cm distance between plants
3. Control (0 compost) + 50 cm distance between plants
4. Compost (78.54Kg N/hect.)+ 30 cm distance between plants
5. Compost (78.54Kg N/hect.)+ 40 cm distance between plants
6. Compost (78.54Kg N/hect.)+ 50 cm distance between plants
7. Compost (159.46Kg N/hect.)+ 30 cm distance between plants
8. Compost (159.46Kg N/hect.)+ 40 cm distance between plants
9. Compost (159.46Kg N/hect.)+ 50 cm distance between plants
10. Compost (238Kg N/hect.)+ 30 cm distance between plants
11. Compost (238Kg N/hect.)+ 40 cm distance between plants
12. Compost (238Kg N/hect.)+ 50 cm distance between plants

The plants were collected at full flowering stage in 15th May during the two successive seasons and the following data were recorded:

Vegetative growth characters:

a. Plant height (cm).
b. Number of branches per plant.
c. Fresh and dry weights of leaves, stems and roots (g/plant).
d. Fresh weight of flowers per plant (g/plant).

Chemical constituents:

a. Essential oil % in fresh leaves and flowers: Samples of fresh leaves and flowers for each treatment were separately subjected to water distillation for 3 h according to A.O.A.C. [20].
b. Essential oil yield, were calculated for plant and Hectare.

Table 1: Physical-chemical properties of organic compost fertilizer

Wet %	O.M %	pH	E.C mmohs/cm	C/N ratio	Organic carbon %	N %	P %	Fe ppm	Mn ppm	Cu ppm	Zn ppm
35	70	7.24	2.1	23:1	25.8	1.2	0.8	790	190	73.1	150

c. Oil components:
The samples were dehydrated over anhydrous sodium sulphate then subjected to GC/MS. Separation of the resulting crude, fractions and volatile oil was accomplished on a Varian Gas Chromatography (Thermo Inst., USA) mass spectrometer and a 30 cm x 0.25 mm. DB^{-5} capillary column film thickness (J and W Scientific, USA). The column temperature was programmed from 50°C (constant for 3 min.) at a rat of 7°C/min to 250°C with 10 min. isothermal hold. The injector temperature was 220° and transition time temperature was 250°C. The carrier gas was helium and the column head pressure was 10-15 psi. The identification of the constituents was determined by comparing the spectrum with the other stored in Wiley Mass Spectral Library containing over 147000 volatile compounds.

d. Rutin percentage in dried leaves, determined according to method of Zhuang *et al*[21].

e. Coumarin percentage in dried leaves estimation as described by Harbone [22].

f. Mineral content in leaves, including total nitrogen content using the modified micro-Kjeldahl methods as Jackson [23]. Phosphorus and potassium (%) according to Chapman and Pratt [24] and Cottonie *et al*., [25], respectively.

Statistical methods: Comparisons among means of different treatments were performed using the least significant difference procedure (LSD) at 0.05 levels as illustrated by Snedecor and Cochran [26].

RESULTS

Growth characters

Effect of compost fertilizer on growth characters: Data presented in Table 2 showed a pronounced increment in plant height due to applied highest compost level, while the lower level (78.54 Kg N/hectare) caused insignificant decrement for these criteria. Moreover, the difference between plant height of plants treated with the maximum and the minimum level of compost reached to 6.7%. From the same table, it is noticed clearly that the

Table 2: Influence of compost fertilizer and sowing distance on vegetative characters of *Ruta graveolens* L. (means value of two seasons)

			Fresh weight (g/plant)				Dry weight (g/plant)			
Treatments	Plant height cm	Branches No/plant	Leaves	Stem	Root	Total	Leaves	Stem	Root	Total
A) Effect of compost:										
Comp 0	39.3	13.8	17.4	28.9	5.1	51.4	7.4	11.4	2.9	21.7
Comp 1	38.5	13.6	14.0	25.5	5.4	44.9	8.7	12.5	3.3	24.3
Comp 2	37.6	13.9	18.6	35.8	6.4	60.8	8.4	13.7	3.7	27.8
Comp 3	41.1	13.2	25.9	46.9	6.5	79.2	9.0	18.5	3.5	31.4
LSD %5	1.4	N.S	1.26	1.64	0.56	0.69	0.60	0.80	0.34	1.17
B) Effect of sowing distances:										
30 cm	37.4	13.6	17.5	29.9	5.2	52.6	9.0	12.1	3.1	11.1
40 cm	40.5	13.2	20.4	31.4	5.9	57.7	8.1	14.9	4.3	27.3
50 cm	39.5	14.2	19.1	40.8	6.5	66.2	8.0	15.2	4.4	27.7
LSD %5	1.21	0.48	1.09	1.42	0.49	0.60	0.54	0.69	0.29	1.01
C) Effect of the interaction between compost and sowing distances:										
Comp 0										
30cm	39.9	14.1	20.4	35.3	5.0	60.7	8.9	14.6	3.0	26.5
40cm	40.1	12.5	16.6	25.0	4.9	46.5	6.7	9.6	2.9	19.2
50cm	37.8	14.9	15.2	23.3	5.3	43.8	6.5	10.0	2.7	19.2
Comp1										
30cm	36.6	13.8	10.9	15.7	4.2	30.8	10.9	9.2	3.5	23.6
40cm	39.9	14.5	15.7	31.5	6.2	53.4	8.2	14.9	3.4	26.5
50cm	39.1	13.0	15.4	29.2	5.9	50.5	7.1	13.5	3.0	23.6
Comp2										
30cm	34.1	15.1	17.4	28.9	6.4	52.7	8.3	11.4	3.5	23.2
40cm	38.9	11.8	20.9	37.2	6.3	64.4	8.8	17.6	3.7	33.1
50cm	39.8	14.9	17.6	41.2	6.4	65.2	8.0	12.2	3.9	27.1
Comp3										
30cm	39.1	12.0	21.4	39.6	5.0	66.0	7.8	13.2	2.5	23.5
40cm	43.0	13.9	28.2	31.8	6.3	66.3	8.8	17.4	4.3	30.5
50cm	41.3	13.8	28.0	69.4	8.4	105.4	10.5	25.0	4.8	40.3
LSD%5	2.42	0.96	2.19	2.84	0.97	1.20	1.09	1.39	0.58	2.02

Comp1: 78.54 Kg N/hect. Comp2: 159.46 Kg N/hect. Comp3: 238 Kg N/hect

application various of compost levels had insignificant effect on number of branches/plant.

Concerning the effect of compost levels on fresh and dry weight of various plant organs, it could be observed that the highest compost levels caused a marked improved effected on fresh weights of leaves, stems, roots and total plant. The increment percentages for these characters over the control reached to 48.9, 62.3, 27.5 and 54.1% respectively. Similarly, the stimulation effect on dry weight of the same organs as a result of higher compost level reached to 21.6, 62.3, 34.5 and 44.7%, respectively compared with control plants.

Effect of plant distances on growth characters: The results presented in Table 2 indicated that different plant distances markedly effect on vegetative growth characters. The medium distance (40 cm) resulted in tallest plant height which reached to 40.5 cm, while the narrow distance (30 cm) produced shortest one which reached to 37.4 cm. The wider spacing was more effective to produce significant increment for branches number of rue plants. Increasing sowing distances gradually from 30 cm to 50 cm increased number of branches about 4.5%. Similarly, a positive relationship was noticed between plant distances and fresh or dry weights of stems, roots and whole rue plants. Thus the maximum weights were noticed as a result of wider distance (50 cm between plants) which gave an increment in fresh weight (comparing with narrow distance 30 cm) reached to 25 and 25.9% for stems and roots respectively while the increment in corresponding dry weight reached to 25.6 and 46.9% respectively. Otherwise, the medium distance (40cm), led in general to significant promotion for leaves fresh and dry weights.

Effect of the interaction between compost and plant distances on growth characters: Regarding to combined effect of various compost levels and different plant spacing (Table 2), the obtained data revealed that the maximum plant height and the heaviest fresh weight of leaves were recorded with plant supplied with highest compost level and grown under medium distance condition (40 cm). Meanwhile, the highest number of branches was obtained by treating plants with medium compost level combined with narrow plant distance. On the other hand, the pronounced increment in fresh and dry weight of other different plant organs of rue plants were occurred when the highest compost level was added to plants grown at wider distance (50 cm).

Table 3: Influence of compost fertilizer and sowing distance on flowers yield and essential oil of *Ruta graveolens* L. (means value of two seasons)

	Flower yield	Essential oil (%)		Essential oil ml/hect.	
Treatments	g/plant	Leaves	Flowers	Leaves	Flowers
A) Effect of compost:					
Comp 0	39.2	0.119	0.131	517.22	1288.34
Comp 1	36.2	0.121	0.164	425.0	1511.73
Comp 2	44.6	0.103	0.135	510.46	1491.21
Comp 3	64.8	0.112	0.109	712.93	1535.00
LSD %5	2.18	0.006	0.003	14.95	158.32
B) Effect of sowing distances:					
30 cm	43.4	0.131	0.133	726.69	1711.98
40 cm	45.6	0.110	0.144	568.63	1623.37
50 cm	49.6	0.100	0.128	363.66	1034.35
LSD %5	1.89	0.005	0.004	12.95	137.09
C) Effect of the interaction between compost and sowing distances:					
Comp0					
30 cm	40.0	0.099	0.123	637.82	1561.23
40 cm	38.3	0.125	0.127	525.46	1233.72
50 cm	39.3	o.134	0.143	388.42	1070.048
Comp1					
30 cm	32.7	0.171	0.180	590.22	1869.04
40 cm	39.1	0.116	0.163	462.01	1617.02
50 cm	36.7	0.076	0.150	222.77	1049.10
Comp2					
30 cm	37.7	0.140	0.143	774.26	1710.39
40 cm	42.1	0.100	0.172	530.55	1837.88
50 cm	54.0	0.068	0.090	226.58	925.344
Comp3					
30 cm	63.3	0.113	0.085	767.93	1707.22
40 cm	62.9	0.100	0.113	715.86	1804.87
50 cm	68.3	0.123	0.128	654.98	1092.90
LSD%5	3.77	0.012	0.009	21.3	208.98

Comp1: 78.54 Kg N/hect. Comp2: 159.46 Kg N/hect. Comp3: 238 Kg N/hect.

Flowers yield

Effect of compost fertilizer on flowers yield: The flowers yield of rue plants as affected by various compost levels were shown in Table 3. Significant promotion effect with two highest compost levels was recorded. Moreover, the highest compost level produced the highest flowers yield, which reached to 64.8 g/plant, in corresponding to 39.2 g flowers/plant for control plants.

Effect of plant distances on flowers yield: Data presented in Table 3 indicated that the wider distance (50 cm) was more favorable for producing highest flowers yield/plant. Significant increment was noticed with increasing plant distances from 30 to 50 cm.

Effect of the interaction between compost and plant distances on flowers yields: It is appeared from Table 3 that flowers yield recorded variable effect with applied different compost levels combined with various plant

distances. However, it is cleared that the highest compost level combined with various plant distances, recorded in general heaviest flowers yield compared with medium or low compost level. Meanwhile, the highest significant increment of flowers yield (68.3 g/plant) were noticed with plant treated with compost level (238 Kg N/hect.) and grown on wider distance (50 cm), which increased flowers yield about 70.8% over the control treatment.

Essential oil content (%) and yield

Effect of compost fertilizer on essential oil content (%) and yield: Data tabulated in Table 3 indicated that compost fertilizers had a significant effect on essential oil content (%) and yield (cc/hect.) for both leaves and flowers. The results cleared that essential oil content (%) for flowers was higher compared with essential oil content (%) for leaves. Moreover, compost at different levels caused significant effect on essential oil content (%). Low compost level was more favorable for promoting essential oil accumulation in leaves as well as flowers, which their content (%) reached to 0.121 and 0.164% respectively comparing to 0.119 and 0.131% for control treatment. On the otherwise, essential oil yield in leaves and flowers showed maximum values as a result of highest compost level (238Kg N/hect.).

Effect of plant distances on essential oil content (%) and yield: According to the data in Table 3, an opposite trend was noticed between essential oil (content (%) and yield) for leaves and plant distances, where the narrow distance (30 cm) produced the highest percentage and yield. This promotion effect was decreased with increasing sowing distances. On the other hand the medium distance (40 cm) produced the maximum values for essential oil percentage and yield in flowers.

Effect of the interaction between compost and plant distances on essential oil content (%) and yield: Essential oil content (%) and yield for both leaves and flowers showed various pronounced increments with some exceptions as a result of compost application under different sowing distances. The maximum mean values of essential oil percentage were obtained as a result of the combination treatment between the first compost level (78.54Kg N/hect.) and 30 cm distance between plants. The combination between Compost (159.46Kg N/hect.) and 30 cm distance between plants gave the highest essential oil yield for leaves while the combination between compost (159.46Kg N/hect.) and 40 cm distance between plants gave the highest essential oil yield for flowers.

Table 4: Influence of compost fertilizer and sowing distance on rutin and cumarin (%) of *Ruta graveolens* L. (means value of two seasons)

Treatments	Total rutin (%)	Total cumarin (%)
A) Effect of compost:		
Comp 0	1.31	0.0127
Comp 1	1.43	0.0143
Comp 2	1.51	0.0150
Comp 3	1.52	0.0153
B) Effect of sowing distances:		
30 cm	1.45	0.0145
40 cm	1.40	0.0140
50 cm	1.46	0.0145
C) Effect of the interaction between compost and sowing distances:		
Comp0		
30cm	1.20	0.0120
40cm	1.21	0.0120
50cm	1.42	0.0140
Comp1		
30cm	1.50	0.0150
40cm	1.51	0.0150
50cm	1.31	0.0130
Comp2		
30cm	1.51	0.0150
40cm	1.42	0.0140
50cm	1.61	0.0160
Comp3		
30cm	1.60	0.0160
40cm	1.51	0.0150
50cm	1.52	0.0150

Comp1: 78.54 Kg N/hect. Comp2: 159.46 Kg N/hect. Comp3: 238 Kg N/hect.

Rutin and coumarin content (%)

Effect of compost fertilizer on rutin and coumarin content: The results in Table 4 pointed out that rutin percentage increased with different compost levels. The highest increment was noticed with second compost level (159.46 Kg N/hect.). Mean while the accumulation increment at this level reached to 13.6% over the control treatment. Similarly, the coumarin percentages appeared a marked stimulation with various compost levels. The two highest compost levels produced the highest coumarin percentage, which recorded 15.4% over control plants.

Effect of plant distances on rutin and coumarin content: It is clearly observed from data presented in Table 4 that increased plant distance from 30 cm to 40 cm increased rutin content (%) and this increment reached to 6.7%. More wider in distance to 50 cm, caused opposite effect.

For coumarin content (%), the results indicated that sowing at various distances had no pronounced effect on mean values of coumarin accumulation which ranged between 0.014 to 0.0146%.

Table 5: Influence of compost fertilizer and sowing distance on nutrients content of *Ruta graveolens* L. (means value of two seasons)

	%			ppm		
Treatments	N	P	K	Zn	Fe	Mn
A) Effect of compost:						
Comp 0	2.19	0.81	1.29	555	2129	162
Comp 1	2.71	0.88	1.49	632	2344	197
Comp 2	2.68	0.94	1.53	634	2379	226
Comp 3	2.97	0.97	1.55	642	2371	232
B) Effect of sowing distances:						
30 cm	2.44	0.88	1.42	601	2263	193
40 cm	2.54	0.87	1.45	603	2290	196
50 cm	2.60	0.90	1.45	619	2300	197
C) Effect of the interaction between compost and sowing distances:						
Comp0						
30 cm	2.14	0.80	1.28	551	2112	166
40 cm	2.21	0.82	1.33	555	2141	160
50 cm	2.22	0.82	1.25	560	2135	160
Comp1						
30 cm	2.56	0.88	1.47	6.23	2316	194
40 cm	2.72	0.86	1.49	618	2353	199
50 cm	2.86	0.91	1.51	657	2364	200
Comp2						
30 cm	2.62	0.90	1.50	628	2362	220
40 cm	2.70	0.94	1.52	635	2377	228
50 cm	2.72	0.98	1.58	640	2400	230
Comp3						
30 cm	2.76	0.95	1.54	633	2358	229
40 cm	2.99	0.97	1.55	638	2371	233
50 cm	3.17	0.99	1.56	655	2384	234

Comp1: 78.54 Kg N/hect. Comp2: 159.46 Kg N/hect. Comp3: 238 Kg N/hect

Effect of the interaction between compost and plant distances on rutin and coumarin content: Data recorded in Table 4 indicated that there were marked differences in rutin percentage in leaves due to interaction applied of various compost levels with different sowing distances. Generally, increasing the applied compost dose with increasing plant distances caused more accumulation in rutin content. However, the maximum rutin percentage was recorded with applied second compost level (159.46Kg N/hect.) and sowing plants at 30 cm distance.

For coumarin, it is clearly noticed that application of medium compost level (159.46 Kg N/hect.) with wider sowing distance or the combined treatment between the highest compost level (238 Kg N/hect.) with narrow plant distance accumulated the highest coumarin (%). Moreover, increasing distance from 30 cm till 50 cm with highest compost level produced the same value of coumarin (0.015%).

Table 6: Percentage composition of the leaves essential oil of *Ruta graveolens* L. as influenced by compost and plant distance

Compounds	Con.	1	2	3	4	5
Limonene	0.10	0.06	0.08	0.08	0.04	0.06
Geyrene	1.26	1.41	1.34	1.09	1.20	1.33
1-Nonene	2.45	2.19	3.00	2.18	2.53	2.30
2-Nonene	3.07	2.99	2.85	3.25	3.41	2.56
Undecene	3.51	3.44	2.67	3.88	3.69	4.40
Anthracene	1.21	1.00	1.10	1.14	0.95	0.81
Neophytadiene	0.03	0.06	0.04	0.10	0.05	0.05
3, 4-Dihydrobenzo						
[b] fluoranthene	2.63	2.91	1.86	2.84	2.64	2.47
Total hydrocarbon	14.26	14.06	12.94	14.56	14.51	13.98
2-Octanone	1.60	1.72	1.36	1.55	1.70	1.38
2-Nonanone	10.15	10.27	11.08	11.59	12.61	12.92
Teteradecanal	1.22	1.40	2.02	1.30	1.53	1.44
Dodecanal	2.00	2.16	2.57	2.45	2.30	2.61
2-Docanone	1.73	1.96	1.23	1.07	1.95	1.62
2-Undecanone	51.00	51.28	51.20	51.94	50.01	51.00
2-dodecanone	2.77	2.91	3.06	2.81	2.67	2.84
9-Methyl-10-Methylene-						
Tricyclo (4.2.1.1.2.5)						
Decan-9-ol	0.15	0.15	0.09	0.03	0.08	0.07
1-Dodecanol, 3.7.11-trimethyl	0.51	0.49	0.36	0.47	0.43	0.52
2-Tridecanone	0.57	0.84	0.88	0.87	0.92	0.90
12-Methyl-oxa-cyclododec						
-6-EN-2-one	2.36	2.71	2.36	2.86	2.46	2.14
Elemol	1.98	2.30	2.19	2.18	2.98	2.48
9-Methyl4-(1,3-benzodioxol						
-5-yl) butanoate	0.75	0.42	0.68	0.54	0.82	0.95
Nepetalactol	0.11	0.12	0.14	0.14	0.20	0.15
Ascaridol	0.03	0.11	0.07	0.06	0.10	0.10
Guaiol	0.12	0.19	0.12	0.13	0.13	0.11
Eudesmol	0.19	0.20	0.35	0.15	0.22	0.18
Methyl 4-(1,3-benzodioxol						
-5-yl) butanoate	0.24	0.22	0.16	0.11	0.17	0.13
Hexadecanal	0.38	0.34	0.29	0.40	0.37	0.35
(Z)-8-(3,5-dimethyl-4-						
hydroxyphenyl)-2-octene	0.50	0.66	0.82	0.85	0.69	0.75
9,12,15-Octadecatrienal	0.85	1.02	1.11	1.25	1.51	1.32
Hexadecanoic acid	0.44	0.68	0.75	0.91	0.59	0.66
3-Ethoxy-4-hydroxy-4-						
(4-methoxyphenyl)						
cyclopent-2-enone	0.10	0.17	0.13	0.11	0.08	0.05
9,12,15-Octadecatrienoic						
acid methyl ester	0.55	0.92	0.38	0.51	0.80	0.74
Total oxygenated	80.30	83.24	83.40	84.28	85.32	85.41
Total identified	94.56	97.30	96.34	98.84	99.83	99.39

1 = compost 0+ 30cm 2 = compost 0+ 40cm 3 = compost0 + 50cm 4 = compost 1 + 30cm 5 = compost 2 + 30cm

Table 7: Percentage composition of the flowers essential oil of *Ruta graveolens* L. as influenced by compost and plant distance

Compounds	Con.	1	2	3	4	5
Limonene	0.20	0.10	0.03	0.05	0.06	0.08
Geyrene	3.55	4.02	3.92	2.83	3.85	2.74
1-Nonene	2.31	1.92	2.40	2.50	1.66	1.39
2-Nonene	1.94	1.63	1.92	1.88	1.80	1.33
1-Undecene	3.14	4.00	3.28	2.92	3.29	3.35
Anthracene	0.52	0.24	0.61	0.54	0.44	0.31
Neophytadiene	0.13	0.02	0.25	0.11	0.08	0.11
3,4-Dihydrobenzo[b]fluoranthene	1.11	0.95	0.88	1.17	1.20	1.32
Pentacosane	0.24	0.30	0.39	0.17	0.22	0.15
Total hydrocarbon	13.14	13.36	13.68	12.17	12.6	10.78
2-Nonanone	9.36	11.0	9.55	9.12	9.65	10.36
Cyclotridecanone	o.10	0.14	0.18	0.09	0.11	0.02
2-Docanone	3.15	2.83	3.15	3.42	2.12	3.55
2-Undecanone	60.12	63.05	62.13	64.58	65.0	65.07
Ethyl 3-phenyl propionate	0.34	0.28	0.19	0.28	0.30	0.12
2-Dodecanone	4.02	5.00	3.45	3.98	3.81	3.90
9-Methyl-10-Methylene-Tricyclo (4.2.1.1.2.5) Decan-9-ol	0.08	0.01	0.04	0.15	0.12	0.09
2-Tridecanone	0.41	0.13	0.16	0.29	0.44	0.29
1-Dodecanol, 3.7.11-trimethyl	0.11	0.06	0.08	0.08	0.17	0.17
Epiglobulol	0.12	0.09	0.14	0.23	0.11	0.30
Elemol	0.15	0.01	0.01	0.08	0.03	0.11
2-Tetradecanone	0.08	0.02	0.03	0.04	0.01	0.02
Cycloundecanone	0.13	0.02	0.05	0.08	0.02	0.19
Guaiol	0.20	0.11	0.13	0.09	0.22	0.17
Eudesmol	0.24	0.10	0.16	0.17	0.33	0.30
Cis-2-(3,4-dimethoxy) phenlcyclopetanonol	1.17	1.01	0.25	1.42	1.00	1.15
1-(3,4-dimethoxyphenyl)-1 -Acetoxy-z-propene	0.05	0.01	0.01	0.02	0.07	0.02
(Z)-8-(3,5-dimethyl-4-hydroxyphenyl)-2-octene	1.02	0.66	0.88	0.54	0.83	0.95
9,12,15-Octadecatrienal	0.10	0.01	0.06	0.01	0.02	0.05
Hexadecanoic acid	0.12	0.03	0.11	0.06	0.03	0.12
9,12,15-Octadecatrienoic acid methyl ester	1.11	0.05	0.82	1.03	0.39	0.99
Total oxygenated	82.18	84.62	81.58	85.78	84.78	87.94
Total identified	95.32	97.98	95.26	97.95	97.38	98.72

1=compost 0+ 30cm 2= compost 0+ 40cm 3=compost0 + 50cm
4= compost 1 + 30cm 5= compost 2 + 30cm

Nutrients content

Effect of compost fertilizer on nutrients content: Table 5 showed the concentration of macronutrients N, P, K as well as micronutrients Zn, Fe and Mn in leaves of *Ruta graveolens* as affected by compost fertilizer. It is clear that different levels of compost caused a pronounced increment in all nutrients content. The highest mean values content of various nutrients were obtained with highest compost dose with one exception recorded with Fe. However, the highest increments in macro elements N,P and K in comparison with control reached to 3.56, 19.8 and 20.2% respectively, while the microelements Zn, Fe and Mn reached to 15.7, 11.7 and 43.2% respectively.

Effect of plant distances on nutrients content: Data in Table 5 indicated that the macro and micro elements content increased gradually with increasing sowing distance. The highest increment in nutrients content were recorded with applied wider distance of 50 cm reached to 6.6, 2.3 and 2.1% for N,P and K respectively, corresponding to plants sowing at 30 cm distance. Similarly, microelements content of Zn, Fe and Mn appeared enhanced accumulation with sowing at 50 cm than 30cm distance represented about 3.16, 1.6 and 2.1%, respectively from same three elements.

Effect of the interaction between compost and plant distances on nutrients content: It is clear in Table 5 that the highest compost level combined with wider sowing distance produced the highest accumulation for the nutrients content of N,P,Fe and Mn for *Ruta graveolens* plants. Thus, the applied 238 Kg N/hect. + 50 cm sowing distance increasing the content of these minerals by 48.1, 23.8, 12.9 and 41.0% over the control.

Essential oil components: The essential oil compounds of leaves and flowers collected at second season were identified by GC/MS (Table 6 and 7). The identified compounds in leaves were 32 compounds (represented about 94.56%) and for flowers 33 compounds (represented about 96.45%). The hydrocarbon terpenes were 8 compounds (contain 14.26%) and 9 compounds (contain 13.4%) for both leaves and flowers, respectively. Meanwhile, the oxygenated compounds for leaves were 24 compounds contain 80.30% and for flowers were 22 compounds contain 83.1%.

It was found that 2-undecanone was the major compound for leaves and flowers, as it was found in all cases more than half of the oil compounds and it was about 50.01 to 51.94% in leaves and 60.12 to 65.70% in flowers. However, the main constituents previously in *Ruta graveolens* oil for leaves were in a descending order, 1-undecen, 2-nonene, 1-nonene and 2-dodecanone whereas, for flowers oil were 2-nonanone, 2-dodecanone, geyrene and 1-undecene.

On the other hand, applied various compost fertilizer levels increased the total identified compounds for oil of both leaves and flowers. However, the major compound of leaves did not affect by compost treatments, while essential oil of flowers appeared marked increment with all treatments.

It is clear to notice the highest identified compounds and major constituents for leaves and flowers recorded with highest compost level combined with narrow plant distance (50 cm).

