American-Eurasian J. Agric. & Environ. Sci., 2 (4): 335-340, 2007
ISSN 1818-6769

Influence of *Tithonia diversifolia* Leaf Mulch and Fertilizer Application on the Growth and Yield of Potted Tomato Plants

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Abstract: The influence of Tithonia (*Tithonia diversifolia* A. Gray) leaf mulch and fertilizer application on the growth and yield of tomato seedling (*Lycopersicum esculentum* Mill.) was studied in a pot experiment. The *Tithonia* mulch and fertilizer (viz., N:P:K @ 15:15:15) application arranged in factorial combination to give four treatments. The growth and development of the tomato plants within each treatment were monitored over six weeks. Mulching with *Tithonia diversifolia* leaves and fertilizer application together promoted growth and development i.e. number of nodes, number of leaves and height, as well as fruit production i.e. number of fruits, number of seeds per fruit, fruit size, fruit shape and duration of fruiting activity more than all other treatment combinations. Tomato plants grown on soil without mulch and fertilizer gave the lowest growth and yield response. The uniqueness of *Tithonia* leaf mulch as a source of added nutrient supply to tomato plant and its antagonism to soil organisms (pests and pathogens) being the probable reason for its positive influence on tomato growth and development is discussed.

Key words: *Tithonia diversifolia* · mulch · NPK fertilizer · tomato · blossom end shapes

INTRODUCTION

Tomato (*Lycopersicum esculentum* Mill.) has its origin in Central America. It was domesticated in Mexico and from where it spread to the rest of the world [1]. Tomato is a seasonal; weak stemmed climbing plant of the family solanaceae. Tomatoes are warm season plants and they grow best in well-drained, fertile soil with good moisture retention capacity and having a relatively high level of organic matter. Tomato plants possess both of horticultural and agricultural importance. Though extensively cultivated as a salad vegetable, it is also grown on extensive areas for the production of soup, juice and canned tomatoes [2]. The commonly cultivated varieties in south-western Nigeria are Ibadan local and Roma.

In Nigeria, the fruits are frequently ground and used as condiments in soups and local dishes such as muke and moinmoin. As a result of import restrictions imposed in 1969 on foreign canned tomatoes and their consequent high prices, tomato cultivation increased and the price of fresh tomatoes rose up sharply. A blend of tomatoes and hot peppers had since been canned in Nigeria and marketed under the name tomapep.

In spite of the great achievements in tomato breeding, most of the existing genetic variability among and within *Lycopersicum* spp as reported by Reid [3] is still under-exploited by tomato breeders and its more intensive utilization may allow new objectives to be reached in the future. The fruit, a berry varies considerately in size, shape, fleshiness of the mesocarp and number of seeds per fruit. The potential for extending the duration of fruiting period in order to improve yield output lies generally on genetic quality of plant but most importantly on soil conditions as early growth termination in tomato is often caused by soil nutrient depletion and root infection resulting from build up of soil pathogens.

Fertilizer is any material used on the soil to increase soil fertility. It may be chemical i.e. inorganic compound or single chemical fertilizer, or organic i.e. fertilizer that can be derived from organic matter such as animal waste or plant material e.g. green manure. Examples of chemical fertilizers include sulphate fertilizer, compound fertilizer (NPK) and ammonia fertilizer.

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Mulch is a layer of material on the surface of the soil used to keep soil moist or to serve a wide variety of other purposes [4]. Organic mulches are those derived from dead plant and animal tissues, which apart from soil protection also serve as nutrient sources when they decay. Fertilizer application is more effective when applied to mulched soil than bare soil. According to Dupriez and De-Leener [5] when soil-feeding crops is rich in organic nutrients such as those derived from mulch; cultivated plants are often hardier and healthier than when nutrients come to them straight from factory made minerals. Recently, Osundina and Liasu [6] had found that soils supplemented with organic fertilizer in combination with mycorrhizae inoculation promoted growth and development of tomato better than inoculated soils combined with chemically derived fertilizers. *Tithonia diversifolia* originated in Mexico, but is now widely distributed throughout the humid and sub-humid tropics in Central and South America, Asia and Africa. Evidence suggests that *Tithonia* has been used for a wide variety of purposes. These include fodder, poultry feed, fuel, compost, land demarcation, soil erosion control, building materials and shelter for poultry [7]. The use of *Tithonia* as an effective source of biomass for annual crops has also been reported for rice [8]. But it has been more recently reported as a nutrient source for maize in Kenya, Malawi and Zimbabwe [9]. *Tithonia diversifolia* is typically found in hedges, or as small areas of pure stands in an on-farm context, although it may also extend for large areas in pure stands on common land in less populated areas, for example in the Busia District of western Kenya. Finally, stems and leaves of *Tithonia* has been reported to contain sesquiterpene lactones e.g. tagitinins (terpene) that prevent attack by termites [10, 11] and possess antimicrobial properties. The problem with mulch as source of nutrient is the low output of minerals e.g. P and N which can be alleviated by supplementing mulch from natural sources with a small dose of fertilizer.

