World Applied Sciences Journal 31 (10): 1715-1721, 2014
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2014.31.10.307

Influence of Biofertilizer Mixed Flower Waste Vermicompost on the Growth, Yield and Quality of Groundnut (*Arachis hypogea)*

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Abstract: This present study evaluates the growth, yield and quality of Groundnut (*Arachis hypogea*) by flower waste compost (E1), Flower waste vermicompost (E2), vermicompost enriched with biofertilizers such as Azospirillum (E3), phosphate solubilizing bacteria (E4), blue green algae (E5) and rhizobium (E6) compared with commercial NPK fertilizers (E7) and control (CO). The aim of this study to assess the effect of vermicompost, integrated with vermicompost enriched with biofertilizers for growth, yield and quality of groundnut. All the experimental groundnut plants showed significant morphological growth rate RL, TL, Fwt-R, Dwt-R, RN ($p<0.05$) than E7 and CO however SL, Fwt-S, LAI not showed significant difference ($p>0.05$). In all the experimental plants (E1-E6) leaves pigment concentration increases and boost up the yield parameters such as PP, SW and also increases the Oil content significantly at $p<0.05$. A highest Harvest Index (HI) was recorded in E6 followed by E3 and other vermicompost treated plants than E7 and CO. From the above results it was clearly observed that vermicompost (E2) and biofertilizer enriched vermicompost (E3-E6) shows maximum growth rate and yield than the E7 and CO. The organic fractions of flower waste vermicompost and microorganisms in the biofertilizers could be an alternative to chemical fertilizers to improving the growth and yield of groundnut.

Key words: *Vermicompost · Biofertilizers · Groundnut · Red soil*

INTRODUCTION

Organic vegetable cultivation gets a special attention due to its bio-efficacy, sustainability and eco-friendly. Application of vermicompost as an organic source is an ideal for soil and crop management. India is one of the leading countries where vermicompost is widely applied by the farming community. Use of organic amendments (such as vermicompost) has been found effective for improving soil aggregation, structure, and fertility, increasing soil microbial diversity, populations and enzymes, improving moisture-holding capacity of soils, increasing cation-exchange capacity (CEC) and finally also crop yields [1].

Considering these, the study of nutrient management on cabbage was conducted. Groundnut (*Arachis hypogea L.*) is an important oilseed, grown approximately 24 million ha throughout the world [2]. It is a valuable cash crop planted by millions of small farmers because of its economic and nutritional value. Its kernels are rich source of edible oil (43.55%) and protein (25.28%). About two third of world production is crushed for oil and remaining one third is consumed as food [3]. Groundnut cakes obtained after oil extraction is a high protein animal feed. China, India, United States, Nigeria, Indonesia, Burma and Senegal are the major producers of groundnut. Asia with 63.4 % area produces 71.7 % of world groundnut production followed by Africa. In India, it is

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cultivated on 6.79 million ha with a production of 7.1 million tons and a productivity of 1046 kg per ha. India ranks second in the world groundnut production [4].

Nitrogen has a critical role in producing agricultural products and selecting the amount of nitrogen-containing fertilizers are necessary for having the highest production level. Adsorption of adequate amounts of nitrogen by a plant leads to more protein content and larger cereal and legume seeds. Maintenance of sufficient levels of organic matter in soils is prerequisite for sustainable and high production of crops [5]. Recent studies showed that inoculation with an effective Rhizobium strain increased the yield as well as oil content of groundnut cultivar [6]. Thus inoculation helps to meet the additional nitrogen demand of the plant, by increasing nodulation, so enable to realize the yield potential of the plant. Phosphorus has a role in nodulation of legume crops. A considerable amount of phosphorus, which is present in the soil or applied to the soil become easily unavailable, PSB can make this unavailable phosphorus available-to-plant and thus indirectly influences nodulation, growth and yield of groundnut [6]. Iron (Fe) in the vermicompost play a significant role in growth processes including the synthesis of chlorophyll, energy transfer, respiration and photosynthesis processes, nitrogen fixation [7]. Deficiency of Fe in Leguminosae family is effective in nitrogen fixation and causes the number of pods in the shrub and the seed yield to decrease [8]. Iron deficiency leads to yellow color between leaf veins which could result in the necrosis of all these leaves [9].