DISCUSSION

The improvement effects of compost fertilization treatments on vegetative growth characters can be rendered to the important role of compost on soil properties, moisture retention, better nutrient availability which resulting in good plant growth production [11, 27]. The promotion effect of compost on rue vegetative growth with one exception (number of branches/plant), were coincide with various medicinal and aromatic plants, i.e. Naguib [28] on *Chamomille recutita,* Aly [29] on *Lupinus termis,* Khalil and El-Sherbeny *et al.* [30] on three *Mentha spp.* and El-Sherbeny *et al.* [16] on *Sideritis montana* L.

The variable effect of plant distances on plant height are reported by Shalaby and Razin [31] who recorded that wider hill spacing resulted in shorter rosella plants, while El-Kashlan [32] found that rosella plant height increased with increasing plant distance. Similariy [16] on *Sideritis montana* L. reported that 40 cm distance between plant was the most favourable distance to produced tallest plants comparing with two other distances of 30 cm and 50 cm.

On the other hand, the improvement of fresh and dry weights of *Ruta graveolens* plants may be attributed to the wider plant spacing rendered to the availability of more inter plant spacing enabling the plants to grow will utilizing the growth factors. Similar results has been recorded with El-Gengaihi *et al.* [17] on *Dracocephalum moldavica,* Mokhtar [33] on *Lupinus termis* and El-Sherbeny *et al*. [16] on *Sideritis montana L.*

Regarding to interaction treatments and their effects on growth characters, the results obtained coincide with the findings of El-Sherbeny *et al.* [16] on *Sideritis montana* L and Hussein *et al.* [34] on *Dracocephalum moldavica*.

Concerning the effect of compost levels and plant distances on flowers yield, it is clear that the highest significant increment of flowers yield was noticed as a result of the highest compost level combined with the widest distance. These results may be attributed to the role of macro-and micro-nutrients provided by compost in stimulating metabolic processes, encouraging growth and flowers yield. Moreover, the widest distance resulted in increment the herb which plays an important role for encouraging flowers yield. In this respect, Mohamed and Wahba [35] on *Tagetes erecta* indicated that narrow distance of 36cm gave the heaviest fresh and dry weights of flowers where 48 and 60 cm spacing produced the next values. In contrast, Umesha *et al.* [36] suggested that the greatest plant density gave the maximum yield of leaves and inflorescence of basil.

As for the effect of applying compost on essential oil content (%) and oil yield, it can be noticed that compost at (78.54 Kg N/Hect.) caused an increment in essential oil content (%) for both leaves and flowers. On the other hand, the maximum value of essential oil yield (ml/plant) was obtained as a result of applying compost at (238 Kg N/Hect.).This result may be due to effect of compost on accelerating metabolism reactions as well as stimulating enzymes. This increment may be due to the effect of compost on mass production or/and oil content (%). Concerning the effect of plant spacing, it is found that the narrow distance and medium one gave the highest value of oil content for leaves and flowers respectively, while the maximum value of oil yield was obtained as a result of narrow space. In this respect, El-Sherbeny *et al.* [16], reported that wider space (40 cm between plants) led to the highest accumulation in oil percentage and yield of *Sideritis montana* L.They added that essential oil yield per feddan decrease by increasing planting distances from 20 to 40 cm. Meanwhile, Sadek *et al.* [37] on rosemary plants, El-Dean and Ahmed [38] on black cumin seed found that oil percentage and yield increased by increasing plant spacing. Hussein *et al.* [34] on *Dracocephalum moldavica* concluded that wider treating plants with highest compost level (16.5 ton/fed.) combined with a wider plant spacing (40 cm) had a promotive effect on oil percentage and oil yield.

The promotive effect of compost or/and sowing distance on rutin and coumarin content (%) may be due to it's effect on growth, photosynthetic pigments, nutrient status and enzymes. In this connection, El-Gengaihi and Abd-El-Fattah [39] revealed that the nitrogen forms had no effect on rutin and coumarin content. They added that the increment or decrement of rutin as well as total flavonoids were almost a diurnal variation. This means that these substances increased during the day and a corresponding decrease occurred during the night. Also,

the increment or decrement of flavonoids may be attributed to the seasonal variation or plant age [40]. On the other hand, Pereira *et al.* [41], indicated that coumarin concentration was raised by organic fertilization (humus or manure) while inorganic nutrient (different levels of nitrogen) induced increased phytomass of stem and leaf yield of *Mikania glomerata*.

From the above results it could be indicated that to produce plants contain highest nutrients content, plants must be treated with compost at 238 Kg N/Hect.combined with sowing at 50 cm distance.The results were in harmony with those obtained by Herrera *et al.* [12] who indicated that minerals content of N, P, K, Ca and Mg of thyme seedlings were increased by increasing compost ratio in growth media. In addition, Krishnan *et al.* [42] reported that compost application caused enhancement of N and K in fenugreek plants. Meanwhile, Aly [29] on *Lupinus termis* revealed that N and K content increased significantly by increasing compost levels, but contrast was true for P, Fe, Mn and Zn which the accumulation were inhibited gradually by increasing compost level from 0 to 16 ton/fed.

Concerning oil constituents, results obtained revealed that 2-undecanone was detected as the major compound for leaves and flowers. In this connection several authors identified similar major compound of *Ruta graveolens* L. Pino [43] indicated that leaf oil of *Ruta graveolens* L. grown in Cuba identified 32 components and the major constituents was 2-undecanone (48.67%) followed by curcuphenol (8.18%) and hexadecanonic acid (5.68). Stashenko [44] found that the main constituents of extracts from leaves, flowers, stems and roots were 2-nonanone (8.9%), 2-undecanone (13.4%0, chalepensin (13.0%) and geijerene (19.3%), respectively. The above results which were mentioned the effect of compost and/or sowing distances coincided with those of [14] on *Rosmarinus officinalis* and [16] on *Tagets erecta* who reported that compost level at 3.5 ton/fed. and 7 ton/fed. increased the percentage of the identified constituents over the control.

CONCLUSION

According to previous results, it appears that the two factors of compost at different levels and various sowing distances have an important role in growth and flowers characters as well as essential oil, rutin and coumarin accumulation for *Ruta graveolens* plants. It could recommend fertilizing plants with compost at level of 238 Kg N/Hect. Combined with 50 cm as sowing distance to produce the highest yield for both leaves and flowers (g/plant) while for maximum values of essential oil yield (Kg/Hect.), it could apply (compost at 159.46 Kg N/Hect. X 30 cm.) or (compost at 78.54Kg N/Hect.X30cm) for leaves and flowers respectively.

REFERENCES

1. De Feo, V., D. Simone and F. Senatore, 2002. Potential allelochemicals from the essential oil of *Ruta graveolens*. Phytochemistry, 61: 573-578.
2. Oliva, A., K.M. Meepagala, D.E. Wedge, D. Harries, A.L. Hale, G. Aliotta and S.D. Duke, 2003. Natural fungicides from *Ruta graveolens* leaves including a new quinolon alkaloid. J. Agric. and Food Chem., 51: 890-896.
3. Kuzovkina, I., I. Al·terman and B. Schneider, 2004. Specific accumulation and revised structures of acridon alkaloid glucosides in the tips of transformed roots of *Ruta graveolens.* Phytochemistry, 65: 1095-1100.
4. Browner, C.H., 1985. Plants used for reproduction health in Oscaca, Mexico. Econ.Bot., 39: 482-504.
5. Alzoreky, N.S. and K. Nakaka, 2003. Anti-bacterial activity of extracts from some edible plants commonly consumed in Asia. Intl. J. Food Microbial., 80: 223-230.
6. Chavez, M., I. Franco and M. Gonzalez, 2003. Tradicion Herbolaria Remedios Caseros. Mexico City, Ce-Actal, AC, pp: 80-81.
7. Atto, A.H. and A. Alkofahi, 1998. Anti-nociceptive and anti-inflammatory effects of some Jordanion medicinal plant extracts. J. Ethnopharmacol., 60: 117-124.
8. San Miguel, E., 2003. Rue (*Ruta* L. *Rutaceae*) in traditional Spain: Frequency and distribution of it's medicinal and symbolic application. Econ. Bot., 57: 231-244.
9. Chiu, K.W. and A.Y.L. fung, 1997. The cardiovascular effects of green beans (*Phaseolus aureus*). Common rue (*Ruta graveolens*) and Klep (*Laminaria japonica*) in rats. General Pharmacol., 29: 859-862.
10. Pathak, S., A.S. Multani, P. Banerji and P. Banerji, 2003. Ruta 6 selectively induces cell death in brain cancer cells but proliferation in normal peripheral blood lymphocytes: A novel treatment for human brain cancer. Intl. J. Oncol., 23: 975-982.
11. Khandar, U.R. and K.B. Nigam, 1986. Effect of farmyard manure and fertility level on growth and yield of ginger (*Zingiber officinale*). Ind. J. Agric. Sci., 66: 549-550.

12. Herrera, E., N. Trembla, B. Desroches and A. Gosselin, 1997. Optimization of substrate and nutrient solution for organic cultivation of medicinal transplants in multicell flats J. Herbs, Spices and Medicinal plants. 4: 69-82.
13. Tara, A., O' Brien and V.B. Allen, 1996. Growth of peppermint in compost. J. of Herbs, Spices and medicinal Plants, 4: 19-27.
14. Khalil, M.Y., 2002. Influence of compost and foliar fertilization on growth and chemical composition of *Rosmarinus officinalis*. Egypt. J. Appl. Sci., 17: 684-699.
15. Khalil, M.Y., N.Y. Naguib and S.E. El-Sherbeny, 2002. Response of *Tagetes erecta* L. to compost and foliar application of some microelements. Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo, 10: 939-964.
16. El-Sherbeny, S.E., M.Y. Khalil and N.Y. Naguib, 2005. Influence of compost levels and suitable spacing on the productivity of *Sideritis montana* plants recently cultivated under Egyptian conditions. Bull. Fac. Agric., Cairo Univ., 56: 373-392.
17. El-Gengaihi, S., H. Wahba, K.P. Sroboda, J.C. Langhlin and V.E. Brown, 1995. The response of *Dracocephalum moldavica* plant to nitrogen fertilization and planting density. Acta Hortic., 390: 33-39.
18. Omar, E.A., S.S. Ahmed, T.B. Fayed and A.A. Ezz-El-Din, 1998. Seed yield of *Silybum mariamum* L. as affected by row spacing and fertilization in new reclaimed lands of Egypt. Egypt. J. Hort., 25: 281-293.
19. Black, C.A., 1983. Methods of Soil Analyses, Part I and II, Am. Soc., Agron. Inc. Pub., Madison, Wisc, USA.
20. A.O.A.C., 1990. Association of Official Agricultural Chemists. Official Methods of Analysis. Washington DC, USA.
21. Zhuang, X.P., X.Y. Yu and G.S. Yang, 1992. Determination of total flavonoid in the leaves of ginko, Chinese. Traditional and Herbal Drugs, 23: 122-124.
22. Harbone, J.B., 1998. Phytochemical Methods. A guide to modern techniques of plant analysis, New York, USA, pp: 54.
23. Jackson, M.L., 1973. Soil Chemical Analysis. Hall of India Private Ltd. M.97, Connaaught Circus, New Delhi, India.
24. Chapman, H.D. and P.E. Pratt, 1978. Methods of Analysis. For soil and water.2nd Ed. Chapter, Univ. Cali., Div. Agric., USA, 17: 150-161.
25. Cottonie, A, M. Verloo, L. Kerlan, G. Velghe and R. Camereynck, 1982. Chemical analysis of Plants and Soils. Lab. of Anal.. and Agrochem., State Univ., Ghent-Belgium, pp: 44-45.
26. Snedecor, G.W. and G.W. Cochran, 1980. Statistical Methods. 7th Edn., Iowa State Univ.Press, Ames, USA.
27. Rauiv, M., 1998. Horticultural uses of composted material. Acta Hortic., 469: 225-234.
28. Naguib, N.Y., 2003. Impact of mineral nitrogen fertilizer and organic compost on growth, herb and chemical composition of German chamomile (*Chamomilla recutita* L.) Egypt. J. Appl. Sci., 18: 301-323.
29. Aly, M.S., 2003. Response of lupin (*Lupinus termis* L.) plants to compost as organic fertilizer. Egypt J. Appl. Sci., 18: 273-284.
30. Khalil, M.Y. and S.E. El-Sherbeny, 2003. Improving the productivity of three Mentha species recently cultivated under Egyptian condition. Egypt. J. Appl. Sci., 18: 285-300.
31. Shalaby, A.S. and A.M. Razin, 1989. Effect of plant spacing on the productivity of roselle (*Hibiscus sabdariffa* L.) grown in newly reclaimed land. J. Agron. Crop Sci., 162: 256-260.
32. El-Kashlan, S.H., 1984. Studies on response of roselle (*Hibiscus sabdariffa* L.) to plant density and nitrogen fertilization. M.Sci. Thesis, Fac. Agric Cairo Univ.
33. Mokhtar, S.A., 2002. Effect of plant density, nitrogen and phosphorus fertilization on yield and yield components on lupin (*Lupinus termis* L.). Annals Agric. Sci., Moshtohor, 47: 225-235.
34. Hussein, M.S., S.E. El- Sherbeny, M.Y. Khalil, Y.N. Naguib and S.M. Aly, 2006. Growth characters and chemical constituents of *Dracocephalum moldavica* plants in relation to compost fertilizer and plant distance. Scientia Horticulturae, 108: 322-331.
35. Mohamed, S.M. and H.E. Wahba, 1993. Effect of planting distance, pinching and zinc application on growth, flowering and carotene of *Tagetes erecta*. Annals of Agric. Sci, Moshtohor, 31: 1031-1045.
36. Umesha, K., K.M. Bojappa, A.A. Foroogi and N.S. Suresh, 1990. Influence of plant density on growth and yield of basil (*Ocimum gratissimum* L.). Indian Perfumer, 34: 173-175.
37. Sadek, A.A., A.M. Kandeel and S.M. Mohamed, 1992. Effect of some agricultural treatments on the growth and chemical composition of Rosemary plant (*Rosmarinus officinalis* L.) 1-Effect of planting distances. Egypt J. Appl. Sci., 7: 353-364.

38. El-Dean, E. and T. Ahmed, 1997. Influence of plant distance and some phosphorus fertilization sources on black cumin (*Nigella sativa* L.) plants. Assiut Journal of Agric. Sci., 28: 39-56.
39. El-Gengaihi, S. and K.S. Abd-El-Fattah, 1976. The effect of nitrogen forms on growth, nutrient content and the active ingredients of *Ruta graveolens* plants. League of Second Arab Conference on Petrochemicals. Abu Dhabi 15-22 March.
40. Balbaa, S.L., A.Y. Zaki and A. El-Shamy, 1974. Qualitative and Quantitative study of the flavonoid content of the different organs of *Sphora japonica* at different stages of development. Planta Medica, 25: 325-330.
41. Pereira, A.M.S., A. Menezes, F.L.A. Camara and S.C. Franca, 1998. Influence of fertilizer on coumarin content and biomass production in *Mikania glomerata Sprengel*. J. of Herbs, Spices and medicinal Plants, 6: 29-36.
42. Krishnan, N., D. Ravi and M.K. Gajapathy, 1995. Effect of neem better addition on free nitrogen fixers and fungi in soil and on plant fenugreek growth. Advances in Plant Sci., 8: 65-75.
43. Pino, J.A., A. Rosado and V. Fuentes, 1997. Leaf oil of *Ruta graveolens* L. grown in Cuba. J. Essential Oil Research, 9: 365-366.
44. Stashenko, E.E., R. Acosta and J.R. Martinez, 2000. High-resolution gas chromatographic analysis of secondary metabolites obtained by subcritical fluid extraction from Colombian rue (*Ruta graveolens* L.). J. Biochem. Biophys. Methods, 43: 379-390.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 282-288, 2007
ISSN 1818-6769

Growth and Chemical Constituents of *Cupressus sempervirens* L. Plant as Influenced by Kinetin and Iron Treatments at Nubaria

Fatma E.M. El-Quesni, Lubna S. Taha, Soad M.M. Ibrahim and M.M. Farahat

Department of Ornamental Plants and Woody Trees, National Research Centre, Dokki, Cairo, Egypt

Abstract: Pot experiment was carried out in two seasons (2005 and 2006) at Research and Production Station, Nubaria, National Research Centre, Dokki, Cairo, Egypt to study the effect of foliar application of kinetin (0, 20, 40 ppm) and iron (0, 20, 40 ppm) and their interaction on vegetative growth and some chemical constituents of *Cupressus sempervirens* L. plant. Most criteria of vegetative growth expressed as plant height, stem diameter, number of branchlets, root length fresh and dry weight of plants were significantly affected by application of the two factors which were used in this study. Foliar application of kinetin 40 ppm to cupressus plant significantly promoted plant height, stem diameter, number of branchlets, root length, fresh and dry weights of shoots and roots, as well as chemical constituents except total soluble phenols compared with control plants. Iron application increased stem diameter, number of branchlets, root length, fresh and dry weights of roots due to 40 and 20 ppm Fe, whereas Fe 20 ppm decreased plant height, fresh and dry weight of shoots as well as pigments content and total indoles than control plants in both seasons. Essential oil content was significantly increased by the application of the two factors which were used in this study. The highest recorded data were obtained in plants treated with kinetin 40 ppm + Fe 40 ppm, it increased significantly all vegetative growth parameters, (chl a and b), total soluble phenols and essential oil percent, whereas decreased total indoles than control plants. Plants treated with kinetin 40 ppm + Fe 20 ppm significantly increased plant height, stem diameter, number of branchlets, root length, fresh and dry weight of shoots and roots as well as essential oil content, whereas decreased chl a, chl b, total indoles, total soluble phenols compared with control plants.

Key words: *Cupressus sempervirens* L. % kinetin (Ki) % iron (Fe)

INTRODUCTION

Cupressus sempervirens L., Family Cupressaceae, the Mediterranian cupresses is a species of cupressus native to the Mediterranean region in north Libya, south Greece, Turkey, Western Syria, Lebanon and western Jordan. It has been widely cultivated as an ornamental timber tree for its source of woods, shade and forage in different kinds of soils. Medicinal and windy resistance trees at California, south Africa, southern Australia and Italy, Chittendon [1], this species is known to have antiseptic, aromatherapy, astringent, balsamic and anti-inflammatory activities in the cones and young branches, Bean [2]. Polunin and Huxley [3] stated that the leaves contain about 2% essential oil, whereas the wood contains about 2.5%, it is used in perfume and soap making. Wood is very hard and durable and it has scented wood, it is useful for building uses, cabinet making and wardrobes owing to retains its fragrance, repels moths and impervious to wood warm. *Cupressus sempervirens* L. is a medium-sized evergreen tree, its length reached 35 m., with a conic crown, with level branches, it is very long lived to over 1000 years old. The foliage grows in dense sprays, dark green in colour, the leaves are scale-like 2-5 mm in length and produced on rounded shoots.

Cytokinins are important plant hormones that regulate various processes of plant growth and development, cytokinins appeared to play an important role in the regulation of cell division, differentiation and organogenesis in developing plants, enhancement of leaf expansion, nutrient mobilization and delayed senescence [4-6]. Shudo [7] reported that chemical structure of cytokinin-active substances has determined two groups of adnine cytokinins and urea cytokinins with similar physiological effects, it has pronounced effect on cotyledon growth and expansion and other processes.

Corresponding Author: Dr. Fatma E.M. El-Quesni, Department of Ornamental Plants and Woody Trees, National Research Centre, Dokki, Cairo, Egypt

Karanov *et al.* [8] reported that application of kinetin on *Mentha spicata* and *Salvia officinalis* resulted an increases in total fresh weight including leaf weight and stem, kinetin affects plant growth. Runkova [9] revealed that it stimulated plant height, number of lateral branches on the main stem and number of leaves of some ornamental plants. The influences of cytokinins on the biosynthesis and accumulation of fixed oil and fatty acids were studied by many investigators, Vasudevan *et al.* [10] reported that spraying three sunflower cultivars with cytokinin produced the highest seed oil content.

The beneficial effects of micronutrients on plants and their involvement in the other processes, carbohydrate and nitrogen metabolism as well as the resistance of plant to diseases and adverse environmental conditions. Micronutrients are also essential for organization and rapid alternation of nutrition compound within plant owing to their great importance in contribution to direct the enzymes way in metabolism [11] Iron is among the essential micronutrients needed for better plant growth and high quality, Hussein *et al.* [12] on *Hibiscus* sp., who reported that Fe at 25 ppm stimulated growth characters. Misra and Srivastava [13] on *Mentha arvensis* L. reported that plant grown under iron deficiency had smaller leaves with smaller mesophyll cells compared with plants given sufficient iron, Liethy [14] on *Nigella sativa* added that application of iron increased plant height, number of leaves, fresh and dry weight/plant through its effect on enhancement of cell division and/or cell enlargement. The same author stated that application of iron increased chlorophyll contents and total carbohydrate.

Azza and El-Mesriy [15] on *Foeniculum vulgare* showed that iron application gave the highest values of N, P, K, Zn, Mn and Fe percentage in treated plants compared with control plants.

The aim of the present work is enhancing the vegetative growth of *Cupressus sempervirens* L. by foliar application with kinetin and iron, beside their effects on chemical constituents and essential oil content at Nubaria region, Egypt.

MATERIALS AND METHODS

The present investigation was carried out at National Research Centre (Research and Production Station, Nubaria) during two successive seasons of 2005 and 2006. It intended to find out the individual and combined effects of foliar application of kinetin and iron on growth and chemical composition of *Cupressus sempervirens* L.

One year old seedlings of Cupressus were obtained from nursery of Forestery Department/Horticultural Research Institute. In the Agricultural Research Centre, the seedlings were planted on the first week of January during the two successive seasons 2005 and 2006 in plastic pots 30 cm. in diameter, filled with 10 kg of peatmoss and sandy soil (1:1 by v/v), one plant/pot, the average heights of seedlings were 15-20 cm. the available commercially fertilizer used through this experimental work was kristalon (NPK 19: 19: 19) produced by Phayzen company, Holland. The fertilizer rates 5.0 g pot^{-1} in four doses after 4, 8, 16 and 20 weeks from transplanting.

Plants were sprayed twice with freshly prepared solutions of kinetin (0, 20, 40 ppm), Fe application used was ferrous sulphate as foliar spray at (0, 20, 40 ppm), interactions treatments of the different concentrations of the two factors had been also carried out, in addition to the untreated plants (control) which were sprayed with tap water.

Foliar application of kinetin and Fe was carried out two times of 30 days intervals, starting at the first week of February at both seasons. The experiments were sit in a Completely Randomized Design (CRD) with three replicates, two factors kinetin (0, 20, 40 ppm.) and iron (0, 20, 40 ppm.) concentrations and their interactions, all other horticulture practices were done as needed.

At the first week of January 2006 and 2007, the following data were recorded: plant height (cm), stem diameter (mm), number of branchlets, root length (cm), fresh and dry weights (g) of plant organs. Total soluble sugars were determined in the methanolic extract by using the phenol-sulphoric method according to Dubois *et al.* [16], photosynthetic pigments: including chlorophyll (a and b) as well as carotenoid contents were determined in fresh branchlets sample as mg mg^{-1} fresh weight, according to the procedure achieved by Saric *et al.* [17]. The total indoles were determined in the methanolic extract, using P. dimethyl amino benzaldhyde test "Erlic's reagent" according to Larsen *et al.* [18] and modified by Salim *et al.* [19]. Total soluble phenols were determined colourimetrically by using Folin Ciocaltea reagent AOAC [20]. Nitrogen content was determined according to the method described by Cottenine *et al.* [21]. Iron was determined by Atomic Absorption described by Chapman and Pratt [22]. A minimum of three representative 100 g samples of fresh shoots, weighed and homogenized and finally extracted with N-hexane solvent which was added to cover the sample …etc.

The extracted essential oil was kept in freezer to be ready to calculate oil percent according to Badawy *et al*. [23].

The data were statistically analyzed test according to Steel and Torrie [24] and the treatments means were compared using LSD test.

RESULTS AND DISCUSSION

Effects of foliar application of kinetin and iron on growth: The results in Table 1 show that all growth characters increased by foliar application of kinetin at 40 and 20 ppm, the highest values of plant height, stem diameter, number of branchlets and root length were obtained at 40 ppm kinetin, whereas 20 ppm kinetin decreased number of branchlets. Application of kinetin at 40 ppm increased fresh and dry weights of shoots and roots by 7.94 and 6.41% respectively than the corresponding values of the control plants. Whereas 20 ppm kinetin decreased fresh weight of shoots by 1.38% and increased significantly fresh weight of roots by 18.42%. these results are in accordance with those obtained by Al-badawy *et al.* [25] on *Matricaria chamomilla* plants. Runkova [9] on some ornamental plants and Youssef *et al.* [26] they found that spraying *Matthiola incana* plants with kinetin at the rate of 20 or 40 ppm led to significant increases in all growth parameters. In this work, the increments in all studied parameters may be attributed to the effect of the used treatments on cell division and/or cell elongation [4, 14].

From the same table, data show that the highest increases in plant height, stem diameter, number of branchlets and root length were found in plants treated by Fe 40 and 20 ppm compared with control plants, whereas 20 ppm Fe decreased plant height, the increments of the aforementioned characters may be due to the positive effect of Fe on enhancement of cell division and/or cell enlargement, deficiency of iron inhibits cell division [12, 14] on *Hibiscus* sp. and *Nigella sativa*, respectively. Iron spraying could be explained in the light of its role in the oxidation or reduction in respiration and photosynthesis and hence, for that a marked effect on photosynthetic efficiency. Data presented in Table 1 show that application of Fe 40 ppm caused an increase in fresh weight of shoots and roots by 3.29 and 42.63%, respectively compared with control plant. The role of Fe enhancing the synthesis of chlorophyll and protein for optimum growth as well as increasing the enzyme systems activity, Fe enhancing the metabolism of carbohydrates and protein as well as the enzyme systems, consequently the vegetative growth, the fresh and dry weights of leaves. These results are on line with those obtained by Abd El-Salam and Inas [27].