Not much has been documented on the effect of leaf mulch in interaction with chemical fertilizer on the growth and yield of tomato. It is believed however [4] that mulch can modify the nutrient dynamics of fertilizer to enable plant derive maximum benefits from it.

MATERIALS AND METHODS

Seed collection: Tomato seeds (*Lycopersicum esculentum*) Ibadan local variety were collected on request from National Institute For Horticultural Research (NIHORT), Ibadan, Oyo State.

Soil collection: Good (i.e. loamy) top soil from the back of the Faculty of Pure & Applied Biology was scrapped with hoe and used to fill twenty four planting bags, meant to be used later for planting. The planting bags were perforated at the bottom (about eight small holes) to permit drainage of excess water and guide against the soil being water-logged.

Preparation of nursery: Two nursery boxes constructed with planks were made at the back of the faculty and filled with the soil after which the tomato seeds were broadcasted evenly on the soil. The soil within the nursery boxes was watered before and after planting of the seed. Wetting of the nursery continued twice every day (i.e. very early in the morning before sunrise and late in the evening after sunset.

Transplanting: The tomato seedlings were allowed to grow for three weeks after which they were transplanted. Prior to transplanting, all the planting bags were filled with moistened top soil and the seedling transplanted in the evening in order to give the seedlings enough time to get acclimatized to their new environment before sunrise thus safeguarding them from transplantation shock. After establishment, the tomato seedlings in each bag were thinned to one per pot.

Fertilizer application: Twenty grams of compound (Nitrogen, Phosphorus and potassium) N:P:K @ 15:15:15 fertilizer was ring applied to twelve out of the twenty-four pots. The fertilizer was applied to the tomato plant by making node around the stem and sprinkling it along the circle already marked out and later covering it with soil. Fertilizer was applied twice in the life of the tomato plants. The first one was before bud formation and the second application was just at the beginning of flower set.

Mulching: Wild sunflower (*Tithonia diversifolia*) plant leaves were collected from a nearby hedge containing pure stands and the leaves equivalent to 0.5 tones ha^{-1} were applied to cover the soil of each potted tomato plant as mulch. Six bags from each of fertilized and unfertilized soils were subjected to mulching leading to the establishment of six replicates of four treatments namely; fertilized mulched, fertilized unmulched, unferltized mulched and unfertilized unmulched. The tomato plants within the four fertilizers and mulch treatments were allowed to grow for twelve weeks and growth and development monitored starting from the first week after transplantation.

Data collection: The following plant growth parameters were measured at weekly intervals in plants within all replicates of the four treatments beginning from day of transplanting: Plant height using a meter rule, number of nodes and leaves plant^{-1} were measured every week after transplantation for six weeks. The means of six replicates were computed for the data generated at each week and plotted graphically against week after transplanting. Fruit yield parameters such as fruit size, shape were recorded pictorially using a Yashica camera. The mean number of fruits plant^{-1} and the average number of seeds fruit^{-1} were determined by direct counting every week beginning from the end of the week after first ripe fruit production. Fresh weights of ripe fruits harvested at the end of each week were measured using a spring balance. At the end of the experiment the weekly fruit harvests were bulked and the mean of total fresh weight yields of each of the six replicates of each treatment were determined. Standard error of means were calculated for each treatment mean (generated from six replicates) and used to separate the mean values of one treatment from the other.

RESULTS

Tomato plants subjected to mulching and fertilization exhibited the highest plant height when compared with the other treatment combinations. Weekly increases in plant height of mulched unfertilized, unmulched fertilized and mulched unfertilized tomato were comparable (Fig. 1).