In the present study, we evaluate the growth and yield performance of Ground nut (*Arachis hypogea*) by flower waste compost (E1), Flower waste vermicompost (E2), vermicompost enriched with biofertilizers such as Azospirillum (E3), phosphate solublizing bacteria (E4), blue green algae (E5) and rhizobium (E6) compared with commercial NPK fertilizers (E7) and a control (Co). The objective of this present study to compare the nutrient present in flower waste vermicompost inoculated with biofertilizers (Azospirillum, PSB, BGA and Rhizobium), inorganic fertilizers and a control on growth, yield and chemical composition of ground nut cultivated in the greenhouse.

MATERIALS AND METHODS

Experimental Description: A pot culture experiment was conducted in the greenhouse using flower waste vermicompost, vermicompost enriched with biofertilizers and chemical fertilizers (NPK). Biofertilizers such as Azospirillum, PSB, BGA and Rhizobium were added 1gm/1kg of vermicompost. Red soil was collected from agricultural lands sieved and packed (10 kg/pot) in black plastic bags with 40 cm in diameter and 40 cm in depth. The experiment was conducted in a complete randomized block design with 3 replicates included 1 control and 7 treatments, as follows:

Co- Control (Red soil alone).

- E1- Red soil + Control compost (Flower waste+ Cow dung)
- E2-Red soil + Vermicompost (Flower waste+ Cow dung)
- E3-Red soil + Vermicompost (Flower waste+ Cow dung+ Azospirillum)
- E4- Red soil + Vermicompost (Flower waste+ Cow dung+ PSB)
- E5- Red soil + Vermicompost (Flower waste+ Cow dung+ BGA)
- E6- Red soil + Vermicompost (Flower waste+ Cow dung+ Rhizobium)
- E7-Red soil + Recommended Dose of Fertilizers (RDF) - NPK

The experiment was conducted in the greenhouse for 110 days (28.08.2007 to 18.12.2007). Ground nut seed (*Arachis hypogea L.)* TMV-1 was soaked in water for one day and kept in a dark place for 4 days 92% of germination was recorded. Five germinated seeds were sown in each plastic pot (10kg) and then thinned to two after 20 days. Application of manure (40%) to the experimental plants was done at the time of sowing and flowering with the proper level of eventual irrigation. The chemical analysis of control compost, vermicompost, vermicompost enriched with biofertilizers and Chemical fertilizers were given in Table 1.

Plant Analysis: The ground nut growth parameters such as shoot length (SL), root length (RL), total length (TL), fresh weight of shoot (Fwt S), root (Fwt R) and total plant (Fwt TP), dry weight of shoot (Dwt S), root (Dwt R) and total plant (Dwt TP), No of root nodules (RN), No of pods per plant (PP), 100 seed weight (SW), Leaf area index (LAI), Chlorophyll a, b and total and biochemical parameters such as carbohydrate (%), protein (%) and oil content (%) were analyzed. Leaf area index (LAI) is the ratio of leaf area per plant to the land area occupied by the plant and was calculated by using the formula as suggested by [10].

Table 1: Chemical analysis of Control compost, Vermicompost and Biofertilizer enriched vermicompost

Organic manures	pH	OC%	N%	P%	K%	C:N	Fe (ppm)	Zn
Control compost - E1	7.4±0.34	28.42±1.22	1.9±0.52	14.8±2.0	7.4±0.34	28.42±1.22	1501±12.36	53±2.23
Vermicompost - E2	6.9±1.0	28.42±4.38	2.03±0.97	13.0±1.0	6.9±1.0	28.42±4.38	1887±8.26	51.11±4.16
Vermi + Azo - E3	7.2±0.2	29.58±0.68	2.29±0.91	12.92±1.0	7.2±0.2	29.58±0.68	1874±5.16	47±3.89
Vermi+PB - E4	6.86±1.33	27.29±3.19	2.2±1.0	12.39±0.05	6.86±1.33	27.29±3.19	1817±9.13	43.33±4.12
Vermi+BGA - E5	7.2±1.31	25.68±0.91	2.25±0.85	11.86±4.1	7.2±1.31	25.68±0.91	1847±7.31	40±3.15
Vermi+Rhizo - E6	7.06±0.06	26.06±1.0	2.29±1.19	11.39±0.1	7.06±0.06	26.06±1.0	1873±8.06	32.3±3.25

$$\text{LAI} = \frac{\text{Leaf area per plant (dm}^2\text{)}}{\text{Land area occupied by a plant (dm}^2\text{)}}$$