Table 1: Effect of foliar application of kinetin and iron on the growth of *Cupressus sempervirens* L. plants (Means of the two seasons 2006 and 2007)

Treatments	Plant height (cm)	Stem diameter (mm)	Number of branchlets	Root length (cm)	Fresh weight of shoots (g)	Dry weight of shoots (g)	Fresh weight of roots (g)	Dry weight of roots (g)
Effect of kinetin								
Control	64.57	6.46	57.44	36.66	52.6	18.68	13.24	6.06
Ki 20 ppm	67.54	6.71	54.22	37.07	51.87	17.73	15.68	6.89
Ki 40 ppm	76.18	7.2	65.11	38.79	56.78	19.81	14.09	7.08
LSD at 5%	2.95	0.56	5.78	1.6	2.84	1.34	1.38	0.68
Effect of iron								
Control	70.28	6.23	55.78	36.65	53.43	18.71	11.54	6.19
Fe 20 ppm	67.09	7.1	63.22	37.3	52.62	17.9	15.01	6.48
Fe 40 ppm	70.92	7.03	57.78	38.57	55.19	19.61	16.46	7.36
LSD at 5%	2.95	0.56	5.78	NS	NS	1.34	1.38	0.68
Effect of interaction								
Control	53.67	5.63	50.33	33.5	46.53	16.03	8.73	3.63
Ki 20 ppm	79.73	6.73	56.33	36.13	58.03	20.5	12.47	6.83
Ki 40 ppm	79.37	6.33	60.67	40.33	55.73	19.6	13.43	8.1
Fe 20 ppm	70.57	6.43	59.67	37.8	54.9	18.13	14.2	6.47
Fe 40 ppm	69.47	7.3	62.33	38.67	56.37	21.87	16.8	8.07
Ki 20 + Fe 20 ppm	59.97	7.33	53.67	38.37	47.8	16.2	16.67	6.67
Ki 20 + Fe 40 ppm	62.93	6.07	52.67	36.73	49.77	16.5	17.9	7.17
Ki 40 + Fe 20 ppm	70.73	7.53	76.33	35.73	55.17	19.37	14.17	6.3
Ki 40 + Fe 40 ppm	78.43	7.73	58.33	40.3	59.43	20.47	14.67	6.83
LSD at 5%	5.12	0.97	10	2.78	4.92	2.32	2.39	1.17

Kinetin: Ki, Iron: Fe

Table 2: Effect of foliar application of kinetin and iron on chemical constituents of *Cupressus sempervirens* L. plants (Means of the two seasons 2006 and 2007)

	Chlorophylls as mg gG^{1} fresh weight				
Treatments	Chl (a)	Chl (a)	Total chl (a+b)	Carotenoids (mg gG^{1})	Total soluble sugars (mg gG^{1})
Effect of kinetin					
Control	1.6	5.42	7.02	0.15	0.37
Ki 20 ppm	1.54	4.7	6.24	0.14	0.56
Ki 40 ppm	1.61	5.72	7.33	0.14	0.8
LSD at 5%	0.054	NS	NS	NS	0.02
Effect of iron					
Control	1.63	5.64	7.27	0.15	0.35
Fe 20 ppm	1.46	4.48	5.95	0.14	0.36
Fe 40 ppm	1.65	5.85	7.5	0.14	0.78
LSD at 5%	0.054	NS	NS	NS	0.02
Effect of interaction					
Control	1.55	5.19	6.74	0.15	0.19
Ki 20 ppm	1.64	6.02	7.66	0.16	0.27
Ki 40 ppm	1.77	5.72	7.49	0.14	0.61
Fe 20 ppm	1.61	5.96	7.57	0.15	0.25
Fe 40 ppm	1.65	5.21	6.86	0.15	0.66
Ki 20 + Fe 20 ppm	1.42	4.06	5.48	0.14	0.69
Ki 20 + Fe 40 ppm	1.55	4.04	5.59	0.11	0.74
Ki 40 + Fe 20 ppm	1.33	3.43	4.76	0.13	0.88
Ki 40 + Fe 40 ppm	1.72	5.4	7.12	0.15	0.93
LSD at 5%	0.094	1.66	1.94	0.026	0.03

Kinetin: Ki, Iron: Fe

Hence only through interaction like those reported above kinetin can play an important role in the regulation of cell division, differentiation and enhancement of leaf expansion [5], in addition to iron is the among essential micronutrients needed for plant growth and high quality [12], the highest increases in plant height, stem diameter, number of branchlets, root length, fresh and dry weights of shoots were found in plants treated with 40 ppm kinetin combined with 40 ppm Fe, it significantly increased by 46.13, 37.30, 15.89, 20.29, 27.72 and 68.04% respectively than the corresponding values of the control plants, while 40 ppm kinetin + 20 ppm Fe increased significantly number of branchlets, fresh weight of shoots and roots by 51.65, 18.65 and 62.81% respectively than control plants.

Effect of kinetin and iron on chemical constituents

Pigment content: Data presented in Table 2 show that foliar application of kinetin 40 ppm significantly affected chl (a), chl (b) content of cupressus branchlets compared with control plant. These results were in accordance with those obtained by Youssef *et al.* [26] on Matthiola incana L. this phenomenon may be due to the enhancement of leave expansion, nutrient mobilization and chlorophyll content [4, 5], foliar application of Fe 40 ppm significantly increased chl (a) content, whereas it had insignificant effect of chl (b) content of cupressus branchlets as compared with control plant. These results are in line with those obtained by leithy [14] on *Nigella sativa* L. Considering the interaction, foliar application with kinetin 40 ppm combined with iron 40 ppm gave the highest value of chl (a) and chl (b) content of cupresses branchlets as compared with control plant.

Total soluble sugars: Data in Table 2 show that total soluble sugars content significantly increased in plants treated with the two concentrations of kinetin and iron compared with control plant. The positive effect of Fe on enhancing the total soluble sugar may be due to the importance in contribution to direct the enzymes way in metabolism [11]. As for the interaction between kinetin and iron application the higher values obtained by kinetin 40 ppm + Fe 40 ppm followed by kinetin 40 ppm + Fe 20 ppm, kinetin 20 ppm + Fe 40 ppm and kinetin 20 ppm + Fe 20 ppm, in total soluble sugars content of cupressus plant as compared with control plant.

Total indoles: According to the data illustrated in Table 3 the total indole levels were determined in branchlets of cupressus plant were highly significantly affected by the application of kinetin at 20 and 40 ppm, it

Table 3: Effect of foliar application of kinetin and iron on chemical constituents of *Cupressus sempervirens* L. plants (Means of the two seasons 2006 and 2007)

Treatments	Total indoles mg gG^{1} FW	Total soluble phenols mg gG^{1} FW	Mineral ions as Total N (%)	Mineral ions as Fe as ppm	Essential oil (%)
Effect of kinetin					
Control	2.4	4.8	0.59	170	2.64
Ki 20 ppm	3.74	4.28	0.95	548	2.66
Ki 40 ppm	3.04	4.67	1.17	622	2.77
LSD at 5%	0.33	0.22	-	-	2.46
Effect of iron					
Control	3.94	4.34	0.59	170	2.65
Fe 20 ppm	2.79	4.64	0.83	204	2.61
Fe 40 ppm	2.45	4.76	1.14	246	2.63
LSD at 5%	0.33	0.22	-	-	NS
Effect of interaction					
Control	3.39	4.69	0.59	170	2.36
Ki 20 ppm	4.31	4.32	0.95	548	2.78
Ki 40 ppm	4.11	4.03	1.17	622	2.8
Fe 20 ppm	1.93	5.38	0.83	204	2.42
Fe 40 ppm	1.87	4.32	1.14	296	2.6
Ki 20 + Fe 20 ppm	3.36	4.33	0.71	392	2.63
Ki 20 + Fe 40 ppm	3.56	4.2	0.74	194	2.57
Ki 40 + Fe 20 ppm	3.07	4.2	1.02	290	2.77
Ki 40 + Fe 40 ppm	1.92	5.77	0.98	486	2.73
LSD at 5%	0.58	0.39	-	-	0.18

Kinetin: Ki, Iron: Fe

increased total indoles by 55.83 and 26.66%, respectively than control plants. The highest values of total indoles were obtained at interaction treated plants with kinetin and iron, which exceeded by 5.01% due to ki 20 ppm + Fe 40 ppm than control plants. Whereas Fe application at 40 and 20 ppm produced lower values which were less than control plants by 3.78 and 29.18%, respectively than control plants.

Total soluble phenols: The results in Table 3 emphasized that the amounts of total soluble phenols were highly significantly influenced by iron application at 40 and 20 ppm, it increased by 9.67 and 6.91%, respectively than control plant. Data on the response of total soluble phenols content to the interaction of kinetin and iron significantly increased by 23.02% due to ki 40 ppm + Fe 40 ppm, than that of control plants. This strongly leads to the conclusion that application of iron and the interaction of kinetin and iron had an inductive effect on increasing the concentration of total soluble phenols. These results are in agreement with those obtained by Essam [28] on *Acacia saligna* L.

Mineral content: Regarding the effect of kinetin and iron foliar application on nitrogen concentration of cupressus plant was gradually increased by increasing the concentrations of kinetin and iron to 40 ppm compared with control plant, these increments lead to quantitative and qualitative changes in proteins content which acted positively in cell division and cell elongation resulting in addition to vegetative growth. These results are in line with those obtained by Bekhata and Mahgoub [29]. Concerning the interaction, foliar application with kinetin 40 ppm + Fe 20 ppm followed by ki 40 ppm + Fe 40 ppm were lead to significant increase in this criterion. As regarding that spraying cupressus plants with kinetin and iron at all the used levels lead to increases in Fe content compared with control plants. These increments led to positive effects on growth parameters and increased total nitrogen and Fe percent. In relation to the effect of iron concentrations on the percentage of the previous mineral in the leaves were gradually increased by increasing Fe level, these increments due to enhancing effects of Fe on the absorption and/or translocation of those minerals. Such phenomenon may be due to its effect on enhancing the plant metabolism [30].

Oil content: Data presented in Table 3 show that oil percent in *Cupressus sempervirens* branchlets were significantly affected as a result of foliar application with different concentrations of individual kinetin and iron or

collectively with iron treatment. The highest recorded oil percentage in plants treated with kinetin 40 and 20 ppm, it significantly exceeded by 12.60 and 8.13%, respectively than control plants.

These results are in line with those obtained by Vasudevan *et al*. [10] who reported that spraying three sunflowers cultivars with cytokinin produced the highest seed oil content, whereas Fe 40 and 20 ppm it produced less oil content by 0.75 and 1.50% due to Fe 40 and Fe 20 ppm, respectively than control plants.

The interactions application of the two factors, the highest values of oil percentage of cupressus were obtained from ki 40 ppm combined with Fe 20 ppm, followed by ki 40 ppm + Fe 40 ppm, ki 20 ppm + Fe 20 ppm and ki 20 ppm + Fe 40 ppm, it increased significantly by 17.37, 15.6, 11.44 and 8.89%, respectively than the corresponding values of the control plants.

From the above mentioned results, it could be concluded that foliar application of kinetin 40 ppm combined with Fe at 40 or 20 ppm promoted growth parameters and possessed the best oil percentage in *Cupressus sempervirens* L. plant.

REFEERENCES

1. Chittendon, F., 2001. RHS Dictionary of plants plus supplement. 1956, Oxford Univ. listing of species and how to grow them.
2. Bean, W., 1981. Trees and shrubs hardy in Great Britain., Vol. 1-4.
3. Polunin, O. and A. Huxley, 1987. Flowers of the Mediterranean. Hogarth. A very readable pocket flora that is well illustrated. Gives Some Information on Plant Uses.
4. Skoog, F and D.J. Armstrong, 1970. Cytokinins. Ann. Rev. Plant Physiology, 21: 359-384.
5. Hall, R.H., 1973. Cytokinins as a probe of development processes. Ann. Rev. Plant Physiol., 24: 415-444.
6. Hassan, E.A. and F.E.M. El-Quesni, 1989. Application of growth regulators in Agriculture. A cytokinin-induced new morphogenetic phenomena in carnation (*Dianthus caryophyllus* L.). Bull. Fac. Agric., Cairo Univ., 40: 187-196.
7. Shudo, K., 1994. Chemistry of Phenylurea Cytokinins. In Cytokinins: chemistry, activity and function. Mok, D.V. and M.C. Mok, (Eds.). CRC press, Boca Raton, pp: 35- 42.
8. Karanov, En., L.K. Iliev and V.S. Alexieva, 1992. Phynylurea Cytokinins Chemistry, Physiology and Application (minireview). In: Physiology and biochemistry of cytokinins in plants. Kaminek, M., D.W.S. Mok and E. Zazimalova, (Eds.), pp: 199-204.
9. Runkova, L.V., 1985. Cytokinins effects on some ornamental plants. Acta Hortic., 167: 69-77.
10. Vasudevan, S.N., K. VirupaKshappa, S. Bhaskar and M. Udayakumar, 1996. Influence of growth regulators on some productive parameters and oil content of sunflower (*Helianthus annus*, L.). Ind. J. Plant Physiol., 1: 277-280.
11. Massoud, A.M., M.Y. Abou Zeid and M.A. Bakry, 2005. Response of Pea plants grown on silty clay soil to micronutrients and Rhizobium inoculation. Egypt. J. Appl. Sci., 20.
12. Hussein, M.S., S.E. El-Sherbeny, H.M. El-Said and M.M. Kandeel, 1989. Field experiments of foliar application with B-9 and micronutrients of (*Hibiscus sabdariffa* L.). 1. growth, yield and hormonal, content. Egypt. J. Hortic., 16: 55-58.
13. Misra, A. and N.K. Srivastava, 1990. Iron nutrition related to growth and physiology. New Delhi, India, 2: 5-20.
14. Leithy, S.M., 1998. Effect of soil type and micronutrients on growth, yield and chemical constituents of *Nigella Sativa* L. Ph.D. Thesis, Fac. of Agric., Cairo Univ., Egypt.
15. Azza, A.M. Mazhar and T.A. EL-Mesriy, 2000. Influence of some micronutrients under variable irrigation intervals on growth, yield, chemical composition and essential oil productivity of fennel (*Foeniculum vulgare*, Mill) plants. Annals of Agric. Sci., Moshtohor, Egypt, 38: 773-794.
16. Dubois, M., F. Smith, K.A. Gilles, J.K. Hamilton and P.A. Rebers, 1966. Colorimetric method for determination of sugars and related substances. Anol. Chem., 28: 350-356.
17. Saric, M.R., T. Kastrori, Cupina and I. Geris, 1967. Chlorophyll determination Univ. Unoven Sadu-Prakitikum is Kiziologize Bilijaka- Beagrad, Haucua Anjiga, pp: 215.
18. Larsen, P., A. Harbo, S. Klungsan and T.C. Asheim, 1962. On the biosynthesis of some indole compounds in *Acetobacter xylinum* Physiol. Plant., 15: 552-565.
19. Salim, H.H., M.A. Fayek and A.M. Sweidan, 1978. Reproduction of Bricher apple cultivar by layering. Annal of Agric. Sci., Moshtohor, 9: 157-166.

20. A.O.A.C. 1985. Official Methods of Analysis of the Association of Agriculture Chemists, 13th Ed., Benjamin Franklin Station, Washington, DC, B.O. Box 450.
21. Cottenie, A., M. Verloo, G. Velghe and R. Camerlynek, 1982. Chemical Analysis of Plant and Soil. Laboratory of Analytical and Agrochemistry State Univ. Ghent, Belgium, pp: 100-129.
22. Chapman, H.D. and P.F. Pratt, 1961. Methods of Analysis for Soils, Plant and Water. Div. of Agric. Sci., Univ. of California, Berkely, USA, 445.
23. Badawy, A.M., S. Morsi, S. Sakr, El-Bahr and H.S. Taha. 1991. Production of the essential oil obtained from callus of different organs of chamomile plant *in vitro*. Bull. Fac. of Agric., Cairo Univ., 42: 1485-1500.
24. Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics. 2nd Edition, MC Graw-Hillbook Co., Inc., New York, Toronto, London.
25. Al-Badawy, A.A., N.M. Abdalla, G.A. Rizk and S.K. Ahmed, 1984. Growth and volatile oil content of chamomile plant as influenced by kinetin treatments. Proc. 11th Plant Growth Regulator Society of America, Boston, Massachusetts, pp: 215-219.
26. Youssef, A.A., M.H. Mahgoub and M.I. Talaat, 2004. Physiological and biochemical aspects of *Matthiola incana* plants under the effect of putrescine and kinetin treatments. Egyp. J. Appl. Sci., pp: 19.
27. Abd El-Salam and Z-Innas, 1999. Physiological studies on *Foeniculum vulgare* Mill Plant. Ph.D. Thesis, Fac. of Agric., Cairo Univ., Egypt.
28. Essam, M.A. Youssef, 1993. Rejuvenation in *Acacia saligna* L. Bull. Fac. of Agric., Cairo University, 44: 105-130.
29. Bekheta, M.A. and M.H. Mahgoub, 2005. Application of kinetin and phenylalanine to improve flowering characters, vase life of cut flowers as well as vegetative growth and biochemical constituents of carnation plants. Egypt. J. of Appl. Sci., 20: 234-246.
30. Amberger, A., 1974. Micronutrients, dynamics in the soil and function in plant metabolism. Proc. Bot. Sci. Workshop, Cairo, Egypt.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 289-296, 2007
ISSN 1818-6769

Effect of Nitrogen, Boron, Potassium and Zinc Sprays on Yield and Fruit Quality of Date Palm

[1]M. Khayyat, [1]E. Tafazoli, [1]S. Eshghi and [2]S. Rajaee

[1]Department of Horticultural Science, College of Agriculture, Shiraz University, Shiraz, Iran
[2]Department of Horticultural Science, College of Agriculture, Jahrom University, Jahrom, Iran

Abstract: The present research was accomplished on *Phoenix dactylifera L.* cv. Shahany to investigate the effect of macro and micronutrients on fruit quality and quantity. Treatments were urea (0.5, 1%), boric acid (1500, 2500 ppm), potassium sulfate (1, 2%) and zinc sulfate (300, 600 ppm). Higher and lower yield were obtained from H_3BO_3 (1500 ppm) and control, respectively. The greater part of pulp weight, pulp/seed ratio, fruit length and diameter were resulted from H_3BO_3 (1500 ppm). Total soluble solids were the most in control; however, there were significant differences among treatments. The results of this study showed that mineral nutrients especially boron, increased yield and quality of fruits in 'Shahany' date palm.

Key words: Urea % boron % potassium % zinc % date palm % yield % fruit quality

INTRODUCTION

Date palm is one of the ancient domestic fruit trees in the Middle East countries and their fruits play an important role in the nutritious pattern of many people. In Iran, many cultivars are grown in different regions according to the diversity of their climatic necessity, particularly average temperature and relative humidity that effect fruit growth and development. In each zone, soil conditions are different and generally undesirable, which possibly lead to lower nutrient flowing in inflorescences and fruits and consequently cultivar reproductive potentials don't become evident. One of the best tools for date palm reproductive potential studies is direct application of nutrient elements on inflorescences and fruits.

Nourish effects of some macro elements upon date palm yields and fruit qualities were reported by other [1-7]. In addition to macro elements, micro elements had also important role in fruit set, retention, development and cause efficient yield and quality improvement [8-10]. The efficient use of fertilizers to increase crop yield is an important goal in all agricultural systems [11]. However, matching nutrient application to crop requirements is not easy. It has been and will continue to be an ambitious pursuit for researchers and growers to maximize nutrient uptake by crops on the other hand, minimizing fertilizer application and leaching loss [11]. Plants usually absorb water and nutrients by their roots, therefore fertilizers are traditionally applied into the soil [12]. While soil application can supply enough nutrients to improve plant production, it also causes world-wild anxiety about environmental contamination for nutrients leaching into ground water [13]. Increasing public concern, excessive nutrient loss from agricultural land encourage the researchers to find more efficient ways to apply fertilizers [11]. The power of plant leaves to absorb nutrients has resulted in the fact that the foliar application of nutrients becomes a recurrent method for supplying nutrients to plants [14]. Foliar fertilization has the advantage of low application rates, uniform distribution of fertilizer materials and quick responses to applied nutrients. Moreover, hidden hungers can easily be managed [15]. Many workers have shown that fruit trees receiving foliar nitrogen applications, use fertilizers N more efficiently than trees that receive soil N applications [16, 17]. Faust [18] reported that plant growth stage and timing of fertilizer application affect nutrient uptake [18]. Using isotopically labeled N, it has been possible to demonstrate that developing inflorescences and fruits are a strong N sink [19]. Abou Aziz *et al*. [20] reported that urea application on avocado trees gave a highly significant increase in the tree yields [20]. However, soil and foliar urea applications on avocado cause increasing yield [21]. Yogaratnam *et al*. [22] reported that foliar applied urea, zinc and boron alone or in combination had no effect on fruit size in apple trees, but urea application causes increasing yield, moreover boric acid was inconsistent in

Corresponding Author: Mr. M. Khayyat, Department of Horticultural Science, College of Agriculture, Shiraz University, Shiraz, Iran

effect [23, 24]. Potassium application increased yield and fruit quality in lemons and oranges [25]. Foliar sprays with $ZnSO_4$ failed to increase yields of 'Eureka' lemon trees [26]. Agaev [27] reported significant increases in yield of potato plants in response to soil and foliar Zn applications in the Caucasus region of the former Soviet Union. Yield increases were caused by both elevated numbers of tubers and their sizes [27]. The main aim of this study was to investigate the effects of some nutrient elements on fruit yields and quality of date palm trees.

MATERIALS AND METHODS

Plant selection and treatments: The experiment was conducted at a commercial plantation suburban Jahrom of Iran on date palm cultivar 'Shahany' in 2006 growing seasons. Nine uniform trees were selected based on height (350±50 cm), diameter (45±5 cm) and inflorescence's number (4 inflo.). The selected trees at on-year were treated according to the usual farm management, for example, artificial pollination, pruning, irrigation, fertilization and manuring. Spray treatments were:

- Control (Distilled water+wetter)
- Urea (0.5, 1%+wetter)
- H_3BO_3 (1500, 2500 ppm+wetter)
- K_2SO_4 (1, 2%+wetter)
- $ZnSO_4$ (300, 600 ppm+wetter)

All treatments were applied separately at *Khalal* stage of fruit growth and development. Sprays were applied by watering-can until 'run-off 'stage. Wettering agent was tween-20.

Yield: The value for the yield is means of 10 mature fruits in each of replications and 4 replications in each treatment. Means are given in grams per treatment.

Pulp characters: Pulp characters were calculated based on length (cm), weight (g), pulp/seed ratio (g) and diameter (cm).

Seed characters: Seed characters were calculated based on length (cm), weight (g) and diameter (cm).

Fruit quality: Water-soluble dry matter (%) in fruit was measured using a hand refractometer.

Statistical analysis: Each of inflorescences and trees were selected as one replication and a block in experiment, respectively. The experiment was arranged in completely randomized block design (CRBD) with 9 treatments and 4 replications. Means were compared with using Duncan's multiple range tests at 5% level. SPSS (11.5) was use for determine correlation among treats.

RESULTS AND DISCUSSION

Yield: Higher and lower yield were obtained from boric acid (1500 ppm) and control, (15.55 and 10.82 g) respectively (Fig. 2). Data (Table 1) indicated that fruit and seed development independent. Were shown that the rate of dry matter accumulation is accelerating by the live ovule at the fruit development period [28]. In seeded fruit the rapid increase in fruit growth starts at the beginning of the *Khalal* stage, simultaneously the seed entirely ceases growing [28]. Yogaratnam and Greenham [23] has shown that urea spray on apple trees did not increase yield, but, at our experiment urea spray caused higher fruit yield compared to control and there were no significant differences between H_3BO_3 (1500 ppm) and urea treatments.