Similarly (Fig. 2), the tomato plants subjected to mulching and fertilizer application exhibited the highest number of leaves plant^{-1} than all the other plants subjected to the remaining mulch and fertilized treatments. Similar trends were observed in the weekly increases in number of nodes with tomato plants growing in mulched and fertilized soils producing more nodes plant^{-1} than the other remaining combinations. The number of nodes plant^{-1} increased sharply in the first week after planting up to the 3rd week and more gently after the 3rd week up to 6th week when the experiment stopped. Mulching irrespective of fertilizer application promoted increase in number of nodes (Fig. 3).

The number of fruits produced during the first week of fruit production was highest in mulched and fertilized tomato plants with a mean of 18 fruits plant^{-1} followed by those growing in unmulched and fertilized soils with a mean of 12 fruits plant^{-1}. In mulched but unfertilized tomato plants the mean number of the fruit is 8 while in

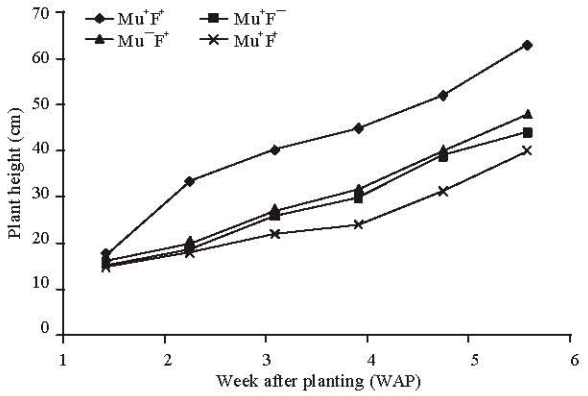

Fig. 1: The effect of *Tithonia diversifolia* leaf mulch and fertilizer (NPK) application on weekly increase in height of potted tomato plants

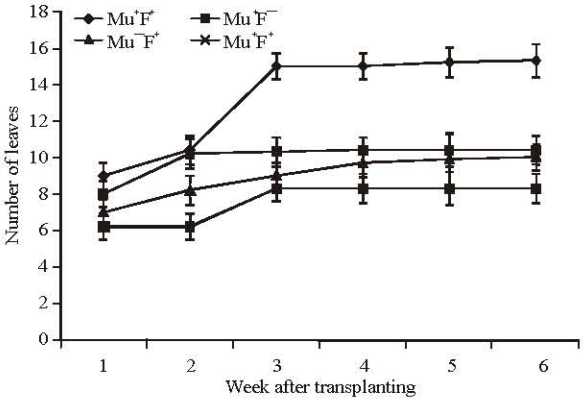

Fig. 2: Effect of *Tithonia diversifolia* leaf mulch and fertilizer (NPK) application on weekly increase in number of leaves of potted tomato plants

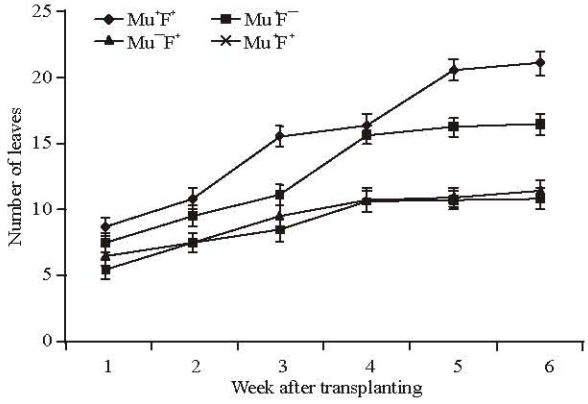

Fig. 3: Effect of *Tithonia diversifolia* leaf mulch and fertilizer (NPK) application on number of nodes