Harvest Index (HI) was calculated by seed weight divided by total plant weight

$$\text{Harvest index (\%)} = \frac{\text{Seed weight (g)}}{\text{Total plant weight (g)}}$$

Chlorophyll a, b and total chlorophyll analyze following the procedure of [11]. Protein, Carbohydrate and Oil content were determined in the seeds according to [12].

Statistical Analysis: The results were analyzed by using analysis of variance (ANOVA) and the group means were compared by Duncan's Multiple Range Test. Values are considered statistically significant when $p<0.05$.

RESULTS AND DISCUSSION

The results of ground nut plant growth parameters were presented in the Table 2. The growth parameters such as RL, TL, Fwt-R, Dwt-S and Dwt-R, RN, SW, PP were statistically significant at $p<0.05$ level. Plants fertilized with vermicompost have shown greater ability to assimilate essential macro and micro nutrients and resulted in the improved root development [13-15]. These results in an increased efficiency of the rooting system which in turn improves upper growth; including the shoots, leaves, flowers and fruit [16]. The maximum overall growth and yield record of the vermicompost treatment and admixed with biofertilizers were confirming the earlier findings of [17]. Vermicompost has a potential for improving plant growth and dry matter yield when added to the soil [18, 19]. Karmegam *et al.* [20] and Karmegam and Daniel [21] showed that the fresh and dry matter yields of cowpea (*Vigna unguiculata* L.) were greater when soil was amended with vermicompost. Vermicompost and vermicompost in combination with biofertilizer indicates the vital role of bio-organic fertilization which releases more of available nutrient elements to be absorbed by plant roots and this in turn increase dry matter content in the different peanut plant organs (Saber and Kabesh, [22]on lentil; Ahiabor and Hirata, [23] on peanut). Shaheen and Rahmatullah [24] and Basu *et al.* [25, 26] also observed the positive effect of Rhizobium inoculation on the shoot length, no of branches per plant, LAI and DM accumulation of groundnut plant. The increased growth and yield in all vermicompost (E1- E6) has more Fe content than C and E7. Higher iron content increased fertile flowers which resulted in more pod yield, increased number of mature pods and pod weight than the C and E7. Lachover et al.[27] reported that using 10kg/ha iron in a loam-clay soil with a 15% calcium carbonate content increased pod yield up to 50%. Panjtandoust [28] studied different amounts of iron fertilizer used in two spraying and in the soil methods and observed that using this fertilizer in both methods affected the peanut seed yield. The increased number of root nodules may be in the presence of high levels of P in the treated soil and biofertilizers particularly PSB (E4) and Rhizobium (E6) which are indirectly influenced on nodulation, growth and yield of groundnut [6]. Dubey [29] was observed in soybean that farmyard manure and biofertilizer increased the total number of root nodules per plant. In mung bean the total number of root nodules increased with organic manure [30] and in green gram with vermicompost [31]. The highest number of pod yield was also observed in biofertilizer enriched vermicompost treatment plants (E3, E4 and E6).

Leaf pigments such as chlorophyll a, b and total chlorophyll were statistically significant at $p<0.05$ level. Tanaka *et al* [32] stated that vermicompost has readily available nutrients such as N, P, K, Ca, Mg, Fe, Cu and Zn which are used for the formation of chlorophyll which is required for light harvesting and subsequent conversion into chemical energy via photo-assimilation. Nitrogen plays a significant role in photosynthesis, cell division and differentiation, growth and somatic embryogenesis, chlorophyll (Chl) content, rubisco activity, electron transport rate, photosynthetic rate, anthocyanin production and is an important component of proteins required for the metabolic processes that take place during plant growth [33]. Phosphorous improves leaf expansion, auxillary bud growth and shoot canopy, improved photosynthetic surface area and carbohydrate utilization [34]. Zinc increases the chlorophyll content in the leaves, the number of nodules and pod yield [35]. Tejada *et al*. [1] reported that significant increase in yield, fruit quality of tomatoes was attributed to improved uptake of N, P and K from vermicompost as well as increased chlorophyll production in leaves. A significant increase in the ratio of chlorophyll a and b was observed by Baldatto *et al.* [36] when applying of vermicompost to pineapple (*Ananas comosus*) relative to the control. All of the biochemical processes of photosynthesis depend on nitrogenous compounds which provide the basis for all the reactions that take place inside the chloroplast, including chlorophyll, proteins and enzymes required for the photosynthesis process [37]. Application of 10 to 20% Vermicompost increased chlorophyll content in rye grass (*Lolium perenne*) compared with plants from un-amended soils [38].