Pulp characters: The fruit length was shown in Fig. 1 and 11-18. Lower fruit length (Fig. 1 and 11) was resulted from control (Fig. 3). Larger fruits resulted from urea spray

Table 1: Correlations between fruit and seed characters

	Fruit length (cm)	Seed length (cm)	Seed weight (g)	Pulp. weight (g)	Pulp/ seed ratio	Fruit weight (g)	Seed diameter (cm)	Fruit diameter (cm)
Fruit length (cm)	1			**	**	**		
Seed length (cm)	0.092	1	*				*	
Seed weight (g)	-0.535	0.688*	1		**		**	
Pulp. weight (g)	0.778**	0.393	-0.1441	1	*	**		
Pulp/seed ratio	0.875**	-0.275	-0.774**	0.727*	1	*	*	
Fruit weight (g)	0.776**	0.460	-0.101	0.996**	0.989*	1		
Seed diameter (cm)	-0.558	0.733*	0.853**	-0.071	-0.676*	-0.020	1	*
Fruit diameter (cm)	-0.341	0.295	0.308	0.177	-0.148	0.181	0.666*	1

[** correlation is significant at the 0.01 level], [* correlation is significant at the 0.05 level]

Fig. 1: Effects of nutrient elements on fruit length [up to down: zinc (600,300 ppm), urea (1, 0.5%), boron (1500, 2500 ppm), potassium (1, 2%) and control]

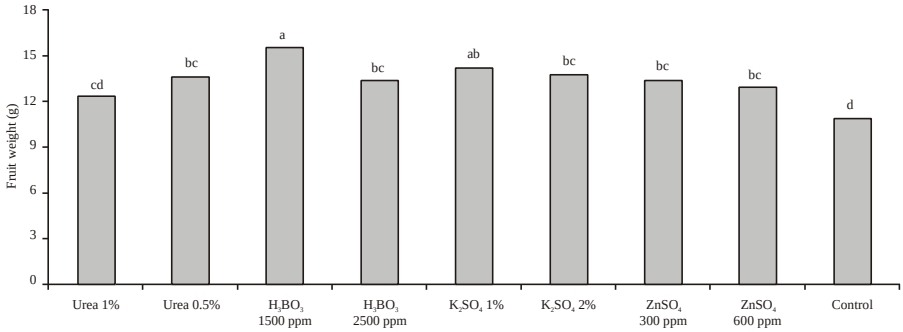

Fig. 2: Effect of urea, boron, potassium and zinc on fruit weight (g). Bars with the same letters are not significantly different according to DMRT at 5% level

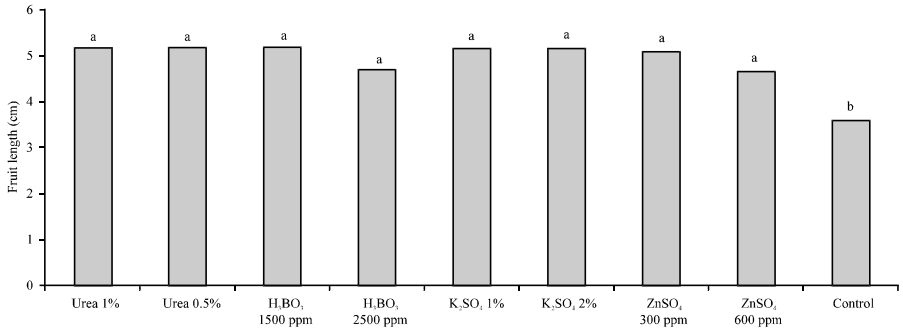

Fig. 3: Effect of urea, boron, potassium and zinc on fruit length (cm). Bars with the same letters are not significantly different according to DMRT at 5% level

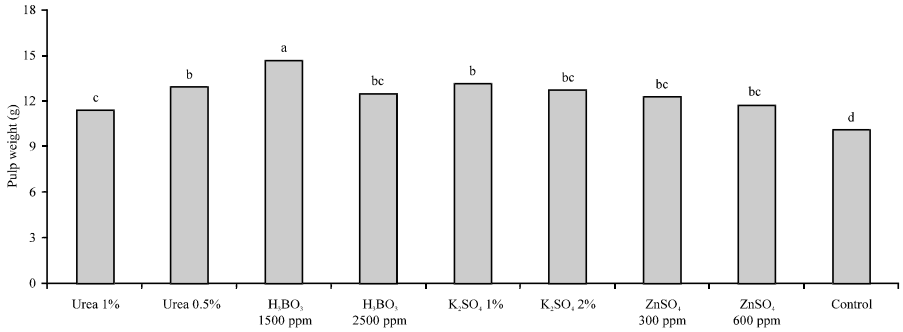

Fig. 4: Effect of urea, boron, potassium and zinc on pulp weight (g). Bars with the same letters are not significantly different according to DMRT at 5% level

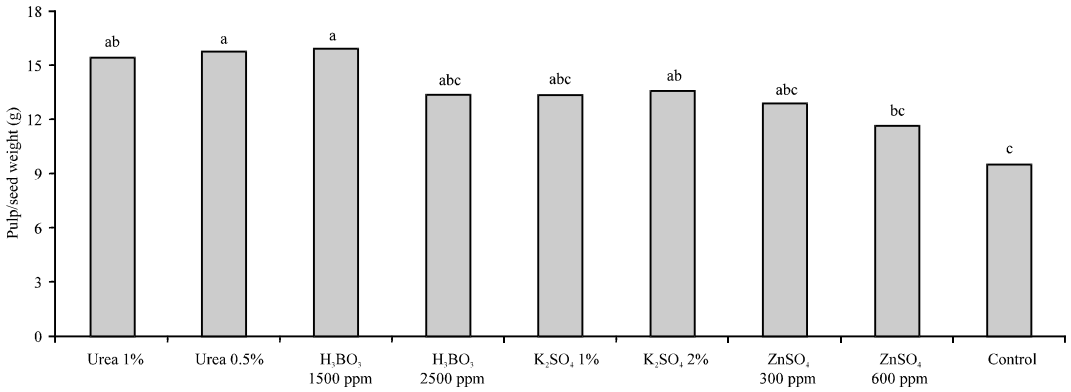

Fig. 5: Effect of urea, boron, potassium and zinc on pulp/seed weight (g). Bars with the same letters are not significantly different according to DMRT at 5% level

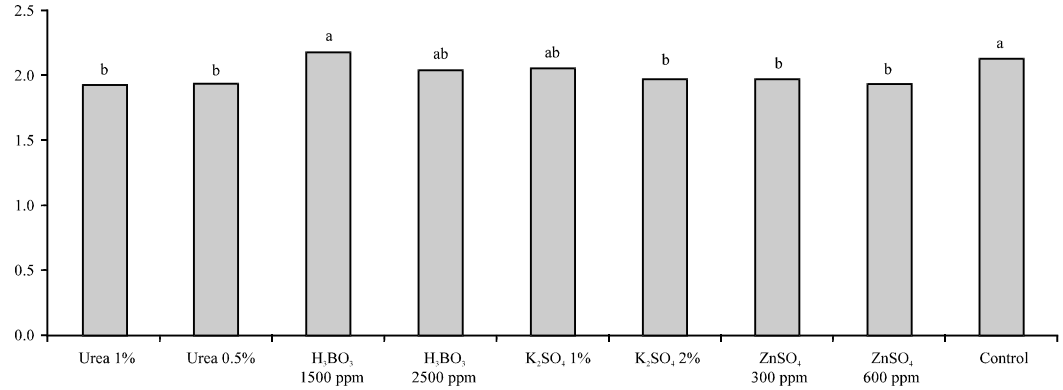

Fig. 6: Effect of urea, boron, potassium and zinc on fruit diameter (cm). Bars with the same letters are not significantly different according to DMRT at 5% level

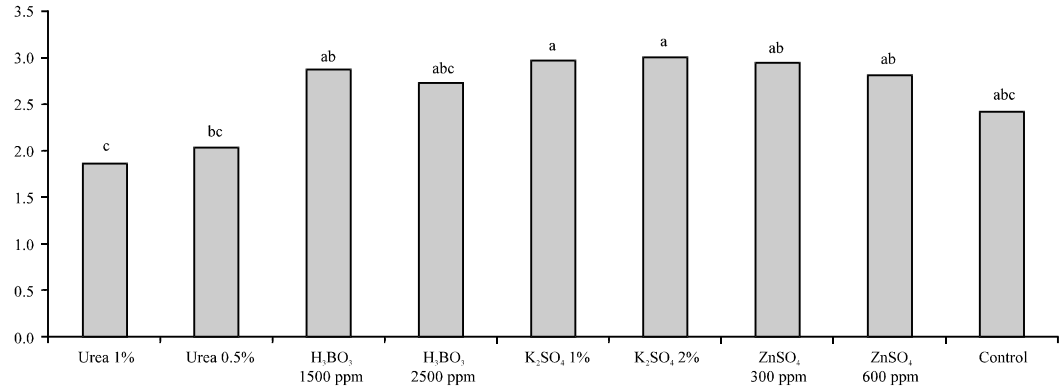

Fig. 7: Effect of urea, boron, potassium and zinc on seed length (cm). Bars with the same letters are not significantly differen according to DMRT at 5% level

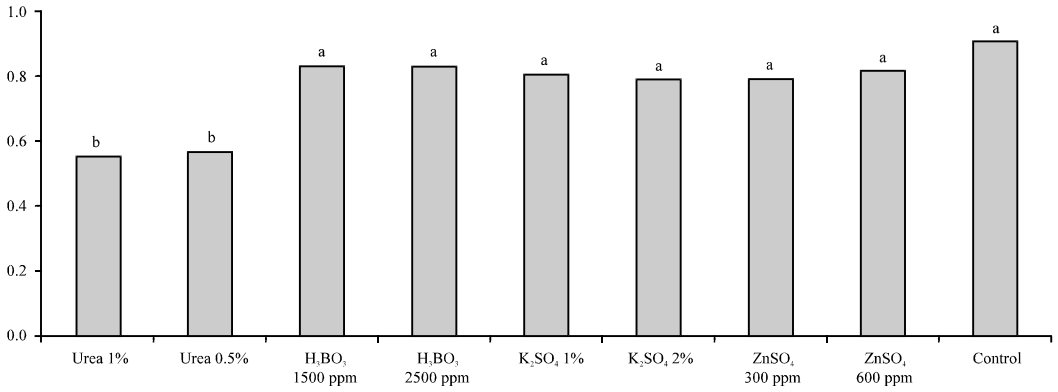

Fig. 8: Effect of urea, boron, potassium and zinc on seed diameter (cm). Bars with the same letters are not significantly different according to DMRT at 5% level

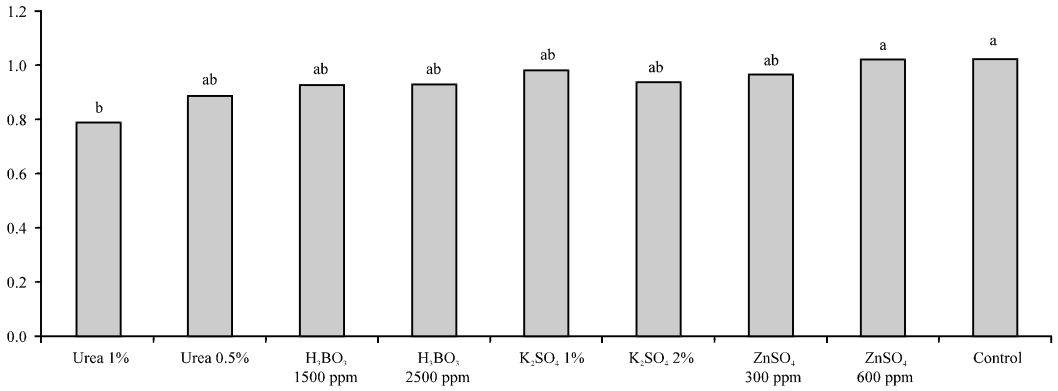

Fig. 9: Effect of urea, boron, potassium and zinc on seed weight (g). Bars with the same letters are not significantly different according to DMRT at 5% level

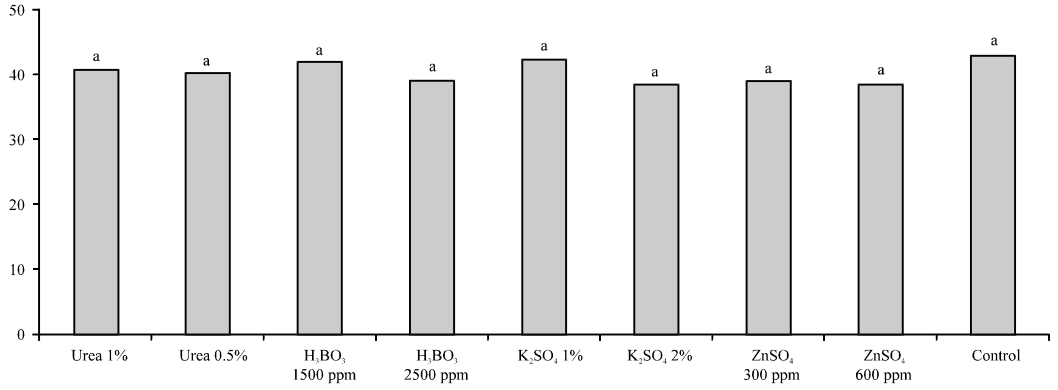

Fig. 10: Effect of urea, boron, potassium and zinc on total soluble solids (%).Bars with the same letters are not significantly different according to DMRT at 5% level

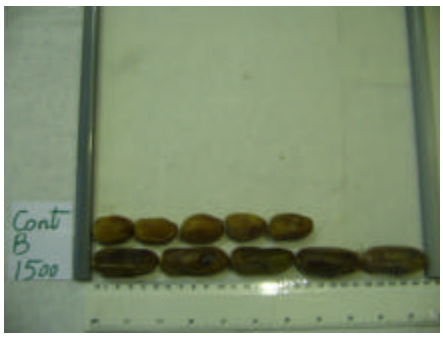

Fig. 11: Control [up], boron1500 ppm [down]

Fig. 12: Boron 2500 ppm [up], 1500 ppm [down]

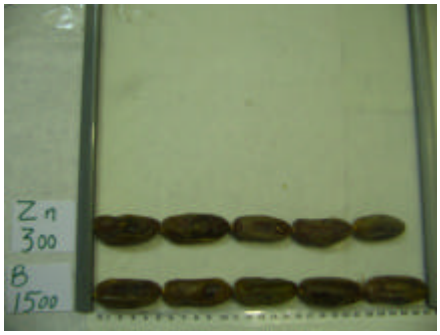

Fig. 13: Zinc 300 ppm [up], boron 1500 ppm [down]

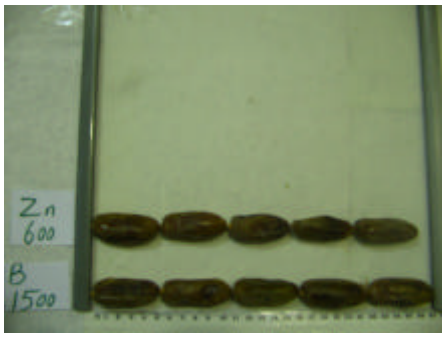

Fig. 14: Zinc 600 ppm [up], boron 1500 ppm [down]

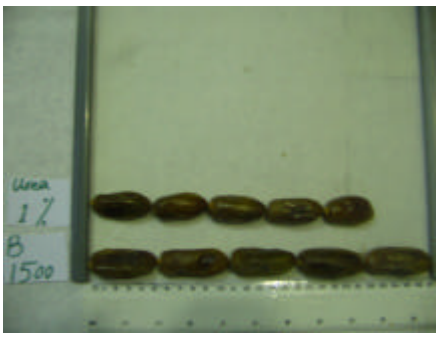

Fig. 15: Urea 1% [up], boron 1500 ppm [down]

Fig. 16: Urea 0.5% [up], boron 1500 ppm [down]

Fig. 17: Boron 1500 ppm [up], potassium 1% [down]

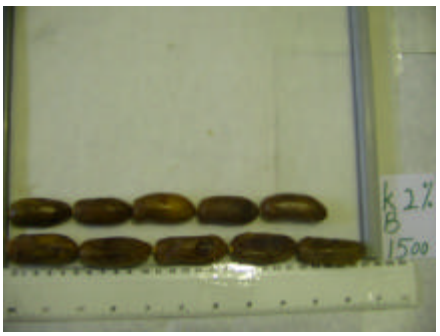

Fig. 18: Potassium 2% [up], boron 1500 ppm [down]

compared to control (Fig. 1) that was in agreement with De La Rocha and Flores [29] in young avocado, strawberries and oranges; Nevin [21] and Abou Aziz *et al*. [20] in avocado tree results. There were no significant correlations between seed length, pulp weight, fruit weight, fruit diameter and fruit length (Table 1). There were positive correlations between fruit length with pulp weight, fruit weight and pulp/seed ratio (Table 1). There were significant differences among treatments on pulp weight and higher pulp weight showed at boric acid (1500 ppm) treatment (Fig. 4). By increasing pulp weight, seed weight decreased (Table 1). Pulp weight increment could be due to improving cell size or cell number by nutrient elements. Higher and lower pulp/seed ratio (Fig. 5) were resulted from H_3BO_3(1500 ppm) and control, respectively. Moreover, pulp/seed ratio was close to H_3BO_3(1500 ppm) results in urea treatments. Positive and negative correlations were shown between pulp/seed ratio with fruit length and seed weight, respectively (Table 1). Fruit diameter (Fig. 6) was higher on H_3BO_3 (1500 ppm) and significantly differs with other treatments, except by control. Positive correlations were obtained between fruit and seed diameter at the 0.01 level (Table 1). Acid boric sprays in our study caused improving in fruit size that in contrast with Yogaratnam and Johnson [30] results on apple trees. Potassium Sulfate sprays caused fruit improvement, in agreement with Umer *et al*. [15] on groundnut; Jones and Embleton [25] on lemons and oranges; Dialami and Pejman [31] on date palm trees results. Zinc Sulfate sprays in our studies increased fruit size and pulp/seed ratio compared to control. Fruit improvement from this treatment was in agreement with Eliyeva [32] results on apple trees. Acid boric causes cell division or nucleic acid synthesis within fruit growth and development period and consequently fruit growth improves [33]. Potassium is essential for fruit enlargement [34]. Moreover, potassium in some plants cause cell turgidity supplementally by reducing carbohydrates [35].

Seed characters: With increase potassium level (from 1 to 2%), seed length increased (Fig. 7). Higher seed diameter (Fig. 8) was resulted from control. Positive correlation was shown among seed diameter and weight (Table 1). Lower seed weight (Fig. 9) was resulted from urea 1% treatment. There were positive and negative correlations between seed weight with seed diameter and pulp/seed ratio, respectively (Table 1).

Fruit quality: Higher total soluble solids (Fig. 10) were obtained from control; however, no significant differences were resulted among treatments.

CONCLUSIONS

The improvement occurred in the fruit yield and quality could be attributed to effects of nutrients on carbohydrate influx or plant growth regulators synthesis in growing fruits. Our results have revealed that nutrient spray applications can also cause yield and fruit size improving, without thinning agent's requirements.

REFERENCES

1. Furr, J.R. and T.R. Brown, 1963. Comparative yield of 'Deglet Noor 'date palms fertilized with manure or Ammonium nitrate. Date grower's. Rept., 40: 2-3.
2. Hussein, F. and M.A. Husssein, 1972. Effect of nitrogen fertilization on growth, yield and fruit quality of dry dates grown at Aswan. 1st Egypt. Congr. Bot., Cairo, 25-27 March.
3. Kalifa, A.S., A.M. Hammady, M.M. Hammady and Y.A. Wally, 1975. Effect of ethephon on some physiological and chemical properties of date fruits. Egypt. J. Hort., 2: 12-16.
4. Abdalla, K.M., S.I. Gaafer, A.S. Kalifa and El-Hammady, 1987. Influence of fertilization with potash on 'Hayany' dates grown in sandy soil. Annals Agric. Sci. Fac. Agric. Ain Shams Univ., Cairo, Egypt, 32: 649-656.
5. Melouk, A.M., M.A. Basal and U.K. El-Abbasy, 1999. effect of nitrogen fertilization on growth and yield of 'Zaghloul' date palm. Ï. Yield and fruit quality. Intl. Conf. Date Palm. Assiut University, 9-11 November.
6. Atalla, A.M., M.M. Attia and H.S. Aly, 1999. Effect of NPK fertilization trials on yield and fruit characteristics of 'Zaghloul' date palm cultivar grown in Egypt. International Conf. Date Palm. Assiut University. 9-11 November.
7. Shawky, I., M. Yousif and A. El-Gazzar, 1999. Effect of nitrogen fertilization on 'Sewy' date palm. Intl. Conf. Date Palm. Assuit University, 9-11 November.
8. Singh, R.S. and Sant Ram, 1983. Studies on the use of palm growth substances for fruit retention in mango cv. Dashehair. Ind. J. Hort., 40: 188-194.
9. Babu, R.S.H., C.B.S. Rajput and S. Rath, 1984. Effect of zinc, 2,4-D and GA_3 in 'Kagzi' Lime (*Citrus aurantifolia* SWINGLE). IV. Fruit quality. Haryana. J. Hortic. Sci., 11: 59-65.
10. Khan, N., A.B. Malik, M.I. Makbdoom and A. Hag, 1993. Invastigations on the efficiency of exogenous synthetic growth regulators on fruit drop in mango (*Mangifera indica* L.). Egypt. J. Hort., 20: 1-14.

11. Dong, S., L. Cheng, C.F. Scagel and L.H. Fuchigami, 2005. Timing of urea application affects leaf and root N uptake in young Fuji/M9 apple trees. J. Hortic. Sci. Biotech., 80: 116-120.
12. Mengel, K., 2002. Alternative or complementary role of foliar supply in mineral nutrition. Acta. Hortic., 594: 33-47.
13. Dinnes, D.L., D.L. Karlen, D.B. Jaynes, T.K. Kaspar, J.L. Hatfield, T.S. Colvin and C.A. Cambardella, 2002. Nitrogen management strategies to reduce nitrate leaching in tile-drained Midwestern soils. Agron. J., 94: 153-171.
14. Swietlik, D. and M. Faust, 1984. Foliar nutrition of fruit crops. Hort. Rev., 6: 287-355.
15. Umer, S., S.K. Bansal, P. Imas and H. Magen, 1999. Effect of foliar fertilization of potassium on yield, quality and nutrient uptake of groundnut. J. Plant. Nutr., 22: 1785-1795.
16. Hill-Cottingham, D.G. and C.P. Lloyd-Jones, 1975. Nitrogen-15 in apple nutrient investigations. J. Sci. Food. Agric., 26: 165-173.
17. Weinbaum, S.A., 1988. Foliar nutrition of fruit crops. In: Plant Growth and Leaf Applied Chemicals. Neuman, P.E. (Ed.). CRC Press, Inc. Boca Raton, FL. USA., pp: 81-100.
18. Faust, M., 1989. Physiology of temperate zone fruit trees. John Wiley and Sons, New York, USA, pp: 53-132.
19. Klein, I. and S.A. Weinbaum, 1984. Foliar application of urea to olive: Translocation of urea nitrogen as influenced by sink demand and nitrogen deficiency. J. Am. Soc. Hort. Sci., 109: 356-360.
20. Abou Aziz, A.B., I. Desouki and M.M. El-Tanahy, 1975. Effect of nitrogen fertilization on yield and fruit oil content of avocado trees. Sci. Hortic., 3: 89-94.
21. Nevin, J.M., T.W. Embleton and C.I. Lovatt, 1990. Problems with urea-N foliar fertilization of avocado. Acta. Hortic., 275: 535-541.
23. Yogaratnam, N. and W.P. Greenham, 1982a. The application of foliar sprays containing nitrogen, magnesium, zinc and boron to apple trees. I. Effects on fruit set and cropping. J. Hortic. Sci., 57: 151-158.
25. Jones, W.W. and T.W. Embleton, 1969. Potassium nutrition of subtropical fruits. Hort. Sci., 4: 37-38.
26. Embleton, T.W., E.F. Wallihan and G.E. Goodal, 1965. Effectiveness of soil vs. foliar applied zinc and of foliar applied manganese on California lemons. Proc. Am. Soc. Hort. Sci., 86: 253-259.
27. Agaev, N.A., 1989. Agrocheical grouping of soils of lesser Caucasus by content of trace elements and their effecton potato yield (in Russian). Doklady vsesoyuznoi Akademii Sels kokhozyaistvennykh Nauk Im. V. I. Lenina, 5: 16-18.
28. Reuveni, O., 1986. Date. In: Handbook of Fruit Set and Development. Monselise, P.S. (Ed.). CRC Press, Inc. Boca Raton, FL. USA, pp: 119-140.
29. De La Rocha, G.G. and C.D. Flores, 1955. Tests on nitrogen foliar nutrition. Inf., mens. Estac. Exp. Agric. La Molina, 29: 5-9, Hort. Abstr., 1956, Vol: 26.
30. Yogaratnam, N. and D.S. Johnson, 1982b. The application of foliar sprays containing nitrogen, magnesium, zinc and boron to apple trees. Ï. Effects on the mineral composition and quality of the fruit. J. Hortic. Sci., 57: 159-164.
31. Dialai, H. and H. Pejman, 2005. Effects of potassium sulfate, potassium nitrate and manganese sulfate on yield and fruit quality of 'Toory' date palm cultivar grown in Iran. 1st. Int. Conf. Date Palm, 20-21 November.
32. Eliyeva, Z., 1975. The effect of foliar nutrition with minor elements on the growth and productivity of apple trees in the Kubinskii region of Azerbaijan. Sbornik Trudov Azerb. Sadovodstva, Vinogradarstva I Subtrop. Kultur., 8: 98-100.
33. Van Goor, B.J. and P. Van Lune, 1980. Physiol. Plant., 48: 21-26.
34. Fisher, E.G., K.G. Parker, N.S. Luepschen and S.S. Kwong, 1959. Proc. Am. Soc. Hort. Sci., 73: 78-90.
35. Marschner, H., 1986. Mineral nutrition in higher plants. New York: Academic Press.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 297-302, 2007
ISSN 1818-6769

Studies on Genetic Variability in Cultivated Sorghum (*Sorghum bicolor* L. Moench) Cultivars of Adamawa State Nigeria

[1]D. Bello, [1]A.M. Kadams, [1]S.Y. Simon and [2]D.S. Mashi

[1]Department of Crop Production and Horticulture, [2]Department of Biological Sciences,
Federal University of Technology, P.M.B. 2076, Yola, Nigeria

Abstract: Studies were carried out to estimate the extent of genetic variability in cultivated strains of sorghum (*Sorghum bicolor* L. Moench*).* Thirty landraces were evaluated for one year (2001) across two environments, to obtain information on genetic and morphological diversity. Significant mean squares were obtained for almost all characters in the individual analysis of variance as well as the combined analysis across environments, suggesting that, this sorghum population was highly variable for almost all the characters, therefore, would respond to selection. Mean performances for the combined analysis identified Whilawa, Jerma, Mbaburi, Jigarigir, Jigarimuv and Mboderi as the promising cultivars in terms of yield per hectare, flag leaf length, panicle length, panicle width, earliness and length of inter-node respectively. Individual and the combined analyses indicated that most characters had higher genotypic and phenotypic variance components than the environmental variance estimates, which is indicative that character expression in this sorghum population was genetic and can be exploited in breeding programs. The genotypes also exhibited varying degrees of heritability estimates. Characters such as plant height, days to 50 % flowering, number of nodes per plant, panicle length, number of leaves per plant and days to 95% maturity responded positively to selection because of high broad sense heritability estimates.

Key words: Sorghum % cultivars % yield components % variances and heritability

INTRODUCTION

Progress in plant breeding depends on the extent of genetic variability present in a population. Therefore, the first step in any plant breeding program is the study of genetic variability, which cannot easily be measured. The phenotypic variability in a given environment can be measured easily, but it reflects non genetic as well as genetic influence on the phenotypic expression. The genetic facts are inferred from phenotypic observations, which are the results of interactions of genotype and the environment. Lukhele and Obilana [1], Abu-Gasim and Kambal [2], Aba *et al*. [3] studied their research materials under more than one environment to ascertain their stability across environments. Studies on variability in sorghum confined to one environment have been reported by several authors [4-6]. In the present study, therefore, the variability present in thirty (30) sorghum cultivars collected from Adamawa state, where sorghum is frequently cultivated [7], were studied with the objective of estimating the amount of genetic variability present in this local cultivars across environments.

MATERIALS AND METHODS

During the 2001 cropping season two locations were chosen as experimental environments for the evaluation of the collected germplasm in replicated trials. One of the locations was the Teaching and Research Farm F.U.T. Yola; (lat. 9° 14[1] N and long. 12° 32[1] E). Yola is at an altitude of 200 m above sea level and is located within the Sudan Savannah ecological zone. The soil type of the experimental site is sandy clay loam. The second location was at the College of Agriculture Research Farm Mubi, (lat. 10° 03[1] N and long. 13° 07[1] E) in the Sudan Savannah zone of Nigeria. Mubi is at an altitude of 286 m above sea level, the soil type is sandy loam [8].

At each environment 30 sorghum strains were laid out in a Randomized Complete Block Design (RCBD) with 3 replications. Each of the 30 plots consisted of 4 ridges,

Corresponding Author: Dr. D. Bello, Department of Crop Production and Horticulture, Federal University of Technology, P.M.B. 2076, Yola, Nigeria

each of which measured 5 m long and spaced 0.75 m apart. Three or four seeds per hill, spaced 30cm apart were sown on each ridge. Each stand was later thinned to 1 plant per hill, giving rise to a total of 66 plants per plot. Two and three hoe weeding were carried out in Yola and Mubi respectively. N.P.K. fertilizer was applied at the rate of 60 kg N ha^{-1}, 30 kg ha^{-1} of phosphorus (P_2O_5) and potassium (K_2O) in two split dozes at 3 and 6 weeks after sowing. At maturity, the following characters were measured on ten plants sampled at random from each plot: number of leaves per plant, plant height, width of flag leaf, length of flag leaf, panicle length, panicle width, length of inter-node, number of nodes per plant, number of grains per panicle, 1000 grain weight, grain weight per panicle, days to 50% flowering, yield per hectare and days to 95% maturity.