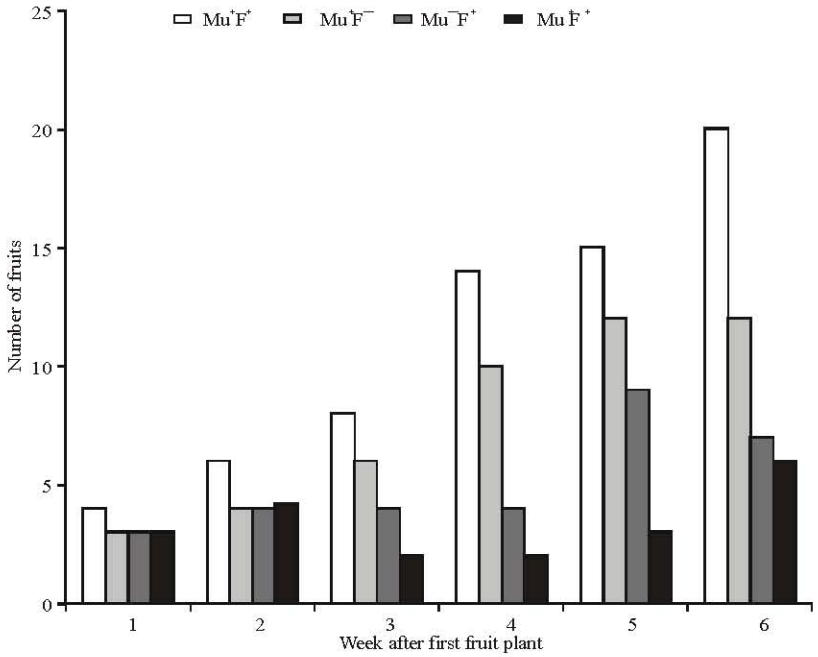

Fig. 4: Effect of *Tithonia diversifolia* leaf mulch and fertilizer (NPK) on the weekly harvests for fruit at different weeks after first fruit production $Mu^+ F^+$ Mulched and fertilized, $Mu^- F^+$ Unmulched Fertilized, $Mu^+ F^-$ Mulched, Unfertilized, $Mu^- F^-$ Unmulched, unfertilized

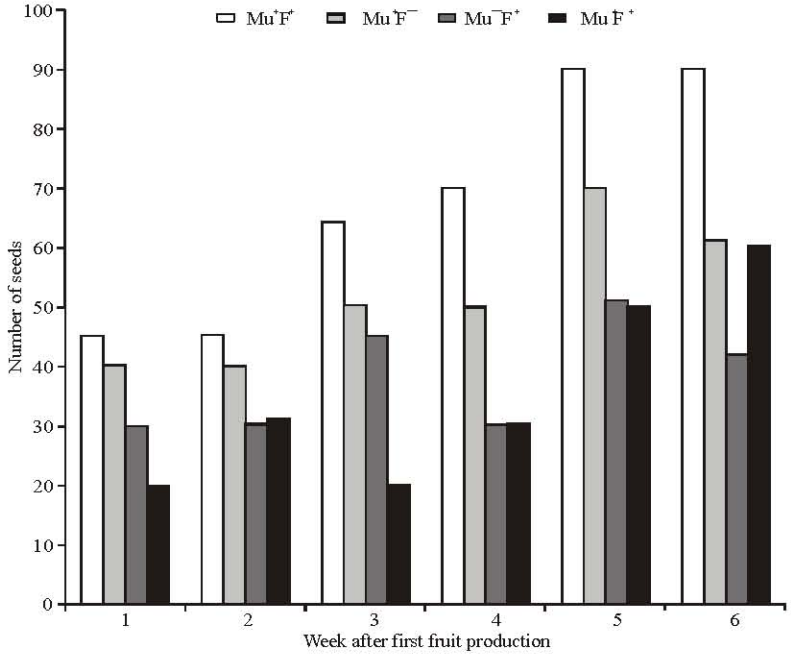

Fig. 5: Effect of *Tithonia diversifolia* leaf mulch and fertilizer (NPK) on number of seeds per fruits at different weeks after first fruit production $Mu^+ F^+$ Mulched and fertilized, $Mu^- F^+$ Unmulched Fertilized, $Mu^+ F^-$ Mulched, Unfertilized, $Mu^- F^-$ Unmulched, unfertilized