Other parameters such as SL, Fwt-S and Fwt-TP, Dwt-TP and LAI were statistically insignificant (p>0.05 level) in the present study. Leaf area index (LAI) was found maximum in all treatment plants (E1 to E6) and the minimum in E7 and C. The increased LAI was agreed with [39] and [40], in intercropping groundnut with maize. Singh *et al*. [41] stated that reduced LAI of groundnut in the intercropping system. Golchi *et al*. [42] reported that leaf area index (LAI) and chlorophyll content of the leaves of pistachio (*Pistacia vera* L.) seedlings, as well as the photosynthesis rate were better in vermicompost treatments relative to the treatments without vermicompost. In Table 2 the HI (%) was found maximum in E6 (60%) and also higher in all vermicompost treatments (E1-E5) whereas recorded minimum in E7 (45%) and C (39%). Dwivedi *et al*. [43] reported that 40% HI with combined biomass under short-and long-day conditions in groundnut. Bell *et al.* [44] reported maximum HI (62%) in Australia and a minimum HI (38%) by Duncan *et al.* [45] in Florida.

Table 2: Growth parameters of *Arachis hypogea* in control and Experimental plants

Parameters	Co	E1	E2	E3	E4	E5	E6	E7
SL	19.11±1.30 a	19.72±2.47 a	20.54±0.56 a	19.10±1.62 a	19.24±2.54 a	19.65±0.86 a	20.26±0.85 a	21.01±4.32 a
RL	17.64±1.02 a	18.91±1.84c,d	19.79±4.01 c	24.03±1.35 d	22.64±0.98c,d	20.34±0.29 b	28.82±1.31 b	19.25±1.02c,d
TL	41.18±1.31 a	40.59±0.67b,c	43.63±3.79 b	37.88±1.35 c	38.23±0.94 c	43.55±0.85 b	42.75±0.92 b	41.74±5.36 b
Fwt-S	19.45±2.06 b	21.70±1.10a,b	22.47±1.74a,b	22.34±6.31a,b	24.01± 0.91 a	23.34±1.94 a	23.69±2.29 a	23.35±3.50 a
Fwt-R	9.85±1.39 e	11.09±0.47b,c	12.48±0.56c,d	14.43±0.55a,b	12.98±1.21d,e	11.29±0.23d,e	15.57±3.19d,e	11.37±0.42 a
Fwt-TP	76.66±3.85 e	94±3.60 d	140±20.66 b	163.66±4.72 a	156.33±2.08a,b	145.67±12.34b	159.66±2.08a,b	126.33±2.34 c
Dwt-S	2.49±0.23 c	3.75±0.45 a,b	2.88±0.09 c	4.02±0.26 a	3.72±0.31 a,b	3.43±0.43 c	3.72±0.18 a,b	3.57±0.61 a,b
Dwt-R	1.53±0.39 d	1.67±0.09 d	3.13±0.20 b	4.08±0.15 a	3.67±0.81 b	2.24±0.21 c	4.16±0.73 a	1.96±0.84 c,d
Dwt-TP	28.0±1.0 c	26.33±2.08 c	46±2.16 a	46±2.0 a	42±1.0 a	41.33±2.52 a	44±1.0 a	35.33±5.51 b
RN	25.5±1.29 d	65.75±8.84 c	85.5±4.79 b	81.5±1.91 b	90±16.08 b	88±18.25 b	103±2.71 a	58.5±4.50 c
PP	25.75±2.36	25.25±1.71	28.5±3.51	37.5±4.20	30±9.13	28±7.61	34.25±3.30	26±2.16
SW-100	47.03±1.59 d	54.46±0.88 c	56.46±1.82 c	66.25±3.30 b	72.52±6.22 b	56.5±7.54 c	81.38±1.39 a	56.09±1.88 c
Chl a	0.16±0.0001e	0.16±0.0004 e	0.17±0.0007 d	0.19±0.002 a	0.18±0.01 b,c	0.18±0.007 b	0.18±0.0002 b	0.17±0.0007 c
Chl b	0.18±0.0003 f	0.21±0.014 e	0.39±0.006 a	0.31±0.006b,c	0.30±0.002 c	0.32±0.008 b	0.38±0.005 a	0.27±0.024 d
Total Chl	0.35±0.008 f	0.39±0.006 e	0.41±0.035 e	0.59±0.008 a	0.45±0.033 c	0.53±0.009 b	0.57±0.012 a	0.42±0.011 d
LAI	0.13±0.005b	0.15±0.0005a,b	0.24±0.15 a,b	0.57±0.76 a	0.31±0.26 a	0.16±0.007 a,b	0.94±0.71 a	0.16±0.004a,b
HI	38.73±1.508	52.56±1.568	55.39±2.405	60.28±3.304	54.71±2.26	51.06±1.805	59.48±1.259	42.12±3.748