To estimate the extent or magnitude of variation among these strains the data obtained was subjected to analysis of variance for each environment based on plot means followed by a combined analysis of the data across the two environments; these were done according to methods described by Singh and Chaudhary [9]. Mean separation was carried out according to Duncans multiple range test (DMRT) described by Duncans [10]. Components of variance (σ^2p, σ^2e, σ^2g) were used for the estimation of coefficients of variation (PCV, GCV) as described by Singh and Chaudhary [9] as follows:

$$PCV = \frac{(\sqrt{\delta^2 g})\times 100}{X}$$

$$GCV = \frac{(\sqrt{\delta^2 g})\times 100}{X}$$

but $\sigma^2g = P-(G\times E)-E$ and $\sigma^2p = \sigma^2g + E$

Where;
PCV = Phenotypic coefficient of variation
GCV= Genotypic coefficient of variation
X = Grand mean
GxE = Genotype x environment interaction effect
σ^2g = Genotypic variance
σ^2p = Phenotypic variance

RESULTS AND DISCUSSION

The significant mean square values obtained from the analysis of variance for the individual location suggests that differences existed between the sorghum cultivars for most characters, indicating that they are highly variable (Table 1). The significant mean square values obtained for location (Table 2), for some of the characters indicated that the conditions in the two locations were not similar in many ramifications and that

Table 1: Mean square values for the fourteen traits measured at Mubi and Yola

Source of variation	DF	Number of leaves per plant	Plant height	Width of flag leaf	Length of flag leaf	Panicle length	Panicle width	Length of inter-node
MUBI								
Replication	2	1.28	484.9	0.17	0.62	47.2	2.35	0.34
Cultivar	29	68.8**	17754.0**	1.60**	60.8^{ns}	282.3**	1.67^{ns}	16.9**
Error	58	2.24	1420.0	0.23	29.39	21.3	1.08	6.53
YOLA								
Replication	2	5.24	702.0	0.32	28.8	2.78	0.41	5.2
Cultivar	29	35.60**	12074.0**	3.031**	69.4^{ns}	5.09.2**	10.48**	26.3**
Error	58	4.63	1871.0	0.77	35.3	26.3	1.98	5.13

Table 1: Continued

Source of variation	DF	Number of nodes per plant	Number of grains per panicle	1000 grain weight	Grain weight per panicle	Days to 50% flowering	Yield per plot (kg/ha)	Days to 95% maturity
MUBI								
Replication	2	5.16	715489.0	4.4	390.2	27.3	72.681	1.90
Cultivar	29	64.2**	574528.0^{ns}	43.8*	398.1^{ns}	709.5**	9604.000^{ns}	1758.30**
Error	58	3.3	385669.0	23.4	249.6	13.5	63218.000	1.12
YOLA								
Replication	2	5.42	617901.0	9.70	144.5	10.81	5014.6	0.63
Cultivar	29	35.80**	1139190.0**	60.30**	587.7**	504.30**	373.0**	1858.20**
Error	58	4.61	321566.3	15.72	179.7	14.70	99720.0	0.91

Table 2: Mean square values for the fourteen traits measured across two locations (Mubi and Yola)

Source of variation	DF	Number of leaves per plant	Plant height	Width of flag leaf	Length of flag leaf	Panicle length	Panicle width	Length of inter-node
Environment	1	28.48 ^{ns}	12632.00^{ns}	1.58 ^{ns}	50.88 ^{ns}	448.43**	99.3**	13.80**
Rep.in environment	4	5.85	91.51	0.38	14.424	13.588	1.95	3.129
Cultivar	29	90.26**	28187.00**	2.48**	92.93**	747.78**	7.9**	33.71**
Cultivar×environment	29	14.02**	1642.40^{ns}	2.15**	37.24 ^{ns}	43.75 ^{ns}	4.16**	9.58 ^{ns}
Error	116	3.49	1681.80	0.50	32.61	24.39	1.55	5.89

Table 2: Continued

Source of variation	DF	Nodes per plant	Number of grains per panicle	1000 grain weight	Grain weight per panicle	Days to 50% flowering	Yield per plot (kg/ha)	Days to 95% maturity
Environment	1	23.5 ^{ns}	321495.0^{ns}	398.50**	2777.30*	11.76 ^{ns}	1868157.0**	9.800^{ns}
Rep.in environment	4	10.4	892728.0	0.86	52.28	3.51	34561.0	2.317
Cultivar	29	87.8**	839986.0**	65.15**	291.44^{ns}	1028.80**	280688.0**	3596.000**
Cultivar x environment	29	12.2**	873732.0*	38.94 ^{ns}	694.34**	185.10**	189637.0^{ns}	19.890**
Error	116	3.9	361215.0	19.76	223.10	14.66	82213.0	1.023

ns = not significant, * = Significant at (p=0.05), ** = Significant at (p=0.01)

Table 3: Estimate of phenotypic ($*^2$p), genotypic ($*^2$g), environmental ($*^2$e) variances and standard errors for the fourteen characters over two environments (Mubi and Yola) in 2001

Traits	$*^2$p	$*^2$g	$*^2$e	SE
Flag leaf length (cm)	55.69	23.08	32.61	3.30
Flag leaf width (cm)	0.67	0.17	0.50	0.41
Panicle length (cm)	704.05	679.66	24.39	2.85
Panicle width (cm)	3.74	2.19	1.55	0.72
Number of leaves/plants	76.24	72.75	3.45	1.07
Plant height (cm)	26544.60	24862.80	1642.40	23.23
Number of nodes/plant	75.60	71.70	3.94	1.14
Length of inter node (cm)	24.13	18.24	5.88	1.40
Number of grains./panicle	33670.40	394961.00	361215.66	346.99
1000 grain weight	26.21	6.45	19.76	2.57
Grain weight/panicle (g)	34073.30	626.00	23.09	8.62
Days to 50% flowering	843.70	829.04	14.66	2.21
Days to 95% maturity	3576.11	3575.09	1.02	0.58
Yield/plot (Kg haG^{1})	91051.00	8838.00	82213.20	165.54

is why the genotypes did not perform similarly in both environments. The significant effects of cultivar (genotype) x location, interaction mean squares that were observed (Table 2), in most characters also suggests that the environmental conditions in the two locations influenced the performance of the genotypes, thus suggesting the need to test genotypes over different environments across years to ascertain their stability for use as reliable genetic materials for crop improvement practice. Non-significant mean square values observed for some characters showed that the genotypes are genetically similar with regards to these characters. Selecting for these characters will therefore show no impact on genetic improvement.

The variance components for the two environments showed that most of the characters had higher phenotypic and genotypic variance estimates than the environmental variance estimates (Table 3). Therefore, expressions for most of the characters were genetic, which can be exploited in breeding programs. This finding is in agreement with the findings of Basu [4] and Abu-Gasim and Kambal [2] for several quantitative characters in sorghum genotypes. Zaveri *et al.* [11] also reported similar results in pearl millet. Lukhele [12] observed that high error or environmental variance estimate for some characters similar to what was obtained in this study could be attributable to sample size. To reduce error and consequently increase the precision and

Table 4: Mean performances of the fourteen traits across the two environments

Cultivars (Genotypes)	Plant height (cm)	Flag Leaf width (cm)	Flag Leaf length (cm)	*Panicle length (cm)	*Panicle width (cm)	*No. of Leaves/plant	Length of internodes (cm)
Jerma	358.9AB	7.03BCDE	48.12A	41.25BC	6.8BCD	17.47DE	20.38AB
Mboderi Pelepeleri	298.9CDEF	6.30EFGHI	39.20DEFG	10.20M	5.3DE	18.40CD	17.04CDEFGH
Shakeli	343.6ABC	6.82CDEFG	46.46ABC	41.30BC	7.2BCD	20.78ABCD	17.49CDEF
Madiya hadawa	281.5EFG	6.67CDEFG	42.60ABCDEF	14.65KLM	7.3BCD	18.01DE	12.68JKL
Ndaneri Pelepeleri	161.3JK	5.72HIJ	35.13H	16.37KLM	5.3DE	10.53H	14.06IJK
Jigarigir	179.0JK	7.72B	36.60FGH	21.06HIJKL	10.3A	15.11EF	12.26KL
Pelepelefara	198.5HIJ	8.72A	41.36BCDEFGH	10.22M	5.3DE	15.17EF	10.86L
Farafara	211.4HIJ	6.85CDEFG	39.30DEFGH	16.38KLM	5.8CDE	13.52FG	15.03EFGHIJ
Sharalewa	131.8K	5.20J	36.13FGH	12.43LM	6.5BCDE	9.02H	14.50GHIJK
Germa	194.9HIJ	6.08FGHI	36.38FGH	18.03JKLM	6.7BCDE	11.22GH	17.74ECDE
Ngarwahai	379.9A	6.87CDEF	43.45ABCDE	23.08GHIJK	6.4CDE	21.53ABC	18.05ABC
Komguno	326.5ABCDE	6.60CDEFG	45.81ABC	10.04M	5.3DE	18.16DE	18.27ABC
Pelepele	321.6BCDE	6.57CDEFG	37.51EFGH	10.20M	5.3DE	18.20DE	17.89ABCD
Lamjare	298.4CDEF	6.05GHI	34.98H	41.05BC	7.0BCD	18.21DE	17.14CDEFG
Thirgawa	189.61J	6.62IJ	35.73GH	12.61LM	6.3CDE	13.83FG	13.88JK
Kwomchama	244.9FGH	6.86CDEFG	41.80ABCDEFG	12.09LM	4.3E	18.52CD	13.33JKL
Mbaburi	189.9JK	7.37BC	38.50DEFGH	17.33JKLM	7.8BC	9.17H	20.61A
Bachafurwe	340.5ABCD	6.47DEFGH	45.95ABC	52.38A	6.2CDE	18.55CD	18.56ABC
Whiwaham	319.9BCDE	6.82CDEFG	44.12ABCDE	33.43CDEF	7.9BC	19.03BCD	16.71CDEFGHI
Ngubur	283.3EFG	7.25BCD	47.63AB	19.77IJK	6.7BCDE	19.75ABCD	14.36HIJK
Jigaritu	345.7ABC	6.63CDEFG	40.60CDEFGH	34.68BCDE	6.7BCDE	20.70ABCD	16.84CDEFGH
Zumokunge	165.6JK	6.93BCDE	43.55ABCDE	15.74KLM	7.6BCD	10.95GH	15.16DEFGHIJ
Whijigga	236.9GHI	6.68CDEFG	41.11CDEFGH	25.55FGHIJ	9.9A	19.11ABCD	14.74GHIJK
Kaurari	311.4BCDE	7.08BCDE	46.46ABC	35.48BCDE	7.7BC	21.57ABC	14.53GHIJK
Chakala	285.0DEFG	6.47DEFGH	40.08CDEFGH	32.25DEF	6.9BCD	19.23ABCD	14.87EFGHIJK
Mubba Yare	286.0DEFG	6.63CDEFG	42.16ABCDEFG	15.10KLM	4.6E	19.53ABCD	14.79FGHIJK
Chikala	313.2BCDE	6.82CDEFG	41.96ABCDEFG	38.47BCD	5.9BCD	17.90DE	17.53CDEF
Jigaridzu	287.8DEFG	6.48DEFGH	46.17ABC	32.93CDEF	7.1BCD	20.25ABCD	18.48ABC
Whilawa	332.9ABCDE	6.38EFGHI	44.13ABCD	42.55B	8.8A	22.32A	16.82CDEFGH
Jigarimuv	297.5CDEF	6.37EFGHI	40.33CDEFGH	20.67IJKL	6.6BCDE	21.82AB	13.71JK

Table 4: Continued

Cultivars (Genotypes)	*No. of nodes (cm)	*No. of grains/ panicle	*1000 grain weight (g)	Grain weight per panicle (g)	Days to 50% flowering	*Days to 95% Maturity	*Grain yeild plot (Kg/ha)
Jerma	17.47DE	2296.0ABC	25.28ABCDE	56.44ABC	122.50EFG	180.0BC	701.0BCD
Mboderi Pelepeleri	18.40CD	1560.0C	21.47ABCDEF	43.44ABCDE	122.83DEFG	178.0DEF	639.0BCD
Shakeli	20.78BCD	1665.0C	24.16ABCDE	46.03ABCDE	127.17ABCD	177.0DE	451.0CD
Madiya hadawa	22.32A	2841.0AB	18.03EF	50.51ABCDE	125.17BCDE	182.0B	608.0BCD
Ndaneri Pelepeleri	10.53H	1895.0B	23.94ABCDE	48.46ABCDE	107.83H	128.0O	591.0BCD
Jigarigir	15.11EF	2327.0ABC	25.12ABCDE	59.31AB	105.33H	129.0NO	471.0CD
Pelepelefara	15.17EF	1572.0C	19.48DEF	36.18E	96.83JK	118.0Q	320.0D
Farafara	13.52FG	1828.0BC	24.13ABCDE	46.91ABCDE	100.83IJ	119.0PQ	507.0CD
Sharalewa	9.02H	1632.0C	24.64ABCDE	41.25CDE	86.33L	120.0P	643.0BCD
Germa	11.22GH	1811.0BC	27.10ABCD	45.81ABCDE	100.17IJ	128.0O	476.0CD
Ngarwahai	21.53ABC	2155.0BC	20.57BCDEF	41.19CDE	122.66EFG	175.0HI	469.0CD
Komguno	18.16DE	1681.0C	19.05DEF	32.70E	105.67H	176.0GH	349.0D
Pelepele	18.20DE	1637.0C	28.25AB	38.05DE	124.50CDE	178.0DEF	329.0D
Lamjare	18.21DE	2088.0BC	21.42ABCDEF	46.98ABCDE	123.50DEFG	179.0CD	555.0BCD
Thirgawa	13.83FG	1685.0C	23.62ABCDE	38.92DE	106.00H	130.0N	717.0BCD
Kwomchama	18.52CD	1683.0C	21.25ABCDEF	46.71ABCDE	122.50EFG	181.0B	301.0D
Mbaburi	9.17H	2269.0ABC	22.77ABCDE	56.73ABC	93.33K	132.0M	475.0CD
Bachafurwe	18.55CD	2286.0ABC	21.58ABCDEF	49.19ABCDE	120.00FG	178.0DEFG	1010.0AB
Whiwaham	19.03BCD	2114.0BC	27.78ABC	42.52BCDE	121.83EFG	177.0FG	698.0BCD
Ngubur	19.75ABCD	2225.0BC	22.87ABCDE	45.94ABCDE	104.17HI	182.0B	403.0D
Jigaritu	20.70ABCD	1836.0BC	27.03ABCD	49.87ABCDE	123.33DEFG	164.0K	945.0ABCD
Zumokunge	10.95GH	1723.0C	24.44ABCDE	44.35ABCDE	96.66JK	136.0L	416.0D
Whijigga	19.11ABCD	3267.0A	14.47F	46.24ABCDE	93.33K	173.0J	611.0BCD
Kaurari	21.57ABC	1983.0BC	25.51ABCDE	56.53ABC	129.50AB	174.0IJ	413.0D
Chakala	19.23ABCD	1929.0BC	29.24A	59.58A	121.50EFG	181.0B	677.0BCD
Mubba Yare	19.53ABCD	1557.0C	23.19ABCDE	38.18DE	119.50G	181.0B	472.0CD
Chikala	17.90DE	2315.0ABC	14.47F	37.77DE	130.33A	175.0HI	671.0BCD
Jigaridzu	20.25ABCD	2189.0BC	23.88ABCDE	53.91ABCD	100.67IJ	177.0EFG	708.0BCD
Whilawa	18.01DE	2053.0BC	26.54ABCD	57.05ABC	124.17CDEF	179.0DE	1302.0A
Jigarimuv	21.82AB	2232.0BC	19.77CDEF	49.35ABCDE	128.17ABC	189.0A	443.0CD

Means in the same column with the same letters are not significantly (p=0.05)

Table 5: Estimates of means, ranges, genotypic, phenotypic coefficients of variation and heritability for yield and yield components combined across the two locations

Traits	Means	Range	GCV (%)	PCV (%)	Heritability (%)
Flag leaf length (cm)	41.40	34.98-48.12	81.8	81.1	41
Flag leaf width (cm)	6.70	5.20-8.72	31.4	41.0	25
Panicle length (cm)	26.40	10.04-52.38	302.4	317.3	96
Panicle width	7.00	4.3-10.30	55.5	72.8	58
Number of leaves per plant	17.30	9.02-22.32	129.5	137.0	95
Plant height (cm)	270.20	131.80-379.90	34.9	37.9	93
Number of nodes per plant	17.30	9.02-22.32	127.2	135.8	94
Length of inter-node	15.90	10.86-20.61	78.2	97.5	75
Number of grains per panicle	2040.10	**15.57-32.67**	884.4	1597.8	11
1000 grain weight (g)	23.40	14.72-29.24	80.4	122.0	24
Grain weight/panicle (g)	47.00	32.70-59.58	69.6	228.7	10
Days to 50% flowering	113.50	88.33-130.33	172.5	176.3	95
Days to 95% maturity	581.50	118.00-189.00	271.3	271.4	99
Yield/plot (kg/ha^{-1})	162.80	301.00-1302.00	1066.6	1597.3	10

reliability of estimates Allard and Bradshaw [13] suggested increasing sample size and number of environments or years during trials. However the disadvantage of this suggestion would be delay in the release of results.

Comparative performances of the 30 sorghum cultivars across the two locations for the fourteen characters studied (Table 4) provide a clear indication of the superiority of some of the cultivars over others. Good breeding potential therefore exists for cultivars such as Jerma, Madiyahadawa, Pelepelefara, Mbaburi, Jigarigir, Chikala, Whilawa, Bachafurwe, Jigarimuv, Whijigga and Ngarwahai, which performed very well for both yield and yield components at both locations. Depending on the breeding objectives, there was a wide range of cultivars to choose from. For instance if the breeding objective is to produce high yielding and early maturing variety, then hybridization between Whilawa x Pelepelefara, which are, the highest yielding cultivar per hectare and the earliest maturing cultivar respectively will be promising.

The means, ranges and coefficient of variations namely; genotypic coefficient of variation (gcv) and phenotypic coefficient of variation (pcv) and heritability estimates across the two locations are presented in Table 5. Generally, the gcv are lower in magnitude than the pcv. High gcv and pcv were also observed for some characters, this reveals that the genotypes have a broad base genetic background as well as good potential that will respond positively to selection. Similar results were obtained by William *et al.* [14] while studying effect of environment on yield components of sorghum. High heritability estimates were observed in some characters such as panicle length, number of leaves per plant, plant height, number of nodes per plant, days to 95 % maturity and days to 50 % flowering (Table 5). These characters therefore, could respond to selection pressure [15, 16].

The success of any breeding program depends upon the genetic variation in the materials at hand. The greater the genetic variability the higher would be the heritability, hence the better the chances of success to be achieved through selection. In this study most characters showed high broad sense heritability (Table 5), indicating the possibility of a positive response to selection. This is because there is likelihood of transferring the heritable components from parents to offspring during breeding. The high heritability obtained for most of the characters agreed with the findings of Eckebil *et al.* [17], Totok [18], Aba *et al.* [3] and Biswas *et al.* [19]. Also the moderate heritability obtained for flag leaf length (Table 5) agreed with the findings of Biswas *et al.* [19]. From this study, characters such as number of nodes per plant, panicle length, number of leaves per plant, plant height, days to 50% flowering and days to 95% maturity would respond positively to selection when selected for because of their high broad sense heritability. On the other hand grain weight per panicle, number of grains per panicle and yield per panicle would not respond to selection because of their low heritability estimates in this sorghum population. However, similar results were observed by Bello *et al.* [20], they reported that the low heritability estimate of grain yield is due to the direct or indirect multiplicative effects of several yield components on grain yield. There is need also to understand which portion of heritability is genetic and which is environmental, since the heritability obtained in this study was broad sense, Obilana and Fakorede [21] opined that, if a character is influenced by environment, its heritability would be low in a population in which environments vary widely. On the other hand, in another population in which the environment is rigidly controlled so that those variations do not occur, the same character would tend to have high heritabilility.

CONCLUSIONS

Fourteen characters involving Leaf, Stem, Seed and other parameters were used; there was considerable variability present in the materials analyzed. These results would be useful in choosing populations to use in a breeding program to improve productivity. The variation could be effectively manipulated with appropriate breeding methods to develop improved varieties, synthetics and hybrids for use by farmers and the industries.

ACKNOWLEDGEMENTS

We acknowledged valuable assistance of Mall. Bello Abba Madagali, the truck driver during the sample collection period and also the assistance of Mr. Maurice Chinda zonal extension program Manager, Adamawa Agricultural Development Program (ADADP) Mubi, for his remarkable role during the interior sample collections too. Thank you for making this work possible, God bless you all.

REFERENCES

1. Lukhele, P.E. and A.T. Obilana, 1984. Genetic variability in long Season Random-Mating Grain Sorghum Population. Z pflanzenzuchtg, 92: 40-51.
2. Abu-Gasim, E.H. and A. E. Kambal, 1985. Variability and interrelationship among characters in indigenous grain sorghum of the Sudan. Crop Sci., 11: 308-309.
3. Aba, D.A., C.C. Nwasike, M. Yeye and A.A. Zaria, 2001. Studies on Genetic Variations in sorghum Variety Irradiated with Cobalt-60 (C060). Crop Sci. J., 9: 377-384.
4. Basu, A.K., 1981. Variability and heritability estimate from Inter-season Sorghum Cross. Ind. J. Agric. Sci., 41: 116-117.
5. Soltani, A., A.M. Rezai and M.R. Khajeh Pour, 1998. Genetic variability for some physiological and agronomic traits in grain sorghum. Crop Res. J., 12: 71-76.
6. Ahnert, D., D.F. Austin and C. Livini, 2000. Genetic diversity among elite sorghum inbreds as detected by DNA markers. Crop Res., 18: 71-76.
7. Sajo, A.A. and A.M. Kadams, 1999. Cash Crops of Adamawa State. In: Adebayo, A.A and A.L. Tukur (Eds.) Adamawa in Maps Paraclets. Publishers Nigeria.
8. Adebayo, A.A., 1999. Climate II: Rainfall. In: Adamawa in Maps. Adebayo A.A. and A.L. Tukur (Eds.). Paraclete Publishers and Department of Geography Federal University of Technology Yola, Nigeria, pp: 23-26.
9. Singh, P. K. and S. D. Chaudhary, 1985. Biometrical methods in quantitative genetics analysis. Khalyani New Delhi, India, pp: 318.
10. Duncans, D., 1955. Multiple range and Multiple F-tests. Biometrics, 11: 42.
11. Zaveri, P.P., P.S. Phul and B.S. Dillon, 1989. Observed and predicted genetic gains from single and multi-trait selections using three mating designs in pearl millet. Plant Breeding Abstract, 60: 127-132.
12. Lukhele, P.E., 1981. Estimation of genetic variability in sorghum population. Unpublished M.Sc. thesis, Ahmadu Bello University Zaria, Nigeria.
13. Allard, R.W. and A.D. Bradshaw, 1964. Implication of genotype x environment interaction in applied plant breeding. Crop Sci., 4: 503-507.
14. William, W.T., C.A.P. Boundy and A.J. Millington, 1987. The effect of sowing date on the growth and yield of three sorghum cultivars. The component of growth and yield. Aust. J. Agric. Res., 28: 381-387.
15. Ghandi, A.D., 1964. Genotypic variability and correlation coefficient relating to grain yield and other quantitative characters in Indian wheat. Ind. J. Gene. Plant Breeding, 24: 1-8.
16. Setti, G.S. and H.B. Singh, 1972. Interrelationship of quantitative traits with grain yield in Triticale. Ind. J. Agric. Sci., 42: 281-285.
17. Eckebil, J.P., M.W. Ross, C.O. Gardnerand and J.W. Maranville, 1977. Heritability estimates, genetic correlation and predicted gains from S_1. progeny test in three grain sorghum population. Crop Sci. J., 17: 373-377.
18. Totok, A.D.H., 1997. Estimating heritability values and genetic correlation, in several agronomic characters. Am. J. Bot., 87: 145.
19. Biswas, B.K., M. Hasanuzzaman, F. Eltaj, M.S. Alam and M.R. Amin, 2001. Simultaneous selection for fodder and grain yield in sorghum. J. Biol. Sci., 1: 319-320.
20. Bello, D., A.M. Kadams and S.Y. Simon, 2001. Correlation and Path Coefficient analysis of grain yield and its components in Sorghum. Nig. J. Trop. Agric., A Publication of SAAT, FUT, Yola, Nigeria, 3: 4-9.
21. Obilana, A.T. and M.A.B. Fakorede, 1986. Heritability: A Treatise. Samaru J. Agric. Res., 1: 72-82.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 303-307, 2007
ISSN 1818-6769

Physicochemical Parameters and Growth Yield of Tomato (*Lycopersicum esculentum*): Role of Farm Yard Manure and Neemcake

[1]Basharat Amin Parray, [2]Abdul Majid Ganai and [1]Khalid Majid Fazili

[1]Department of Biotechnology, University of Kashmir, Srinagar, Jammu and Kashmir, India
[2]Department of Animal Nutrition, Faculty of Veterinary Sciences,
S.K University of Agricultural Sciences, Srinagar, Jammu and Kashmir, India

Abstract: With the objective of evaluating the importance of organic farming using the household manure, We conducted field experiments at the Department of Taxonomy, University of Kashmir, Hazratbal campus, Srinagar during the summer season of 2003-2004 and 2004–2005, to evaluate the effect of farmyard manure (FYM) and Neemcake *(Azadirachta indica)* under different treatment levels from 0.0 to 15.0 kg/h. separately and in combination, on hybrid variety of tomato *(lysopersicum esculentum).* Physicochemical characters of the soil were recorded before transplantation of the seedlings and plants were analyzed for various parameters at 15, 30, 45, 90 and 105 days after transplantation. The combination of Neemcake and FYM shows an increase in plant heights (45-60 cm) with number of branches, number of leaves and number of flowers showing an increase with increased levels of Neemcake. The tomato yield increased significantly with the application of Neemcake and FYM. Phenol, chlorophyll, protein, ascorbic acid, oxalic acid, acidity, lycopen and carotenoide contents were enhanced compared to control. The proximate analysis shows significant increase during interaction of FYM and Neemcake. It is concluded that the farmyard manure and Neemcake independently and in combination show significant increase in morphological and biochemical properties and yield of tomato. 8-12 quintal FYM and 5-10 kg Neemcake per hectare of land were optimum for better yield and quality of tomato.