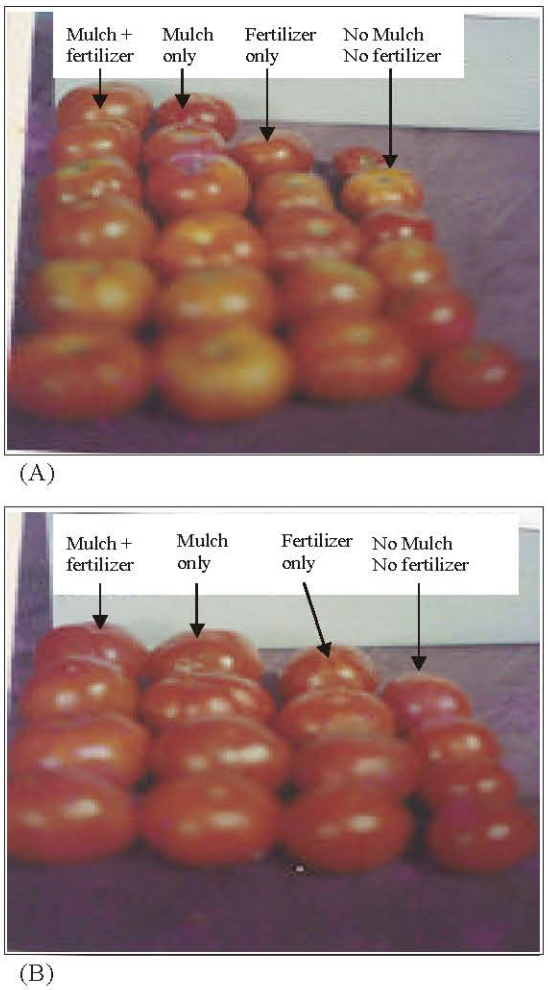

Fig. 6: Variation in (A) blossom end shapes and (B) fruits sizes of Tomato as affected by mulching and fertilizer application

unmulched and unfertilized tomato plants, the mean number of the fruits is 6. The number of fruits plant^{-1} continued to increase in the subsequent weeks until the end of the experiment. In unmulched and fertilized tomato plants, the number of fruits produced stabilized by the 5th week after first fruit production. In mulched and unfertilized tomato plants, number of fruit plant^{-1} stagnated in the 2nd, 3rd and 4th week but increased sharply by the 5th and stagnated in the 6th week (Fig. 4).

In unmulched and unfertilized tomato plants, fruiting activity was initially low as the number of fruits produced was only substantial in the 6th week after first fruit production.

The number of seeds produced fruit^{-1} in the first week of fruit production (Fig. 5) was highest in mulched and fertilized tomato plants i.e. the mean number of seeds fruit^{-1} was 90 in mulched and fertilized tomato plant while in unmulched and fertilized tomato plant, it was 70. In mulched and unfertilized tomato plants, the mean number of seed fruit^{-1} was 60 while in the unmulched and fertilized plants; the mean number of seed fruit^{-1} is 50.

In mulched and fertilized tomato plants, the number of seeds produced fruit^{-1} stabilized by the 5th week after first fruit production before declining by the 6th week. The pattern of weekly variations in seed production fruit^{-1} was such that in unmulched and fertilized tomato plant, the number of seed produced fruit^{-1} during the 1st, 2nd, 3rd and 4th week but increased sharply by the 5th week before declining in the 6th week.

In unmulched and fertilized tomato plants, the number of seeds fruit^{-1} increased during the 1st and 2nd week followed by a decline during the 3rd week but later increased sharply by the 5th and 6th week after the first fruit production.

Tomato plants growing in mulched and fertilized soils had the biggest sizes of fruits each with round blossom end shape while those growing in unmulched and fertilized soils had moderately sized fruits though not as big as that of mulched fertilized tomato plants. They also had round blossom end shape. Unmulched and unfertilized tomato plants had fruits with the smallest sizes and shapes (Fig. 6).

DISCUSSION

Mulch and fertilizer had complementary effect on nutrient availability to plants, because mulch when it decomposes releases nutrients and organic matter (humus) which when supplied into the soil, increase the growth of the plants. Osundina and Liasu [6] made similar observations when tomato growth response to mycorrhizal inoculation in soils amended with organic matter was compared those in soils amended with chemical (inorganic) fertilizers. Humus increase nutrient retention capacity of the soil, by increasing effective cation exchange capacity [4]. Also, the fact that mulch covers the soil thereby (i) reducing the rate removal of water from the soil surface to the atmosphere i.e. evaporation, (ii) protect the soil and its organic content from direct contact with warm air thus increasing soil microbial activity consequently encouraging decomposition is probably the reason for the high growth and yield from tomatoes grown in mulched soils. Furthermore, the application of NPK fertilizer to the tomato plant supplements the nutrient content of the soil

by making available essential elements required for improved nutrition and healthy growth of the plant.