Means for groups in homogenous subsets are displayed Control (Co); shoot length (SL); root length(RL); total length (TL); fresh weight of shoot (Fwt S); fresh weight root (Fwt R) and total plant (Fwt TP); dry weight of shoot (Dwt S); dry weight root (Dwt R) and dry total plant (Dwt TP); No of root nodules (RN); No of pods per plant (PP); 100 seed weight (SW); Leaf area index (LAI); Chlorophyll a, b; Harvest Index (HI)

Table 3: Biochemical parameters of *Arachis hypogea* in control and Experimental plants

	Control	E1	E2	E3	E4	E5	E6	E7
Carbohydrate %	6.37±0.32 a	6.65±0.74 a	6.67±0.73 a	6.72±0.89 a	6.60±0.85 a	6.73±1.82 a	6.87±0.50 a	6.60±0.35 a
Protein %	19.46±1.66 a	20.44±5.81 a	21.52±1.97 a	24.44±0.96	22.46±0.92 a	21.01±0.84 a	24.05±.15 a	20.56±0.63 a
Oil content %	42.24±1.70 d	53.19±1.72 c	56.1±0.85a,b,c	57±1.73 a,b	55.32±1.71 c	53.19±1.72 c	56.29±3.67a,b	53.17±1.37 a

Means for groups in homogenous subsets are displayed

The biochemical parameters (Table 3) such as carbohydrate and protein contents were insignificant at $p>0.05$ level, whereas oil content was significant at $p<0.05$ level. The favorable effect of Rhizobium inoculation (E6) on the higher oil percent was also supported by Jana et al. [46] and Basu *et al*. [47]. Oil percent was higher due to the fact that higher N absorption had enhanced more Acetyl Co-A formation, which was directly related to oil formation. Radwan and Awad [48] stated that the associative action of bio fertilizer and organic wastes led to a significant increase in the oil percentage in seeds as compared to chemical fertilizer treatment.

CONCLUSIONS

Biofertilizers enriched vermicompost (E2 - E6) shows increased growth attributes, yield, protein and oil content than Co and E7. The organic fractions of flower waste vermicompost and the microorganisms in the biofertilizers could be an alternative to chemical fertilizers to improving the growth and yield of groundnut. Vermicompost contains plant nutrients, including (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu) the uptake of this has a positive effect on plant nutrition, photosynthesis, the chlorophyll content of the leaves and improves the nutrient content of the different plant components (roots, shoots and the fruits). Better aeration and microbial activity have direct influence on the uptake of nutrients and improvement in growth and yield components and ultimately yield of groundnut. This study indicates that application of a combination of mineral fertilizer and vermicompost in the field can positively influence the biological properties and fertility of soils and support better plant growth, when compared to the application of mineral fertilizer or vermicompost alone.

ACKNOWLEDGEMENTS

The authors are grateful thank, Head of the Department, Dept. of Zoology, Kandaswami Kandar's College, Velur for providing necessary facilities for doing the above work.

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