Key words: Tomato yield % plant biomass % farm yard manure % neemcake % proximate analysis

INTRODUCTION

Tomato Lycopersicum *esculentum* mill is one of the most widely grown vegetables in the world ranking second in importance to potato in many countries. It belongs to family solanaceae. In India tomato is cultivated in about 80000 hectares of land. Tomato is essential for balanced diet and maintenance of good health. They are important for neutralizing the acids produced during the digestion of meat and other fatty acids. They are valuable rough ages, which promote the digestion and help to alleviate constipation. Tomato is a source of carbohydrates, fats, proteins, vitamins and minerals. It gives brighter eyes than cosmetics. The fruits of tomato are eaten raw or cooked. Tomato seeds contain 24% oils and more medicinal value. It promotes gastric secretion, acts as blood purifier and keeps intestines in good condition. In view of its importance, efforts are underway to improve the yield and the quality of tomato. Farmyard manure has been reported to significantly increase SOC (soil organic carbon), microbial biomass and microbial coefficient [1]. The decomposition of plant material and organic carbon and microbial biomass turn over has been found to be faster under tropical conditions [2-4]. Continuous application of manure in tropical areas has shown an increased SOC and MBC (microbial biomass carbon) with balanced fertilization [4]. However very few studies have been directed at evaluating the influence of long term manure and fertilizer application in tropical areas. FYM has been recently shown to have an insignificant influence upon the growth and yield of *curcuma aromatica* Salisb in western Himalya [5]. We have however used different combinations of FYM and Neemcake to monitor the influence on growth, yield and biochemical parameters of a hybrid tomato (*Lycoperiscum esculentum* mill F1S 2730).

Corresponding Author: Dr. Khalid Majid Fazili, Department of Biotechnology, University of Kashmir, Srinagar-6, Jammu and Kashmir, India

MATERIALS AND METHODS

Field experiments were conducted at Depatmernt of Taxonomy, University of Kashmir during the summer season 2003-2004 and 2004-2005 to evaluate the performance of farm yard manure and Neemcake in Randomized Block Designs with three replications. Twelve treatments with different treatment levels from 0-15 kg haG¹ to find the effect of FYM and Neemcake and their combination on hybrid variety (F1S 2730). The layout of field on 9 March 2003 and the application of the Neem cake and farm yard manure on 10 March 2003. The sowing of nursery bed was done on 10th April 2003 and the transplanting was done on 20 May 2003. The irrigation was provided at 15 days interval and intercultural was done at 20 days interval. The harvesting was done from 10th June. The same methodology was followed in the year 2004-2005. Before transplantation the soil samples were analyzed for physiochemical characters that is texture, colours, presence of litter, pH, available N, P, K, by the pH meter, alkaline permanganate method, Olsens calorimetric method and turbidimetric method. The height of plants were recorded at 30,45, 90, 105 days. The acid, protein, nitrogen uptake, carotenoids, TSS (total soluble solids), diameter of fruit and yield, were analyzed. The proximate analysis like D.M (dry matter), crude protein, crude fiber, ether extract, ash, ADF (Acidic detergent fiber), NDF (Nucleic detergent fiber), lignin, hemicellulose and cellulose, were analyzed as per A.O.A.C., [6]. The observed quantitative data were tabulated and subjected to statistical analysis with the ANNOVA techniques. The mean value and standard deviation were determined by employing the following formula:

$$\sqrt{\frac{n\sum x^2-(\sum x)^2}{n(n-1)}}$$

where; in n represents the number of replications and x represents the values.

The calculations were made using the statistical tools in MS Excel programme. F test was used to determine the significance between the treatments.

The composition for treating the significance was made at 5% and 1% level. The statistical design adopted was factorial design and the field lay out was as RBD. The calculated F value was compared with the table value of F at 5% level of significance. Critical difference and standard error to known weather the combination of two treatments of a time is significant or significant if standard error and standard deviations less than 0than the interactionis significant.

Treatment combinations:

Farmyard Manure	Neemcake
F1 = 500 g/ plot	N1 = 50 g/plot
F2 = 1000 g/plot	N2 = 100 g/plot
F3 = 1500 g/plot	

RESULTS AND DISCUSSION

The site is located 7-10 Km from Srinagar at an altitude of 1730 m above the sea level. The floor showed significant litter. The color of soil was light brown and texture was clay loam. Different levels of FYM and Neem Cake, in isolation and in combination, affected, to different extents, the physical characteristics of the transplanted seedlings and the interaction after 30 and 45 days was maximum in F3N1 combinational treatment. With this treatment, the height of the plants was 23.0±7.55 and 25.33±9.504 cm after 30 and 45 days respectively. However, after 90 and 105 days, the maximal value of 54.33±5.13 and 61.66±1.527 cm for height of these plants was recorded with F0N1 treatment (Table 2).

The maximum numbers of branches were found in F3N1 combinational treatment, followed by F2N1. The statistical analysis shows that there were significant effects of Neem cake on physical parameters, the interaction however, was insignificant (Table 2).

Biochemical analysis revealed that the plants grown in presence of F2N0 treatment level had the highest concentration of chlorophyll, which showed an increase of about 2.6 fold from 17.43±0.46 to 45.23±0.58 mg/100 ml. The statistical analysis showed that both farm yard manure and Neem cake significantly influenced the chlorophyll content of plants, their interaction, however was insignificant. The content of phenols was found to be highest in plants with F1N2 treatment, followed by F2N0. The phenol content increased from 0.56±0.057 mg/100 g to 0.85±0.140 mg/100 g in F2N0 and 0.88±0.117 mg/100 g in F1N2. It showed an increase of 1.5 fold. Phenols are important in imparting resistance to insects and other toxic substances and are influenced by both FYM and Neemcake. The ascorbic acid content was highest in plants treated with F3N1 and showed an increase of 1.5 fold, from 22.0±4.35 mg/100 g in untreated plants to 32.3±1 mg/100 g in F3N1 treated plants (Table 3A). The results are in conformity with the observations made earlier in studies carried under sub tropical conditions [1, 7].

Table 1: Physicochemical characteristics of soil

Sampling site	Altitude	Texture	Colour	pH	N (kg/hec).	P (ppm)	K
1.	1730 m above sea level	Clay loam	Light Brown	7.45	870	13.80	415
2.	Do	Do	Do	6.34	1190	6.50	455
3.	Do	Do	Do	7.18	925	13.10	345
4.	Do	Do	Do	5.95	965	15.3	485
5.	Do	Do	Do	6.60	560	6.0	320

Table 2: Average height, number of branches and number of flowers under different treatment conditions

	Height				Branches				Flowers	
Treatments	30 days	45 days	90 days	105 days	30 days	45 days	90 days	105 days	90 days	105 days
F0N0	12.66±2.517	14.00±2.645	35.00±5	51.66±10.40	4.33±0.152	7.00±1	11.00±1	13.66±0.577	11.00±1	18.00±2.00
F0N1	22.66±6.429	24.33±6.658	54.33±5.132	61.66±1.527	4.66±0.577	6.66±0.577	11.33±2.309	14.66±2.30	14.66±2.309	19.00±5.56
F0N2	22.00±3.786	23.33±3.786	50.00±10	56.00±10.149	5.33±0.577	6.33±0.577	11.33±4.163	15.00±3	15.00±0.577	15.33±2.08
F1N0	16.66±6.658	21.00±3.605	40.00±10	48.33±10.408	4.56±0.251	6.66±1.154	12.00±8	15.00±4.35	16.33±3.60	50.00±10
F1N1	18.00±2.000	20.00±2.646	38.66±5.132	45.33±6.429	4.33±0.577	6.66±1.154	12.66±4.61	16.00±4.35	21.66±1	60.00±36.5
F1N2	16.33±1.527	18.33±1.527	36.66±3.055	41.33±2.3	4.64±0.208	6.66±1.154	12.66±3.785	16.33±3.214	22.00±3.464	50.00±17.32
F2N0	15.33±4.163	16.66±3.786	33.33±7.572	44.33±4.041	4.33±0.577	6.66±0.577	8.66±2.309	14.00±3.214	11.66±4.509	22.33±4.04
F2N1	21.33±4.163	24.00±5.000	46.66±7.024	55.00±5	5.66±0.577	3.66±1.154	15.66±3.51	19.33±3.05	27.66±3.785	83.33±58.59
F2N2	16.66±2.887	18.00±3.464	40.33±6.658	53.33±12.583	5.00±1	7.33±1	14.33±4.041	18.00±3.53	26.00±5.29	58.66±36.143
F3N0	17.33±0.577	21.66±1.527	46.00±5.295	52.33±14.663	4.76±0.321	7.00±1	13.33±4.93	15.66±5.13	11.66 ±4.16	23.00±25.516
F3N1	23.00±7.550	25.33±9.504	47.33±14.189	54.66±16.040	5.66±0.577	7.00±0.577	15.66±1.154	20.33±0.577	29.6±18.77	50.00±30
F3N2	21.33±2.309	24.00±4.359	49.33±10.066	60.00±10.490	5.33±0.577	8.33±2.081	14.33±2.516	17.33±2.30	23.33±5.77	36.66±28.207

Table 3A: Biochemical parameters observed under different treatment conditions

Treatments	Chlorophyll 45 days	Chlorophyll 80 days	Phenol content mg\100 g	Ascorbic acid mg\100 g	Acidity %	Lycopen	Nitrogen uptake mg\100 g
F0N0	7.67±0.206	17.43±0.468	0.56±0.057	22.00±1	0.33±0.35	52.66±32.33	0.16±0.005
F0N1	14.41±0.282	22.02±1.33	0.67±0.060	26.4±0.1	0.41±0.023	55.00±32.04	0.13±0.025
F0N2	14.29±0.30	24.62±0.107	0.64±0.01	22.00±4.35	0.43±0.03	38.00±1.732	0.19±0.015
F1N0	14.43±0.151	16.23±0.208	0.68±0.15	24.00±2.64	0.31±0.23	40.00±1	0.23±0.025
F1N1	9.49±0.270	40.16±0.152	0.80±0.115	26.33±0.577	0.32±0.138	39.33±4.163	0.25±0.005
F1N2	6.41±0.213	37.06±0.585	0.88±0.023	27.43±0.152	0.36±0.035	40.63±0.251	0.27±0.020
F2N0	15.4±0.352	45.23±0.208	0.85±0.117	25.33±0.577	0.37±0.020	36.33±2.08	0.32±0.07
F2N1	8.7±0.075	34.06±0.585	0.74±0.140	25.33±0.577	0.43±0.051	66.66±25.16	1.6±0.057
F2N2	7.64±0.052	36.16±0.152	0.75±0.05	31.00±1	0.39±0.090	60.00±20	0.43±0.57
F3NO	9.83±0.036	43.23±0.208	0.59±0.005	32.00±1	0.41±0.045	66.66±23.09	0.23±0.035
F3N1	10.67±0.064	34.66±1	0.76±0.133	32.33±1.527	0,38±0.080	72.00±23.06	0.34±0.106
F3N2	12.4±0.109	44.00±1	0.81±0.040	32.00±1	0.37±0.096	58.33±27.64	0.52±0.328

Table 3B: Biochemical parameters observed under different treatment conditions

Treatments	Caretonides	Yield kg\sqm.	Oxalic acid %	TSS	Diameter	Protein
F0N0	20.60±5.55	0.41±0.14	0.27±0.03	3.2±0.1	3.33±0.321	2.233±0.577
F0N1	32.33±4.041	0.66±0.288	0.36±0.052	3.33±0.30	3.43±0.152	2.56±0.251
F0N2	42.00±3.464	1.66±0.288	0.33±0.005	3.5±0.435	5.1±0.1	2.7±0.51
F1N0	18.66±1.154	2.16±0.763	0.37±0.01	3.2±0.1	4.36±0.208	2.43±0.416
F1N1	38.66±2.309	4.00±1	0.32±0.020	4.46±0.152	5.26±0.057	2.63±0.152
F1N2	28.6±2.886	5.33±1.154	0.34±0.026	5.2±0.1	6.13±0.152	3.43±0.378
F2N0	47.6±2.886	1.66±0.577	0.33±0.005	3.33±0.577	6.2±1.652	2.46±0.416
F2N1	35.3±2.886	4.66±0.577	0.37±0.005	4.36±0.321	6.03±0.763	3.2±0.69
F2N2	24.3±2.309	4.66±0.577	0.33±0.005	5.33±0.057	5.3±0.953	2.33±0.152
F3NO	22.6±4.509	3.66±0.577	0.32±0.40	5.16±0.152	7.14±1.228	3.53±0.23
F3N1	48.00±2.886	4.6±0.3	0.38±0.040	4.00±1	4.8±0.529	2.00±1.057
F3N2	43.3±5.77	4.6±0.32	0.43±0.041	3.66±1.154	6.1±1.646	3.00±1.053

Table 4: Proximate constituents (%) under different treatment combinations

Treatments	DM	CP	EE	Ash	ADF	NDF	Lignin	Hemi cellulose	Cellulose
F0N0	60.7±0.2	4.36±0.208	1.73±0.152	6.2±0.2	30.4±0.565	50.33±0.305	6.7±0.265	11.23±0.017	17.56±0.493
F0N1	70.43±0.152	4.33±0.127	2.35±0.2	6.33±0.208	32.5±0.476	50.466±0.321	6.2±0.1	11.26±0.115	12.36±0.351
F0N2	75.00±0.152	3.28±0.404	2.46±0.404	6.5±0.435	30.7±0141	50.533±0.35	6.53±0.346	11.33±0.230	17.46±0.288
F1N0	65.2±0.1	4.4±0.519	2.366±0.305	6.21±0.152	30.3±0.141	50.466±0.305	6.5±0.305	11.27±0.208	17.33±0.230
F1N1	80.53±0.321	5.36±0.404	3.266±0.635	6.433±0.404	30.5±0.360	50.633±0.378	6.36±0.208	11.56±0.305	18.33±0.305
F1N2	80.53±0.321	5.53±0.040	3.66±0.115	5.3±0.3	30.55±0.070	50.35±0.353	5.33±0.152	12.3±0.264	13.66±0.115
F2N0	80.8±0.173	5.3±0.1	3.03±0.404	6.66±0.321	30.63±0.208	50.56±0.321	4.5±0.264	12.4±0.2	14.56±0.493
F2N1	82.73±0.152	5.53±0.750	3.26±0.635	6.8±0.173	32.56±0.493	52.46±0.450	3.4±0.34	14.64±0.3	13.43±0.404
F2N2	90.43±0.152	6.46±0.45	3.66±0.125	7.433±0.321	33.5±0.458	52.43±0.450	5.5±0.264	15.46±0.416	14.7±0.173
F3NO	92.7±0.1	4.2±0.378	3.866±0.115	6.455±0.2	30.733±0.152	51.4±0.458	4.5±0.3	12.43±0.404	12.43±0.404
F3N1	93.3±0.264	6.66±0.115	4.33±0.92	8.4±0.260	30.73±0.178	53.26±0.305	7.36±0.385	16.5±0.458	18.7±0.173
F3N2	93.36±0.152	6.76±0.115	4.266±0.635	8.866±0.057	33.46±0.288	54.26±0.461	7.43±0.321	16.36±0.115	18.73±0.057

The total soluble solids were highest in F3N0 treatment combination that was 5.33%±0.057 with a 1.8 fold increase over untreated plants. The statistical analysis revealed that both farmyard manure and Neemcake contributed independently, the interaction was however, insignificant (Table 3B). The lycopen concentration increased from 38.0±1.73 in untreated plants to 66.66±25.16 in plants treated with F3N0 and 72.00±23.06 in F3N1 treated plants, showing 1.9-fold increase. Similar observations have been made on Curcuma aromatica Salisb [5]. The maximum diameter of tomato fruit was 7.14±1.22 cm obtained with F3N0 treatment, it showed a two fold increase compared to untreated plants. The statistical analysis revealed that FYM contributed significantly, but the interaction of FYM and Neemcake was not important. The maximum yield was found in the F2N1 treatment combination which was 4.66±0.577 kg m^{-2} and showed a ten fold increase relative untreated plants, which only produced 0.41±0.14 kg m^{-2}. These results confirm with the findings of Masto *et al*., 2006. The maximum nitrogen content was found in F2N2, which was 1.6 mg/100 g. Carotenoid content was highest in F3N1 treated plants. The statistical analysis shows that Neemcake was significant and their interaction while farmyard manure are non- significant (Table 3B) The protein concentration was found to be highest in the treatment combination F2N2 followed by F1N1 and was 3.5 ±0.230 g and 3.4 ±0.378 g, respectively. The statistical analysis shows that FYM and Neem cake and their interaction were significant. The maximum DM, CP, ASH, ADF, NDF, Lignin, Hemi cellulose, Cellulose & Ether extract were found in F3N2 treatment combination followed by F3N1 combination and were 93.36±0.152, 6.76±0.115, 8.866±0.057, 33.46±0.288, 54.26±0.461, 7.43±.0.32, 16.36±0.115, 18.73±0.057, 4.266±0.635 and 93.3±0.264, 6.66±0.115, 8.4±0.204, 30.73±0.152, 53.20±0.305, 7.36±0.378, 16.5±0.458, 18.7±0.173, 3.866±0.115 respectively, the statistical analysis shows that both farmyard manure and that both farmyard manure and Neemcake and their interaction were significant (Table 4).

The present investigation clearly reveals that the FYM and Neem cake is good for the beneficial plant growth, yield as well as for the disease resistance. The phenol gives the disease resistance and prevents the fungal infection and insect pests. Nitrogen is very important for the plant growth and the present investigation shows that the nitrogen is supplied by the FYM in combination with Neem cake. Organic farming is better to promote the quick growth of plants and prevents the plants from numerous hazards. It acts as the food for the microorganisms, which are able to fix atmospheric nitrogen.

ACKNOWLEDGEMENTS

We are thankful to the Department of Botany, University of Kashmir and S.K University of Agriculture Sciences and Technology for providing the necessary facilities

REFERENCES

1. Masto1, R.E., P.K. ChhonkarÃ, D. Singh and A.K. Patra, 2006. Changes in soil biological and biochemical characteristics in a long-term field trial on a sub-tropical inceptisol. Soil Biology and Biochemistry, 38: 1577-1582.
2. Kaur, K., K.K. Kapoor and A.P. Gupta, 2005. Impact of organic manures with and without mineral fertilizers on soil chemical and biological properties under tropical conditions. J. Plant Nutrition Animal Sci., 168: 117-122.

4. Goyal, S.M., M. Mishra, I.S. Hooda and R. Singh, 1992. Organic matter-microbial biomass relationships in field experiments under tropical conditions: Effect of inorganic fertilization and organic amendments. Soil Biology and Biochemistry, 24: 1081-1084.
5. Singh, G., R.D., Meena, R.L. Singh, M.K. Kaul, V.K. Lal, B. Acharya, Ruchi and R. Prasad, 2006. Effect of manure and plant spacing on crop growth, yield and oil-quality of Curcuma aromatica Salisb. in mid hill of western Himalaya: Industrial Crops and Products, 24: 105-112.
6. A.O.A.C., 1984. Official Methods for Analysis of the Association of Official Analytical Chemists, 14th edition. Arlington, VA.
7. Goyal, C.K.S., M.C. Mundraand and K.K. Kapoor, 1997. Organic matter, microbial biomass and enzyme activity of soils under different crop rotations in the tropics. Biology and Fertility of Soils, 24: 306-310.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 308-311, 2007
ISSN 1818-6769

Nutritional Status of Cassava Peels and Root Sieviate Biodegraded With *Aspergillus niger*

[1]F.A. Aderemi and [2]F.C. Nworgu

[1]Department of Animal Science and Fisheries Management,
Bowen University of the Nigerian Baptist convention, Iwo Osun State, Nigeria
[2]Institute of agricultural Research and Training, Obafemi Awolowo University, Ibadan, Nigeria

Abstract: The ability of *Aspergillus niger* to improve the nutritional status of Cassava Root Sieviate (CRS) and peels was assessed for ten days through biodegradation. The biodegradation within this time had several effects on the proximate content of the substrates. The protein content of CRS recorded for 0, 5 and 10 days were 2.09, 5.21 and 7.34% while these 5.35, 10.70 and12.64% were values for cassava peels. From the results it was obvious that *Aspergillus niger* was able to enrich the protein content of both sieviate and the peels, i.e. there was significant effect ($p<0.05$) effect of the treatment with best result on the 10th day. The detergent fiber content of both substrates were reduced, for Acid Detergent Fiber (ADF), the following values were recorded for peels 5.81, 4.08 and 2.30% for days 0, 5 and 10. While 16.26, 14.48 and 11.26% were recorded for CRS for the respective days the changes were significantly different ($p<0.05$), Acid Detergent Lignin (ADL) also had same, 6.71, 6.62% trend as ADF, 6.97 were the values for sieviate while 7.41, 6.98 and 6.08% were the values for peels same, 6.71, 6.62% trend as ADF, 6.97 were the values for sieviate while 7.41, 6.98 and 6.08% were the values for peels. There was increase in the value of some mineral content of both substrates as the biodegradation period increased.

Key words: Biodegradatio % cassava peels % root sieviate % *Aspergillus niger*

INTRODUCTION

Nigeria stand as the world's foremost cassava producer with about twenty six million tonnes.

Cassava peels and sieviate which are by products of harvesting and processing constitute 25% of the whole plant. Cassava peels is the skin of the peeled while the chaff that results from processing the root into "foofoo" is called cassava root sieviate. However in harnessing these products as poultry feed ingredients it has been discovered that they are high in fiber hence this limit their utilization.

CRS for instance contains high amount of non-starch polysaccharides mostly of non digestible carbohydrate such as cellulose hemicellulose which have a high water holding capacity. This was observed to be poorly digested and bio utilized by laying birds which resulted in depressed weight gain and reduced egg production [1]. The digestibility of a feed for both ruminant and non-ruminants tend to decrease with crude fiber content. Typically a 1% increase in crude fiber brings a 1% decrease in digestibility for ruminants and a 2% decrease for pigs [2, 3].

Biodegradation can be described as a process in which substrates are decomposed by known mono or mixed cultures of micro organism under controlled environmental conditions with the aim of producing high quality product. The substrate is characterized by relatively low water content [4]. Enzymes from micro organisms especially fungi has been indicated to be promising in degrading structural carbohydrates such as cellulose, hemicellulose and lignin and in degrading or structurally modifying proteins and their anti nutritional properties and to liberate phosphorus complex compounds e.g. phytase [5].

MATERIALS AND METHODS

Inoculation of substrate using micro organism in the solid state fermentation was employed. The cassava peels

Corresponding Author: Dr. F.A. Aderemi, Department of Animal Science and Fisheries Management, Bowen University of the Nigerian Baptist convention, Iwo Osun State, Nigeria

and sieviate were collected from processing centre at barracks Eleyele Ibadan Nigeria. These products were separately dried and about 60 g was put in each of 250 ml Erlenmeyer flasks. The flask with their contents were autoclaved at 120°C for 1 h. After autoclaving, the flask with their content were allowed to cool, then sugar inform of syrup was introduced to adjust the moisture content to about 25%. The sugar syrup was added to provide more carbon for the organism *Aspergillus niger* to feed and grow on. The pure culture of *Aspergillus niger* maintained on potato dextrose was collect from the culture bank of the Department of Botany and microbiology University of Ibadan, Nigeria. The substrates were inoculated aseptically with 5 ml of *A. niger* properly mixed and dully labeled the flask were incubated at 35°C. The samples were prepared in triplicates and arranged based on days of biodegradation. At the end of each experimental period, the respective samples were oven dried at 80°C for 24 h and subjected to further analysis.

Mineral analysis: The wet oxidation procedure of A.O.A.C. [6] was applied in the preparation of the digest for the mineral analysis. Suitable preparations of the digest were read on flame photometer for the respective minerals namely calcium,sodium and potassium.

Chemical analysis: The crude fiber of sieviate and peels was verified determined by the method of A.O.A.C. [6] while protein was estimated by the method of Lowry [7].

Statistical analysis: Data were subjected to analysis of variance and level of significance was indicated.

RESULTS AND DISCUSSION

The appearance of the mycelia of the fungi on the substrate feed stuffs after 48 h was on indication that degradation has commenced. This was in line with Ofoya and Nwajiuba [8] thus confirms suitable environmental condition for the fungi.

The degradation of CRS and peels starts with the breakdown of polysaccharides into oligosaccharide which can be hydrolyzed by glycosidase into their component monomer. The metabolism of these monomers can then give energy and carbon for the growth of the micro organism as reported by Smith *et al.* [9].

From this study it was observed there was increase in protein content (Table 1 and Fig. 1) compared to undegraded CRS from 2.09 to 7.34% also cassava peels had an improvement from 5.35 to 12.64%. This implied that *Aspergillus niger* had significant ($p<0.05$) effect on the protein content. The increase in the crude protein observed was probably due to the additional crude protein produced in the fungal mycelia Onilude [10] or the mycelia protein and this is influenced by carbon to nitrogen ratio, similar results had been reported by Abu [11] using sweet potato in solid state fermentation. Also this result was in line with Iyayi and Losel [12] who reported enriched protein of cassava peel and pulp with different fungi types.