Fertilizer and mulch together not only promoted growth and yield of tomato better than fertilizer or mulch only but also improved fruit shapes (i.e. with round blossom end shapes), fruit number and number of seeds fruit^{-1} probably because the nature of the *Tithonia* mulch does not predispose the tomato plant to attack by soil pathogens. Generally, tomato fruit quality and particularly, rounded blossom end shapes are to a large extent determined by calcium and adequate moisture supply to the plant. *Tithonia* mulch apart from being rich in nutrients including calcium, nitrogen and phosphorus can also increase the soils moisture retaining capacity [6, 9, 12]. In general, the cover of mulch creates a favorable microclimate for the activities of soil microorganisms, which help to improve and maintain the biological and physicochemical qualities of the soil thereby improving the growth performance of tomato. That fruiting activities last much longer in plant grown in mulched and fertilized soils than other soil treatments could be attributed to the fact that cessation of growth in field grown tomatoes often result from accumulation of pest and pathogens e.g. termites, bacteria, fungi and nematodes which invade the roots and spread through the plant body causing diseases and symptoms that are terminal. Such diseases also affect fruit quality flower initiation and fruit formation leading to premature termination of fruiting and even death. *Tithonia* has been shown to contain substances that prevent infestation of termites [10, 11] and possess antibiotic qualities. The implication of this unique quality of *Tithonia* mulch is its potential of extending the lifespan of tomato plants on the field, promoting fruit production at the same time consequently increasing farmer's output.

CONCLUSIONS

Addition of mulch and NPK fertilizer to the plants has produced better and healthier growth of tomato and subsequently produced high yield. This can be attributed to the addition of nutrients derived from mulching, i.e. the organic matter and probably phyto-chemicals from the leaves of *Tithonia diversifolia* added to the soil. The phyto-chemicals may play important role in the control of termite infestations and suppression of soil pathogens. Also the combination of mulch with N:P:K @ 15:15:15 provided additional nutrient and the humic materials from decaying mulch increased the nutrient retention capacity of the soil thereby providing sustained source of macro and micro nutrients to the tomato plants [11, 12]. Finally mulch from *Tithonia* has the potential of prolonging the physiologically active lifespan of tomato including the duration of fruit-production.

REFERENCES

1. Onwueme, I.C. and J. Sinha, 1991. Field Crop Production in Tropical Africa: Principles and Practice. C.T.A. Ed. Netherlands, pp: 233-249.
2. Stevens, M.A., A.A. Kadar and M. Albright-Holton, 1997. Intercultivar variation in composition of locular and pericarp portions of fresh market tomatoes. J. Am. Soc. Hortic. Sci., 102: 689-629.
3. Reid, J.B. and M.J. Goss, 1981. Effect of living root of different plant species on the aggregate stability of two arable soils. J. Soil Sci., 31: 521-511.
4. Muller-Samann, K.M. and J. Kotschi, 1994. Sustaining Growth: Soil Fertility Management in Tropical Smallholdings. Magraf. Verlag. Weikersheim.
5. Dupriez, J. and P. De-Leener, 1989. Land and Life: African Gardens and Orchards-Growing vegetables and fruits. C.T.A. Terres and MacMillan. Netherlands.
6. Osundina, M.A. and M.O. Liasu, 1996. Responses of tomato (*Lycopersicum esculentum* Mill.) to vesicular arbuscular mycorrhizal inoculation in soils subjected to chemical and organic fertilization. Biosci. Res. Commun., 6: 181-189.
7. Liasu, M.O. and M.O. Atayese, 1999. Phenological changes in *Tithonia diversifolia* community and its potential for soil conservation. Nig. J. Weed Sci., 12: 35-44.
8. Nagaraj, S. and B.M. Nizar, 1982. Wild sunflower as a green manure for rice in the mid country west zone. Trop. Agric., 138: 69-78.
9. Jama, B.A., C.A. Palm, R.J. Buresh, A.I. Niang, C. Gachengo, G. Nziguheba and B. Amadalo, 2000. *Tithonia diversifolia* as a green manure for soil fertility improvement in Western Kenya: A Review. Agroforestry Systems, 49: 201-221.
10. Adoyo, F., J.B. Mukalama and M. Enyola, 1997. Using Tithonia concoctions for termite control in Busia district. Kenya. ILEIA Newsletter, 13: 24.
11. Wanjau, S., J. Mukalama and R. Thijssen, 1997. Harvesting free fertilizer. In ILEIA Newsletter, Vol: 13.
12. Atayese, M.O. and M.O. Liasu, 2001. Arbuscular mycorrhizal fungi, weeds and earthworm interactions in the restoration of soil fertility the guinea savannah region of Nigeria. Moor J. Agric. Res., 2: 103-109.