The fiber component decreased over the period of degradation this may be due to the hydrolytic nature of the fungi used for the biodegradation. The result here is in line with Chesson [13] who reviewed the early claim that disruption of cell walls and their degradation by microorganism enzyme could be beneficial to host animal.He reported that available cell wall carbohydrate not attacked by digestive enzymes now seem wildly optimistic after biodegradation. He then stressed that total breakdown requires the action not only of the enzymes responsible for the primary attack on the cell wall polysaccharide and glucan hydrolases but also of a second set of glycosidases able to reduce oligosaccharides to their monomeric components. During biodegradation the enzymes from fungi breakdown polysaccharide into less complex structures. The ease of degrading any fiber component is a function of the enzyme composition of fungi and the physicochemical properties of the substrate. Acid detergent fiber and lignin content also decreased

Table 1: Changes in proximate content of cassava root sieviate and peel following biodegrading with Aspergillus

CRS		Crude protein	ADF	ADL	Cellulose	Hemicellulose
Days	0	2.09+0.63	16.26+2.03	6.97+0.11	9.29+1.33	8.75+1.36
	5	5.21+1.02	14.48+1.07	6.71+0.31	7.77+1.24	6.38+1.11
	10	7.34+1.06	11.26+1.17	6.62+0.21	4.64+1.07	4.09+1.31
Cassava peels		Crude protein	ADF	ADL	Cellulose	Hemicellulose
Days	0	5.35+1.21	9.76+1.21	4.81+0.28	5.40+1.34	21.65+3.15
	5	10.70+2.04	8.23+0.96	6.98+0.14	3.42+2.01	18.38+3.08
	10	12.64+1.08	4.87+1.03	6.08+0.19	1.73+2.23	15.92+3.32

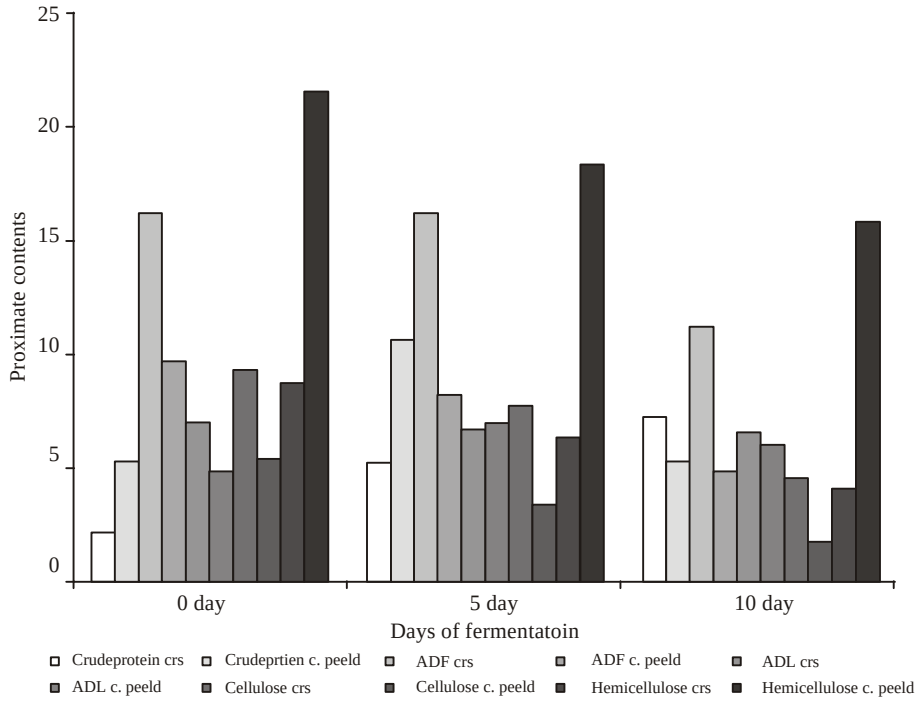

Fig. 1: Effect of *A. niger* on proximate composition of CRS and Cassava peels

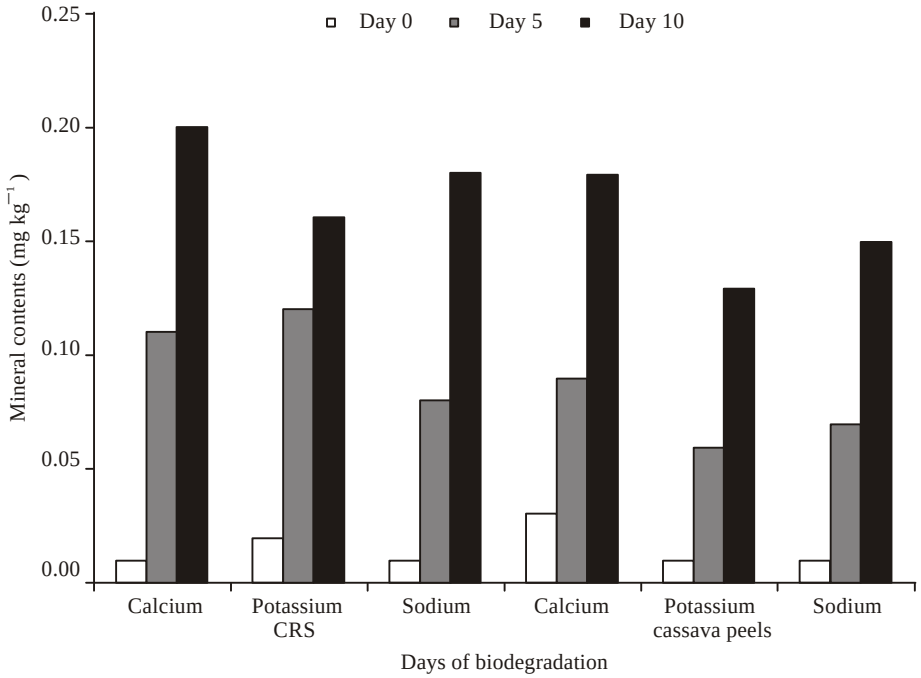

Fig. 2: Effect of *A. niger* on some mineral content of biodegraded CRS and Cassava peels

indicating continuous breakdown activity of the fungi or saccharifytic role of the fungi used. The higher the hydrolyzing or saccharifying ability of the microbes the lower the acid detergent lignin content found in the substrates. Acid detergent fiber is a combination of cellulose and lignin from the result cellulolytic ability of the microbial enzyme was obvious. Biodegradation of cassava peels and CRS also resulted in improvement of

some mineral content Fig. 2. It was observed that there was improvement of the calcium, potassium and sodium as biodegradation proceeds with the highest value at the 10th day this is similar with Smith *et al.* [9].

CONCLUSIONS

The use of microbial enzymes to cleave the $ (1-4) carbohydrates bond can also be used to improve the nutritional value of animal feeds. This is obvious from the result of proximate and mineral analysis obtained in this study.

Since the nutritional value of CRS and peels were improved then it follows that other non conventional feed ingredients which are readily available can also be improved upon using this method. Consequently inclusion of such into livestock feeding will imply reduced cost of production.

REFERENCES

1. Aderemi, F.A., O.A. Ladokun and O.O Tewe, 2004. Study on hematology and serum biochemistry of layers fed biodegraded cassava root sieviate. Bowen J. Agric., pp: 78-83.
2. F.A.D., 1985. Setter utilization of crop residues and by-products in animal feeding. Research guidelines FAD Animals production and Health, 50: 60-64.
3. Aderolu, A.Z., E.A. Iyayi and S.T. Ogunbanwo, 2002. Nutritional status of palm kernel meal inoculated with Trichoderma Harzanium. Trop. J. Anim. Sci., 5: 103-108.
4. Zandrazil, F., Died Riches, M. Janssen, I.T. Schuchrdt and J.S. Park, 1990. Large scale solid state fermentation of cereal straw with *Pleudrotus* spp. In Advances in Biological treatment of lingo cellulosic materials Ceds MP Coughlan and MT *Ameral celloco*). Elsevier Appl. Sci., pp: 43-58.
5. Rai, S.N., K. Sigh, B.N. Gupta and T.K. Lalalli, 1988. Microbial conversion of crop residues with reference to its energy utilization by ruminant. An overview in Sigh, K. and J.B. Schiere (Eds.) fibrous crop residues as animal feed proceedings of international Workshop held 27-28 October 1998. Bangalore India.
6. AOAC, 1990. Association of official analytical chemist, official methods of analysis, 15th EdN. AOAC Incorporation Virginia 2201 USA.
7. Lowry, O.H., 1962. Protein measurement with Folin phenol reagent. J. Biol. Chem., 193: 265-273.
8. Ofoya, C.O. and C.J. Nwajiuba, 1990. Microbial degradation and utilization of cassava peel. World J. Microbiol. Biotech., 6: 114-148.
9. Smith, J.P., A. Rizema, J. Tromper, H.M. Vansonsbeek and W. Knol, 1996. Solid state fermentation of wheat brain by Trichoderma reesei QM 9414: Substrate composition changes balance enzyme production growth and kinetics. Appl. Microbial. Biotechnol., 46: 489-496.
10. Onilude, A.A., 1994. Production Characteristion and utilization of some dietary fiber degrading enzymes as additives in Broilerdiets. Ph.D. Thesis, Department of Botany and Microbiology University of Ibadan, Nigeria.
11. Abu, O.A., 1997. Biochemical characteristic and utilization of processed sweet potato legume batata (L) LAM for rabbit feeding. Ph.D. Thesis Univeristy of Ibadan, Ibadan, Nigeria.
12. Iyayi, E.A. and Dorothy M. Losel, 2001. Protein enrichment of cassava by products through solid state fermentation by fungi the journal of food technology in African, pp: 6: 40 and pp: 116-118.
13. Chesson, A., 1993. Feed enzymes. Animal Feed Sci. Technol., 45: 65-79.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 312-317, 2007
ISSN 1818-6769

Properties, Classification and Suitability Evaluation of Some Selected Cocoa Soils of South-Western Nigeria

A.S. Fasina, S.O. Omotoso, O.S. Shittu and A.P. Adenikinju

Department of Crop, Soil and Environmental Sciences,
University of Ado-Ekiti, P.M.B. 5363, Ado-Ekiti, Nigeria

Abstract: Some selected Cocoa soils of Ekiti State were characterized, classified and evaluated for Cocoa production. Soil samples from pedogenic horizons were analysed. The study revealed four major soil units located at four different sites (Aisegba, Ayedun, Ise and Ikoro). All the soils are well drained but concretional and gravelly in nature. Soil texture consists of sandyloam surface and clayloam/silt loam and clay in the subsurface. The soils are moderately acidic in reaction (6.16) and have low amounts of organic carbon (0.21-1.52%). The effective cation exchange capacities and percentage base saturations are low ranging from 0.70-1.51 meq/ 100 g of soil and 42.86-83.33%, respectively. The Aisegba and Ikoro soils classify as Tupic PIinthudult (Eutric Plinthosol-Ondo series) while Ayedun soils classify as Typic Udipsamment (Cambic Arenosol-Makun series and Ise soil was classified as Acrudoxic Plinthic Kandiudult (Eutric Plinthosol-Fagbo series). The major limitations of the soils are the gravelly Concretional nature of the soils, poor soil fertility and low rainfall distribution. On the basis of these limitations, all the soils have been classified as $S3_{cfs}$ (marginally suitable) for cocoa production.

Key words: Cocoa % Ekiti % classification % suitability

INTRODUCTION

One of the major factors limiting optimum cocoa production in Nigeria is the lack of detailed information on soil and land characteristics of cocoa growing areas. This is particularly true of soils formed on Granitic parent material in South-western Nigeria. When information is available on soil and land characteristics of selected cocoa growing areas, it would be very easy to manage the soils for optimum cocoa production. Information generated also would help to monitor soil and land use activities of these areas.

Information available revealed that soil survey was carried out within the cocoa belts of Nigeria between 1951 and 1962 [1]. The purpose of this survey was to describe and classify the soils of cocoa areas and to asses their agricultural potentialities, especially for cocoa cultivation. The survey revealed that about 62% of Nigeria cocoa is grown on good or fairly good soils and the remaining thirty eight per cent on poor or very poor soil. In furtherance to this, the work done by the Cocoa Research Institute of Nigeria (CRIN) also gave experimental evidence that the chemical and physical property of soil decline with cultivation [2, 3] and also those two major factors are responsible for the decline in cocoa yield. These two factors being poor site selection and lack of fertilizer use.

Most of the soil survey works done on cocoa growing areas in Nigeria were done at reconnaissance level. Most of the information generated from these surveys was not at detailed level. It is either they are also outdated or obsolete and are not relevant with reference to present large scale production of cocoa in Nigeria. Very few detailed soil survey and soil characterization studies culminated in the comprehensive classification of the soil are therefore not available.

The objectives of this study were:

- To make a detailed characterization of some selected cocoa soils of Ekiti State,
- To classify the soils using the criteria of the Soil taxonomy, FAO Revised Legend of the soil map of the world and into local series using Smyth and Montgomery and also
- To evaluate these soils for cocoa production.

Corresponding Author: Dr. S.O. Omotoso, Department of Crop, Soil and Environmental Sciences, University of Ado-Ekiti, P.M.B. 5363, Ado-Ekiti, Nigeria

MATERIALS AND METHODS

Site description: Soil sampling sites were located on benchmark soils identified by Ekiti State Agricultural Development Project for Cocoa production. The selected sites are Ise (5° 26'E, 7° 28'N), Aisegba (5° 29'E, 7° 36'N), Ikoro (5° 03'E, 7°50'N) and Ayedun Ekiti (5° 35'E, 7°49'N), respectively [4]. Detail soil survey (Rigid grid) was carried out on each of the four sites after which the major soil of the area was picked that has the largest coverage area for cocoa production. Each site covered an area of 2 Hectares each. After the soil survey, the major soils were identified. One profile pit was dug at each of the major soil type identified, since these soils have been identified as benchmark soils. The morphological properties of the profiles were described in the field using the criteria of the soil survey manual of soil survey division staff [5] and the guidelines for soil profile description [6]. Soil samples were taken from pedogenic horizons or layers of the profiles for laboratory analysis.

Laboratory analysis and soil classification: Soil samples were air-dried in the laboratory ground and sieved through a 2 mm sieve. The percentage gravel was calculated on the basis of subsamples (500 g of each) of whole soil.

Particle-size distribution was determined by the hydrometer method. Soil pH was determined in water and O.I M kcl solution at 1:2.5 Soil/solution ratio: Exchangeable bases were displaced by NH_4^+ from neutral/MNH4Oac solution. Calcium (Ca) and Magnesium (mg) were determined by the atomic absorption spectrometer (AAS) and potassium (k) and sodium (Na) were determined by flame emission photometry. Cation exchange capacity (CEC) was determined by the neutral/MNH4OAc saturation method. Base saturation was calculated with reference to the NH4Oac-CEC.

Exchangeable acidity was extracted with IMKCL and determined by titration with NaOH solution. Organic carbon was determined by the dichromate wet oxidation method and total nitrogen (N) by the micro-kjeldahl technique. Available P was extracted by the Bray/method and determined colorimetrically. The micronutrients copper (Cu), Zinc (Zn), manganese (mn) and Iron (Fe) were extracted using diethyleretria minepentaacetic aci (CDPTA) and determined by AAS.

Soil classification was by the criteria of Soil taxanomy [5] and the FAO [6]. Revised legend of the soil map of the world while local soil classification was carried out using the Smyth and Montgomery [1] method.

Land evaluation: Suitability of the soils was assessed for cocoa production following the method of Sys [7]. Soils were placed in suitability classes by matching their characteristics with the requirement of cocoa (Table 1). The suitability class of a soil is that indicated by its most limiting characteristics. Thus the classes S1, S2, S3, N1 and N2 represent highly, moderately, marginally, actually not suitable but potentially suitable and actually and potentially not suitable respectively.

Table 1: Climatic, soil and land requirements for cocoa production [7]

Land, soil and climatic characteristics	S1	S2	S3	N1	N2
Climatic					
Annual rainfall (mm)	1,600-2,500	1,400-1,600	1,200-1,400	-	<1,200
	2,500-3,500	3,500-4,500			
Length of dry season (months)	<2	<3	<4	-	<4,400
Mean annual temperature (°C)	23-32	22-35	22-38	-	<21
Relative humidity (%)	40-65	35-75	30-85	any	-
Dryest month (%)	40-60	35-65	30-75	any	-
Topography (t)					
Slope (%)	<8	<16	<30	-	any
Wetness (w)					
Flooding	No	No	F1	F1	any
Drainage	Well	Moderate/better	Imperfect or better	Poor or better	Very poor/better
Physical soil characteristics(s)					
Texture/structure	C-60s to SC	C+60s to SCL	C+60s to LFS	C+60s to LFS	Cm to Cs
Coarse fragments (Vol.%)	<15	<35	<%	<55	any
Soil depth (cm)	>150	>100	>50	>50	any
Fertility characteristic (f)					
Apparent CEC (Meq/ 100 g soil)	>16	<16	any	-	-
Base saturation (%)	>35	>20	any	-	-
Organic matter (% C, 0-15 cm)	>1.5	>0.8	any	-	-`

F1 = Slight, C+60s to SCL = Very fine clay blocky structure to sandy clay loam, C-60V to L = Clay vertisol structure to loam, C+60s to fs = Very fine clay blocky structure to fine sand, C+60v to fs = Very fine clay vertisol to fine sand, C+60s to s = Very fine clay, vertisol structure to sandy soil, CM to SC = Massive clay to sandy clay

RESULTS AND DISCUSSION

Soil morphological properties: The soil of Aisegba was characterized by grey (5 Yr 6/1) sandy loam on top coming down to clay loam yellowish red (5 Yr 4/6) sub soil. The soil structure is angular blocky at all depths. The soil has an argillic horizon which increase in clay content with depth (Table 3). The soil was observed to be well drained. The soils are gravelly and concretional both at the topsoil and subsoils.

The soils of Ayedun (Tables 2 & 3) has no argillic horizon and is characterized by reddish brown (5 Yr 4/4) sandy loam on top coming down to yellowish red down (5 Yr 4/6) silt loam subsoil. There are some few yellowish red (5 Yr 4/4) mottles between 18 to 96 cm depth. The structural type is mostly angular blocky throughout the profile. The clay content of this soil is less than 15% throughout the soil profile. One unique factor of this soil type is that it is very silty throughout the soil profile (Table 3). Silt values ranges from 17.4% at the surface to 45.4% at the subsoil. This is an indication that these soils have been formed from colluvial wash from the crest or upper slope.

The profile at Ise was characterized by dark reddish brown (2.5 Yr 3/3) sandy clay loam on top coming down to reddish (2.5 Yr 4/6) in the middle depth and finally to silty loam red (2.5 Yr 5/8) at the subsoil. The structure is fine crumb at the surface coming down to moderate angular blocky at depth (Table 3). Again this soil type has unusual high silt content (51.4% Table 3). At depth (99-120 cm). This might be as a result of hill wash.

The Ikoro location was characterized by grayish brown (10 Yr 4/3) sandy loan topsoil coming to yellowish brown (10 Yr 5/8) clay subsoil.

There was a substantial increase in clay content right from the second horizontal at a depth of 34 cm (Table 3). This soil structure is crumby in nature at the top coming down to moderate angular blocky at the subsoil (Table 2).

Table 2: Field morphological description of selected cocoa soils of Ekiti State

Depth (cm)	Colour (dry)	Mottles +++	Textrure ++++	Structure *	Consistence +	Boundary **	Drainage class ***	Concretions +++++	Gravels VVV
Pedon A-Aisegba									
0-20	5Yr 6/1	-	SL	Cab	dh	w	IV	P	P, n
20-35	5Yr 5/2	M, yellow	SCL	Mab	Dh	S	IV	P, fe-mn	P, n
35-63	5Yr 4/4	F, reddish	CL	Mab	dsh	S	IV	P, fe-mn	P, n
63-99	5Yr 4/5	M, yellow	CL	Mab	dsh	gs	IV	P	P, n
>99	5Yr 4/6	F, reddish	CL	Mab	dsh	s	IV	P, fe-mn	P, n
Pedon B-Ayedun									
0-18	5Yr 4/4	-	SL	Fab	dh	S	IV	P, fe-mn	P, n
18-36	5Yr 4/6	F, yellowish red	SL	Fcr	dsh	S	IV	P, fe-mn	P, m
36-54	5Yr 4/4	F, yellowish red	SL	mab	dh	S	IV	P, fe-mn	P, n
54-96	5Yr 4/6	F, reddish yellow	SL-silt loam	mab	dsh	S	IV	P, fe-mn	P, n
96-100	5Yr 5/8	F, red	SL-silt loam	mab	dsh	S	IV	P, fe-mn	P, m
Pedon C-Ise									
0-16	2.5Yr 3/3	-	SCL	Fcr	dfr	s	IV	P	P, n
16-34	2.5Yr 3/6	-	CL	mab	dfr	gs	IV	P	P, n
34-50	2.5Yr 4/6	-	C	mab	dfi	s	IV	P	P, n
50-99	2.5Yr 5/6	F	CL	mab	dfi	s	IV	P, Fe-mn	P, m
99-120	2.5Yr 5/8	F	Silt loam	mab	Dfr	s	IV	P, Fe-mn	P, n
Pedon D-Ikoro									
0-14	10 Yr 4/3	-	SL	Fcr	mfr	s	IV	P	P, n
14-34	10 Yr 4/4	-	LS	Mcr	mfr	w	IV	P	P, n
34-54	10 Yr 5/6	F	C	Mcr	ms	s	IV	P, Fe-Mn	P, n
54-97	10 Yr 5 /8	F	C	mab	ms	w	IV	P, Fe-Mn	P, n

Texture ++++: SL = Sandy Loam, LS = Loamy sand, SC = Sandy Clay, C = Clay Loam, S = S and SCl = Sandy clay loam, C = clay, Mottles+++: M = many, f = few Structure*: m = medium, C = coarse, f-fine, cr = crumb ab = angular blocky. Consistence+: d = dry, m = moist, w = wet, l = loose, fr = friable, fi = firm, sh = slightly hard, h = hard, s = sticky. Boundary**: w = wavy, s = smooth, gs = gradual and smooth Drainage***: I = poorly drained, IV = well drained Concretions+++++: a = absent, p = present, Fe-Mn = Iron and Manganese concretion, n = numerous Gravels VVV: a = absent, p = present, n = numerous, f = few, m = moderate

Table 3: Physical and chemical properties of selected cocoa soils of Ekiti State

			PH	Boron	Org. C	Total	Ave.	Ca	Mg	Na	K	Ex. Ac	CEC	B. sat	Mn	Fe	Cu	Zn	Gravel	Text class	Sand	Silt	clay
		Kcl	H20	Ppm	%	N %	P ppm	Me/100 g	Me/100 g	Me/100 g	Me/100 g	Me/100 g	Me/100 g	%	ppm	ppm	ppm	ppm	%	%	%	%	%
A	10-20 cm	5.03	6.68	7.55	1.52	0.37	1.14	0.28	0.4	0.24	0.21	0.4	1.27	62.99	68.0	34.0	1.9	5.5	21.04	SL	69.2	15.4	15.4
Aisegba	20-5 cm	6.73	6.85	8.72	0.59	0.14	2.05	0.26	0.16	0.23	0.13	0.2	0.92	78.26	74.0	29.0	1.5	6.3	21.26	SCL	63.2	11.4	25.4
	35-3 cm	5.58	6.80	6.97	0.36	0.09	1.20	0.32	0.12	0.19	0.08	0.2	0.91	78.02	56.0	46.0	2.3	7.8	21.44	CL	57.2	11.4	31.4
	63-9 cm	5.60	6.69	11.04	0.23	0.06	0.48	0.41	0.18	0.24	0.12	0.4	1.35	70.37	63.0	53.0	2.7	7.1	21.92	CL	49.2	15.4	35.4
	99-100	5.54	6.54	12.20	0.39	0.09	0.66	0.36	0.17	0.25	0.19	0.4	1.37	70.80	48.0	39.0	1.1	4.3	21.32	CL	47.2	21.4	31.4
B	0-18 cm	5.76	6.58	10.46	0.24	0.06	8.01	0.33	0.17	0.22	0.10	0.4	1.22	67.21	53.0	41.0	1.4	3.6	20.98	SL	73.2	17.4	9.4
Aiyedun	18-36 cm	5.61	6.66	6.39	0.46	0.11	5.78	0.24	0.14	0.19	0.07	0.4	1.03	61.17	75.0	31.0	1.7	5.1	10.62	SL	67.2	23.4	9.4
	36-54 cm	5.40	6.36	9.88	0.67	0.17	2.53	0.16	0.08	0.21	0.06	0.6	1.11	45.96	79.0	37.0	2.2	4.3	11.33	SL	57.2	35.3	7.4
	54-96 cm	5.43	6.44	8.13	0.33	0.08	0.72	0.31	0.18	0.23	0.06	0.6	1.38	56.52	81.0	52.0	1.3	6.9	10.69	Silt loam	49.2	45.4	5.4
	96-100	5.52	6.16	12.78	0.46	0.11	0.36	0.30	0.13	0.20	0.08	0.8	1.51	47.02	88.0	44.0	1.7	7.5	10.66	Silt loam	49.2	45.4	5.4
C	0-16 cm	6.11	6.93	13.36	1.47	0.36	0.90	0.42	0.17	0.24	0.17	0.2	1.20	83.3	86.0	49.0	3.3	7.3	21.11	SCL	61.2	13.4	25.4
Ise	16-34 cm	6.10	6.93	8.72	0.93	0.23	3.01	0.30	0.10	0.24	0.20	0.2	1.04	80.77	92.0	27.0	2.6	6.1	11.05	Cl	57.2	13.4	29.4
	34-50 cm	5.93	6.96	9.88	0.44	0.11	1.63	0.28	0.14	0.22	0.08	0.2	0.92	78.26	88.0	21.0	1.6	8.3	11.18	C	45.2	11.4	43.4
	50-9 9 cm	5.23	6.20	12.78	0.39	0.09	0.18	0.38	0.15	0.27	0.06	0.6	1.46	58.90	76.0	33.0	1.9	7.6	10.74	CL	57.2	5..4	37.4
	99-120	5.79	6.97	7.55	0.39	0.09	0.12	0.35	0.16	0.24	0.14	0.2	1.09	81.65	83.0	37.0	3.1	4.8	10.89	Silt loam	35.2	51.4	13.4
D	0-14 cm	5.52	6.40	12.20	1.00	0.24	0.90	0.38	0.13	0.17	0.05	0.4	1.13	64.60	64.0	54.0	1.8	5.4	20.96	SL	71.2	15.4	13.4
Ikoro	14-34 cm	5.53	6.64	8.13	0.44	0.11	0.78	0.14	0.08	0.02	0.06	0.4	0.70	42.86	59.0	48.0	2.4	6.5	22.35	LS	77.2	77.4	15.4
	34-54 cm	5.94	7.07	10.46	0.54	0.13	0.66	0.22	0.18	0.32	0.10	0.2	1.02	80.39	55.0	38.0	3.5	6.9	21.21	C	43.2	7.4	49.4
	54-99 cm	5.18	6.20	11.62	0.21	0.05	0.48	0.19	0.12	0.24	0.09	0.6	1.26	50.79	51.0	45.0	3.2	7.0	21.07	C	37.2	11.4	51.4

All the four soil profiles are well drained. Three of the profiles (Aisegba, Ikoro and Ise) have argillic horizons. All the locations (Aisegba, Ayedun, Ise and Ikoro) are all gravelly and concretional in nature (Tables 2 and 3).

Soil chemical properties: The chemical properties of the soils are presented in Table 3. The soils are moderately acidic with highest values recorded in the surface horizons. The soil pH values in water ranged from 6.16 to 7.07. The percentage organic contents were observed to be low in all the locations (with values ranging from 0.21 to 1.52%). The low organic carbon content observed at all the four sites may be partly due to the effect of arable and land use activities being practiced by the farmers, high temperature and relative humidity which faviour rapid mineralization of organic matter. This finding here on organic matter decomposition confirmed the earlier results obtained by previous workers such as Agboola and Corey [8]. The organic matter has to be substantially increased through effective crop residue management, increased use of leguminous plants as well as the use of nitrogenous and phosphatic fertilizers.

The nitrogen content in all the soils are considerably low ranging from 0.05 to 0.37%. This is considered low when copared to the 1.80% N required by most crop [10-12]. The nitrogen content decreases progressively with depth. The soil nitrogen can be substantially increased through the use of nitrogenous fertilizers and effective crop residue management.

The available phosphorus contents in all soils are low ranging from 0.12 to 8.01 ppm. This value is lower than the average 12 ppm phosphorus value required by cocoa. Phosphate fertilizers are required as a soil management practice. Straws of crops residue should be incorporated into the soils.

The four locations are characterized by low potential for retaining plant nutrients, hence the necessity for adequate soil management. The low base saturation values (<99% by sum of cations [5] can be attributed to Kaolinitic clay content nature of the parent material from which the soils have been formed.

Previous work by Omotoso [12] has shown the importance of Boron to cocoa production. Low boron content had been known to display deficiency symptoms on a large scale. The boron content for all the soils are low on the average ranging from 6.97 to 12.78 ppm as against the 10-40 ppm requirement for cocoa.

Soil classification: The Aisegba soil profile has an argillic horizon which increases in clay content with depth. The organic matter content decreases progressively with depth. A low base saturation (<99% by sum of base method) characterizes the soil and the cation exchange capacity is rather low. Hence, the soil is grouped into the order Ultisol. The soil belongs to the suborder udult because of its udic moisture regime. It is grouped into Great group "Plinthudult" because of its high content of heavy concretions and gravels right from the surface to the lowest horizon below 99 cm. The soil has been classified as Typic Plinthudult at subgroup level. Using the FAO soil classification system. The soil has been classified as Eutric Plinthosol.

The soil is well-drained and has a medium texture down the profile which characterizes soils formed from fine-grained granitic rock and medium grained gneisses parent material. The soil has textures of very clayey sand ("clayey" sedimentary soil which includes iron concretions within 26 cm of the surface. At the series level the Aisegba soil has been classified as Ondo series. The soil colour between depth of 25-75 cm corresponds with the specification of Smyth and Montgomery [1].

Table 4: Physical and chemical properties of surface soil samples of cocoa soils of Ekiti State

Sample depth (cm)	Location	PH (H_{20}) 1:1	P (ppm)	% org. c	% N	Ca (meq/100g)	Mg (meq/100g)	Na (meq/100g)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	K (mwq/100g)	EA (Cmol/kg)	CEC	BS (%)	Particle % clay	Size % silt	Ana. % sand	Text. class
0-5	Aisegba (Pedon A)	7.10	9.58	2.352	0.243	3.501	3.378	0.823	100.41	80.61	25.36	9.66	0.823	1.314	9.877	86.70	4.8	18	77.2	SL
0-5	Ayedun (Pedon B)	6.65	25.17	1.867	0.194	2.992	2.507	0.589	71.12	64.37	20.54	7.47	0.589	1.223	8.134	85.00	6.8	20	73.2	SL
0-5	Ise (Pedon C)	6.60	32.89	2.037	0.211	3.467	3.146	0.763	93.12	64.81	24.60	9.37	0.763	0.816	9.042	86.50	8.8	24	67.2	SL
0-5	Ikoro (Pedon D)	6.41	7.87	1.764	0.183	3.339	2.881	0.665	86.95	53.93	19.84	8.74	0.603	0.603	8.333	92.80	12.8	26	61.2	SL

Table 5: Soil classification and land suitability evaluation of the selected cocoa soils of Ekiti State

Location	Soil Classification: Soil series	USDA	FAO	Rain fall (cm)	Length of Dry season (months)	Mean ann Temp (°C)	Flooding	Drain.	Texture	Coarse Frag.	Soil depth (cm)	CEC meq/100g	Bs %	Om %	Appa. CEC (meq/l00g soil)	Agg. Suitab.
Aisegba	Ondo	Typic plinthudult	Eutric plinthosol	1,300 S3	>3 S3	27 S1	Fo S1	Good S1	SC-LC S1	21.04 S2	100 S1	1.27 S3	62.99 S2	2.62 S2	8.2 S2	S3 cfs
Ayedun	Makun	Typic Udipsamment	Cambic Arenosol	1,300 S3	>3 S3	27 S1	Fo S1	Good S1	SL-Slit S2	20.98 S2	100 S1	1.22 S3	67.21 S2	0.41v S2	12.9 S2	S3 cfs
Ise	Fagbo	Acrudoxic plinthic kandiudult	Eutric Plinthosol	1,300 S3	>3 3	27 S1	Fo S1	Good S1	SCL-Slit loam S1	21.11 S2	100 S1	1.20 S3	83.33 S2	2.54 S2	4.7 S2	S3 cfs
Ikoro	Ondo	Typic plinthudult	Eutric Plinthosol	1,300 S3	>3 3	27 S1	Fo S1	Good S1	SL-C S1	20.96 S2	100 S1	1.13 S3	64.0 S2	1.73 S2	8.4 S2	S3 cfs

The soil of Ayedun has no argillic horizon and has clay content of <5% throughout the soil profile. The cation exchange capacity is equally low. The silt content is high and increases down the horizon (result of a colluvial wash), hence the soil is grouped into order Entisol. There is presence of iron and Manganese concretions and gravels from the topsoil to the lowest horizon. There is evidence of mottles at 18-36 cm even up to depth of 96 cm. The soil has been grouped as Psamment (suborder) and Great group Udipsamment. The soil is classified at subgroup level as Typic Udipsamment and Cambic Arenosol (FAO). The soil was formed from an hill-wash, that is formed from fine colluvial material. This accounts for the silty and fine texture of silt which increases down the depth. The parent material of the Ayedun soil is the fine-grained biotite gneisses and schist as the soil is developed to a great depth and has bright coloured mottles. The Ayedun soil has been classified at series level as Makun Series [1].

The Ise soil profile has argillic horizon with low cation exchange capacity and low base saturation (<99% by sum of bases method) and the organic matter deceases with depth hence it is classified as order Ultisol. It belongs to the suborder Udult due to its udic moisture regime and also fits into Kandiudult great group. The soil is classified as Acrudoxic plinthic kandiudult (USDA) and as Eutric Plinthosol (FAO). The Soil profile is suspected to be formed from fine-grained granitic rock and medium-grained gneisses parent material due to its slightly hard texture. The Ise soil has been classified at series level as Fagbo series because it is characterized by clayey sedentary property and brownish red to red colour within the 25-75 cm soil depth.

The Ikoro Soil profile has an argillic horizon and its organic matter content decrease with depth. The cation exchange capacity and the base saturation are low. Thus, it belongs to the order Ultisol. It belongs to the suborder Udult due to its udic Moisture regime. The soils is characterized by a lot of concretions and heavy gravels and similarly mottled, hence it belongs to the great group Plinthudult and consequently classified at subgroup level as Typic Plinthudult (USDA) and Eutric Plinthosol (FAO). I Ikoro Soil is suspected to have been formed from medium grained granites and gneisses. It is well-drained and has textures of very clayey sand to clay within the depth of 25 to 97 cm, respectively. Ikoro soil has been classified as Ondo series because of its brown to orange yellowish brown colour between the 25 to 75 cm depth.

Suitability evaluation for cocoa production: The conversion table (Table 1) of sys system [7] was used to match the land characteristics of all the sites. The result of the land evaluation for cocoa production is as presented in Table 5. Among the climatic parameters, the most important limitation to crop production in the topics is the amount and distribution of rainfall. Annual rainfall within all the study areas stands at about 1300 mm/ annum [4]. This is insufficient when compared with rainfall requirement for cocoa production (1600-2500 mm) as stated by Sys [7] (Table 1). This makes all the sites fall into suitability class S_3 with reference to rainfall. The mean annual temperature of all the study sites is within 27°C, hence they all fall within S1 (highly suitable) class with reference to temperature requirement. All the study sites are not flooded and are well drained and are

therefore in the S1 suitability class when drainage and flooding are considered.

When textural class was used as an evaluation criteria, the Aisegba, Ise and Ikoro soils fall into the S1 suitability class, while Aiyedun soil falls into S2 suitability class because of the sandy loam and siltloam of the topsoil and subsoil, respectively. This is because the soil moisture reserve ability of the soil would be low. All the locations have gravels and concretions which pose an impediment for root development and movement; hence all the soil sites were all classified into S2 with reference to coarse fragments. The soils are all deep having depth ranging between 99-120 cm, hence classified as S2 class.

The soils have low cation exchange capacity (1.13 to 1.27 meq/ 100 g soils) and low base saturation (62.99 to 83.33%) and therefore fall into S3 and S2 classes, respectively. All the soils are moderately suitable (S2) when organic matter is taken as a yardstick for evaluation. Generally speaking, when all the parameters of land evaluation are considered, it was observed that some limitations are common to all the study sites (precipitation (low rainfall), low CEC, low base saturation, concretional and gravelly nature of the soils). Therefore all the sites have been classified as $S3_{cfs}$ (marginally suitable with rainfall, soil fertility and concretions as limitations) to cocoa production. The low CEC can be addressed by adding fertilizer supplements that contain such nutrient elements as Mg, K and Boron. Irrigation should be carried out to supplement inadequate precipitation especially during the dry season if farmers can afford it.

The different tree crops and deep feeders intercropped with cocoa should be replaced with shallow feeders and arable crops so as to reduce the nutrient uptake from the soils. Some leguminous crops can be planted to return nitrogen back into the soil.

CONCLUSIONS

Four selected cocoa soils developed from basement complex parent material were characterized and classified in Ekiti State, South-westhern Nigeria. The soils were found to be concretional and gravelly in nature. All the four soils are well drained. Three of the soils (Aisegba, Ikoro and Ise) has argillic horizons. All the soils except Ise soil have sandy loam texture on top coming down to either clay loam/siltloam or clay subsoil. All the soils are low in soil fertility. The soil were classified at subgroup level of soil Taxonomy [8] Local Series level [1] and the second level of FAO [6] (in parentheses) as Typic Plinthudult (Eutric Plinthosol and Ondo series-Aisegba). For Aiyedun soil, it has been classified as Typic Udipsamment (Cambic Arenosol and Makun series). The Ise soil has been classified as Acrudoxic Plinthic Kandidult (Eutric Plinthosol and Fagbo series). The Ikoro soil was classified as Typic Plinthudult (Eutric Plinthosol and Ondo series). The soils were further evaluated for cocoa production. The major limitations of these soils are concretional gravelly nature of the soils, poor soil fertility and low rainfall distribution. On the basis of these limitations, all the four soils were grouped into suitability classes for cocoa production as $S3_{cfs}$ (Marginally suitable).

REFERENCES

1. Smyth, A.I. and R.F. Montgonery, 1962. Soil and land use in central Nigeria. Government Printer, Ibadan, Western Nigeria.
2. Omotoso, T.I., 1965. Boron nutrition problems of cocoa in Nigeria. In: Proceeding V International Cocoa Research Conference, Ibadan, pp: 312-315.
3. Omotoso, T.I., 1971. Technical and Research Aspects of Soil Fertility used in Nigeria with special references to cacao. In: Phosphorus in Agriculture 29th year, 1975, No. 64.
4. Ebisemiju, F.S., I.O. Orubuloye, O.A. Ibitoye and F.I. Afolabi, 1993. Ado-Ekiti Region. A Geographical Analysis and Master plan University Press, Ado-Ekiti 1st Edn., pp: 131.
5. Soil Survey Staff, 1990. Keys to soil Taxanomy SMS Tech. Monograph, No. 436.
6. FAO., 1990. Soil mapof the world. 1:5000000. Legend UNESCO, Parris, 1: 55.
7. Soil Survey Staff, 2003. Keys to Soil Taxanomy SMS Tech. Monograph (9th Edn.). Virginia. Virginia Polytechnic Institute State University, pp: 442.
8. Agboola and Corey, 1976. Nutrient deficiency survey of maize in western Nigeria. Nig. J. Sci., 10: 1-18.
9. Hardy, F., 1958. Soil condition and plant growth. In: Cocoa Growers Bulletin, 17: 27-30.
10. Smyth, A.J., 1966. Soils. In: Cocoa (3rd Edn.). Longmans green and Co. Ltd, London, pp: 34-47.
11. Murray, D.B., 1967. The Botany of cocoa. In. Cocoa (3rd Edn.). Longman, Green and Co. Ltd., London, pp: 7-18.
12. Omotoso, T.I., 1973. Factors guiding the determination of phosphorus fertilizer requirements of cocoa growing soils in western Nigeria. In CRIN Memo, 19: 4.

American-Eurasian J. Agric. & Environ. Sci., 2 (3): 318-320, 2007
ISSN 1818-6769

Susceptibility of Sweet Potato (*Ipomea batatas*) Varieties to Root Knot Nematode, *Meloidogyne Incognita*.

T.I. Olabiyi

Department of Agronomy, Faculty of Agricultural Sciences,
Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Nigeria

Abstract: Two field trials were carried out to assess the susceptibility of three local Nigerian varieties of sweet potato (white star, red nancy and puerto-rico) to root knot nematode, *Meloidogyne incognita*. Within the sweet potato rhizosphere, the population of root knot nematode, *Meloidogyne incognita* increased significantly. All the sweet potato varieties examined were moderately susceptible to root knot nematode infection. There were warty and knobbly symptoms and evidences of root knot nematode galls on the sweet potato tubers. Farmers are advised not to plant sweet potato in root knot nematode endemic areas and that it must not follow another crop that is known to be host of root knot nematode on crop rotational scheme.

Key words: Susceptibility % sweet potato % root knot nematode

INTRODUCTION

Sweet potato, *Ipomea batatas* (L) Lam belongs to the family convolulaceae. It is an important staple food crop providing essential minerals, vitamins and carbohydrate in the diet of many people in the tropical country [1]. Sweet potato is grown primarily for human consumption. Root tubers of sweet potato can be boiled, roasted, baked, fried or chopped into chips, dried and processed into flour [2].

Studies on the pathogenicity of nematodes on some tuber crops have been carried out [3-6]. Information on the effects of nematodes on sweet potato is very rare and scanty. This present research work therefore aimed at assessing the susceptibility of three local Nigerian varieties of sweet potato, which considered the most common sweet potato tuber in Nigerian markets, to the root knot nematode, *Meloidogyne incognita*.

MATERIALS AND METHODS

The experiment was conducted for two consecutive years (2004 and 2005) on the root knot nematode infested field. Root knot nematode galled roots obtained from stock culture of tomato were chopped into small pieces, about 5 cm each and used to inoculate the experimental field in order to augment the naturally infested root knot nematode on the field. Ten (10) kg galled roots were chopped and used for the inoculation of each plot with size 5×5 m. A day after field inoculation, stem cuttings of the local sweet potato varieties of average length of 15 cm were planted on the ridges, at a spacing of 1m (100 cm) within the rows. Varieties of sweet potato planted were red nancy, white star and puerto-rico. Allocation of the different sweet potato varieties into plots within the experimental field was by Randomized Complete Block Design. Each variety was replicated four times, thus there were twelve (12) plots, each was 5m X 5m size, within the experimental field with alleys of 2m wide left in-between plots.

Weeding was done twice at fourth and eighth weeks after planting. N:P:K (15:15:15) fertilizer was applied once at seventh week using band application method. Twenty (20) g of N:P:K fertilizer was applied to each sweet potato stand.

Soil samples (zigzag form) were collected from each plot at planting and harvesting. Root knot nematode was extracted from 200 ml soil sample using a standard technique of nematode assessment in the soil [7]. Root knot nematodes in each sample were counted under a stereoscopic microscope.

At maturity, 20 weeks after planting, tubers were harvested and were assessed for gall indices [8] on a scale

Corresponding Author: Dr. T.I. Olabiyi, Department of Agronomy, Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Nigeria

of 0-5, where 0 = 0 gall; 1 = 1-2 galls; 2 = 3-30 galls; 4 = 31-100 galls and 5 = more than 100 galls. Data were also measured on vine length and weight of tuber per plot.

Analysis of variance was carried out on the data and where necessary the means were partitioned using Duncan's Multiple Range Test.

RESULTS

Root knot nematode, *Meloidogyne incognita*, within the rhizosphere of sweet potato was shown in Table 1. No significant difference was observed between the plant parasitic root knot nematode populations at planting (initial population) in either year, but the populations of root knot nematode at harvesting period (final population) in 2004 and 2005 cropping years differed significantly. The tremendous increases in the population density of the root knot nematode might be due to conducive environmental factor and availability of suitable host.

$$*\text{Multiplication rate} = \frac{\text{Final Population}}{\text{Intial Population}}$$

Moreover, the result on Table 1 shows that sweet potato varieties are moderately susceptible to root knot nematode. Galls (warty and knobbly appearances) were observed on sweet potato tubers in either year. Thus, the sweet potato varieties examined were moderately susceptible to root knot nematode infection. It shows that sweet potato is a potential host of *Meloidogyne incognita*.

Effects of root knot nematode disease on the vine and yield of sweet potato was presented on Table 2.

Though no significant difference was observed on the vine length and yield of the three varieties of sweet potato, it is evident from the data obtained that root knot nematode reduces the vine length and yield of sweet potato.

The average yield in 2004 was higher than average yield in 2005. Therefore, if the farmer continuing the cultivation of sweet potato where there is occurrence of root knot nematode population build-up on yearly basis.

DISCUSSION

The tremendous increases in the population density of the root knot nematode during the course of this experiment might be due to favourable environmental factor and availability of suitable host. An average yield of 3,864 kg ha^{-1} (healthy sweet potato) as against average range of 1905 kg ha^{-1} - 2260 kg ha^{-1} (Table 2) obtained on root knot infested soil during the course of this experiment had been reported [1]. Crop loss due to plant parasitic nematode had been reported to range between 20-100% [10]. *Scutellonema bradys*, yam nematode, is responsible for heavy losses of yam in storage [9, 10]. All the sweet potato varieties examined were moderately susceptible to root knot nematode infection. There were warty and knobbly symptoms and evidences of root knot nematode galls on the sweet potato tubers.

Yield losses on specific crops attributable to root knot nematodes, *Meloidogyne* species, in Nigeria and nearby countries have been put at range between 10% and 100%. Parasitic nematodes have caused 100% losses in tomato, 20-50% in cowpeas, 25-40% in yam [11, 12].

Table 1: Severity of root knot nematode on sweet potato

	Meloidogyne incognita									
	Initial population		Final population		Multiplication rate*		Gall index		Degree of susceptibility	
Sweet potato varieties	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
Red Nancy	360	1074	1060	1807a	2.9	1.7	3.8	3.2	Moderately susceptible	Moderately susceptible
Puerto-rico	355	1080	1070	1904b	3.0	1.8	3.1	3.5	Moderately susceptible	Moderately susceptible
White star	361	1085	1268	1900b	3.5	1.75	3.7	3.4	Moderately susceptible	Moderately susceptible
	N.S	N.S	N.S							

Means followed by different letters in the same column are statistically different at P = 0.05

Table 2: Effect of root knot nematode *Meloidogyne incognita*, on vine length and yield of sweet potato.

	Mean vein length (cm)		Mean yield (kg haG¹)		
Sweet potato varieties	2004	2005	2004	2005	Mean yield of healthy sweet potato (kg haG¹)
Red Nancy	268.5	260	2260	2105	3860
Puerto-Rico	280.4	280	2250	1905	3868
White Star	170.14	171	1925	2050	3864

In conclusion therefore, sweet potato being a potential host of root knot nematode, the farmers should endeavour not to plant it on root knot nematode endemic field. Moreover, sweet potato should not follow another crop known to be susceptible to root knot nematode on crop rotational scheme.

REFERENCES

1. Onwueme, I.C., 1978. Tropical Root and Tuber crops. John Wiley and Sons Press, New York, USA., pp: 234.
2. Truong, V.D., 1986. Root Crop Processing Technology. Recent development. Radix, 8 : 9-4-16.
3. Caveness, F.E., 1977. Cassava seedling susceptibility and damage by root- knot nematodes. "In: Occasional Publication. Nigeria society for Plant Protection, No. 2: 7-9.
4. Adesiyan, S.O. and R.A. Odihirin, 1978. Root-knot nematode as pests of Yams (*Dioscorea* spp) in Nigeria. Nematological, 24: 133-134.
5. Atu, U.C., 1982. Population Studies, Pathogenicity and Control of Root-knot nematode, *Meloidogyne incognita* (Kofoid and White 1919) Chitwood 1949, on *Dioscorea rotundata* Poir, Ph.D. Thesis, University of Nigeria, Nsukka.
6. Nwauzor, E.C. and O.C. Nwankwo, 1989. Reaction of some Cassava cultivars / Lines to root-knot nematode, *Meloidogyne incognita*, race 2 Int. Nematol. Network News, 1.6: 40-42.
7. Southey, J.F., 1986. Laboratory Methods for work with Plant and Soil nematodes Min. Agric. Fish and Food. HMCo, London, pp: 202.
8. Taylor, A.L. and J.N. Sasser, 1978. Biology, identification and Control of Root-knot Nematode, *Meloidogyne* species. North Carolina State University Graphics. Raleigh, pp: 111.
9. Williams, T.D. and J. Bridge, 1983. Plant Parasitic Nematodes. In A Johnson and C. Booths (Eds.). Plant Pathologists pocket book, CAB Common Wealth Mycological Institute, pp: 225-249.
10. Adesiyan, S.O., F.E. Caveness, M.O. Adeniji and B. Fawole, 1990. Nematode pests of Tropical crops. Heinemann Educational Books (Nigeria) Ltd., pp: 19-25.
11. Nwauzor, E.C., 1979. Life cycle of the root-knot nematode *M. incognita* (Tremb) 1983, Chitwood, 1949, in tomato (Lycopersicon esculentus L.cv. Ife 7) and response of some tomato cultivars to population densities of *M. javanica*, M.Sc Dissertation, University of Ibadan, Ibadan, Nigeria.
12. Nwauzor, E.C., 1982. Identification, biology and control of root knot nematode (*Meloidogyne* species) in Eastern Nigeria Ph.D. Thesis, University of Ibadan, Ibadan, Nigeria, pp: 233.

INSTRUCTIONS TO AUTHOR

AIMS AND SCOPE

American-Eurasian Journal of Agricultural & Environmental Sciences (AEJAES) publishes original scientific work related to strategic and applied studies in all aspects of agricultural science, as well as reviews of scientific topics of current agricultural relevance. The papers, which are of international interest but feature a northern perspective, cover a wide range of topics in basic and applied research. The topics are agricultural economics, agricultural engineering, animal science, environmental science, food science, nutrition science, horticulture, and plant and soil science. Submissions are internationally refereed.

HOW TO SUBMIT

American-Eurasian Journal of Agricultural & Environmental Sciences welcomes contributions in the form of original research papers, review articles, technical reports and short communications in all aspects of Agriculture & Environmental Sciences. When a manuscript is submitted, it is assumed that the work has not been published elsewhere and that it is not simultaneously being submitted to another journal. If a manuscript is accepted, the authors will be requested to assign the copyright of the article to American-Eurasian Journal of Agricultural & Environmental Sciences.

ELECTRONIC SUBMISSIONS ARE ENCOURAGED

It is recommended to submit manuscript (MS Word file) through e-mail (idosi@idosi.org or idosi.editor@gmail.com) as an attachment for quick evaluation.

To facilitate editorial work, please keep the editorial office informed of any changes in your address, e-mail address and telephone number.

STYLE OF MANUSCRIPTS

Manuscripts should be written in clear, concise and grammatically correct English. Indent new paragraphs. The manuscript should be presented in the following order.

Headings: Headings should be upper case and in bold type. Sub-headings should be lower case and in italics.

Figures: Figures should be high-quality. A figure legend should be supplied. Color figures can only be accepted if the cost of reproduction is borne by the authors.

Tables: Number in order of mention in the text and Table should be in text form not show as an image.

References: Bibliographic references in the text appear like [1, 2, 5, 6], using square brace. References should be numbered consecutively in text.

REFERENCES

Journal Articles: Ouyang, D., J. Bartholic and J. Selegean, 2005. Assessing Sediment Loading from Agricultural Croplands in the Great Lakes Basin. Journal of American Science, 1(2): 14-21.

A Book: Durbin, R., S.R. Eddy, A. Krogh and G. Mitchison, 1999. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press.

A Chapter in a Book: Leach, J., 1993. Impacts of the zebra mussel (*Dreissena polymorpha*) on water quality and fish spawning reefs of Western Lake Erie. In Zebra mussels: biology, impacts and control, Eds., Nalepa, T. and D. Schloesser. Ann Arbor, MI: Lewis Publishers, pp: 381-397.

A Report: Makarewicz, J.C., T. Lewis and P. Bertram, 1995. *Epilimnetic phytoplankton* and zooplankton biomass and species composition in Lake Michigan, 1983-1992. U.S. EPA Great Lakes National Program, Chicago, IL. EPA 905-R-95-009.

Conference Proceedings: Stock, A., 2004. Signal Transduction in Bacteria. In the Proceedings of the 2004 Markey Scholars Conference, pp: 80-89.

A Thesis: Strunk, J.L., 1991. The extraction of mercury from sediment and the geochemical partitioning of mercury in sediments from Lake Superior, M. S. thesis, Michigan State Univ., East Lansing, MI.

ABBREVIATIONS, UNITS ETC.

Authors should follow internationally agreed rules especially those adopted by the IUPAC-IUB Commission on Biochemical Nomenclature (CBN). The journal will essentially follow the rules defined in the IUPAC Manual of symbols and terminology for physico-chemical quantities and units (Butterworths, London), 1970.

COPYRIGHT AND PERMISSIONS

By submitting a manuscript to the editor or publisher you are deemed to have granted permission to publish the manuscript.

PROOFS

Proofs will be sent via e-mail as an Acrobat PDF (Portable Document Format) file. Acrobat Reader will be required in order to read the PDF. This software can be downloaded from the following website:

http://www.adobe.com/products/acrobat/readstep2.html

This will enable the file to be opened, read on screen and printed out in order for any corrections to be added.

PRINTING / PROCESSING / DELIVERY COST

For single article up to to 6 final pages will be US 95 $. After that IDOSI will charge extra for each single page.

The publishing contents for author contains:
1 Journal Copy + 05 off prints + Online

AUTHORSHIP

For papers to be published in American-Eurasian Journal of Agricultural & Environmental Sciences each author should have participated sufficiently in the work to take public responsibility for the content. (This statement is taken from the authorship policy adopted by the International Committee of Medical Journal Editors and published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals, 1994 and N Engl J Med 336: 309-315,1997.)

CORRECTIONS TO PUBLISHED ARTICLES

If necessary, corrections of significant errors in published articles will be published in a later issue of the Journal. Within two months after publication, authors are requested to bring any errors to the attention of the managing editor.

METHODS OF PAYMENT

Procedure 1: You can send money through Western Union with receiver name **Muhammad Zeeshan**. (After send please inform through E-mail about Money Transfer Control Number (MTCN))

Procedure 2: IDOSI also receive Printing / Processing / Delivery charges through Bank Draft in favor of **IDOSI Publications** and send it to our postal address :

IDOSI Publications
P-100, St. # 7, Sohailabad,
Peoples Colony # 2, Faisalabad, Pakistan

Procedure 3: Our Bank Route for F.T.T Payment into Our Account.

US $ Route:

Receiver's Correspondent:

SWIFT: MRMDUS33
HSBC Bank, NY, USA

Account with Inst-Name & Address:

SWIFT: MEZNPKKA
Meezan Bank Ltd., Karachi, Pakistan

Beneficiary Customer-Name & Address:

Account No: 0401-020-0000-2227
IDOSI Publications
Serena Hotel Branch,
Branch Code: 0401
Faisalabad, Pakistan