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Evaluation of Vermicompost on Maize Productivity and Determine Optimum Rate for Maize Production

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ABSTRACT

Field experiments were conducted at on farm during 2014 summer seasons., kersa wereda located at east of jimma town on 20km distance, to determine the influence of vermicompost on the yield and dry matter accumulation of local and improved maize hybrid. The experiments were laid out in a randomized complete block design (RCBD) with three replications. Each block was composed by seven (7) treatments:0, 2.75, 5.5, 8.25, 11, 13.75t ha^{-1} of vermicompost fertilizer (made of cow dung as sole feeding) and chemical fertilizing with 92 kg ha^{-1} of N and 46kg ha^{-1}. The results obtained showed that maize growth and yield was significantly (P = 0.05) affected by the different rates of vermicompost used. The highest dry maize grain yield was obtained in the local maize type 660BH using vermicompost 13.75t ha^{-1} and recommended NP, while the lowest yield was obtained in the local maize type with vermicompost dose 2.75t ha^{-1}. The trend observed in the other plant attributes measured such as the mean Leaf area, the plant height, the ear height and the dry matter accumulation showed high increase as rates of vermicompost increased from 2.75t ha^{-1} to 13.75t ha^{-1} and had higher nutrient efficiency and conversion rate than the negative control.

Based on the research findings, growing maize sole using vermicompost rate of 13.75t ha^{-1} remains the best recommendation for optimum maize grain yield in the field and application of the vermicompost in the planting furrow can substitute the chemical fertilization, without integration of the vermicompost with chemical fertilizer.
Key Words: Earth worm, Growth, Maize, Treatment and Vermicompost rate.

INTRODUCTION

The excessive and long-term use of inorganic fertilizers without organic supplements damages the soil physical, chemical and biological properties and cause environmental pollution and such situation can be improved through the use of Biofertilizer (Saadatnia and Riahi, 2009). Current trends in agriculture are centered on reducing the use of inorganic fertilizers by Biofertilizer such as vermicompost (Haj Seyed Hadi et al., 2011). The management practices with organic materials influence agricultural sustainability by improving physical, chemical and biological properties of soils (Saha et al., 2008).Techniques of recovery of such degraded soil through the organic fertilization may enable the return to the conditions of ecological balance which come to reduce significantly, or, even, eliminate the use of chemical fertilizers in the productive system. Thus, a simple biotechnological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion in to organic product and amend organic matter status of soil, are getting much attention because of their easy availability, prompt response and feasibility in using over large area in less time. Vermicompost is a nutrient-rich, microbiologically-active organic amendment that results from the interactions between earthworms and microorganisms during the breakdown of organic matter. It is a stabilized, finely divided peat-like material with a low C: N ratio, high porosity and high water-holding capacity, in which most nutrients are present in forms that are readily taken up by plants ((Arancon et al. 2004, Domínguez, 2004). Earthworms act as mechanical blenders, and by fragmenting the organic matter they modify its physical and chemical status by gradually reducing the ratio of C: N and increasing the surface area exposed to microorganisms - thus making it much more favorable for microbial activity and further decomposition (Domínguez et al., 2010).

Vermicompost has been shown to have high levels of total and available nitrogen, phosphorous, potassium (NPK) and micro nutrients, microbial and enzyme activities and growth regulators (Chaoui, 2003). Furthermore, vermicompost has a high nutritional value, with high concentrations of especially nitrogen, phosphorus and potassium, while the contamination by heavy metals and other toxic substances are very low (Asghar, 2006). Continuous and adequate use of vermicompost with proper management can increase soil organic carbon, soil water retention and transmission and improvement in other physical properties of soil like bulk density, penetration resistance and aggregation (Mahdavi damghani, 2007) as well as beneficial effect on the growth of a variety of plants (Atiyeh,et al., 2002). Excessive use of inorganic fertilizers creates environment related problems, and situation can be improved through the use of bio-fertilizers (Saadatnia and Riahi, 2009).

Throughout the world there are many options for replacing the plant nutrients lost from soil, however, in our case in Ethiopia where most of the agriculture is done by smallholder farmers, the best option is vermicompost produced by operation of earthworm and microorganisms. Good quality vermicompost can be made from organic household wastes, crop residues, garden wastes, dropped leaves, dung and droppings from all types of domestic animals. Tharmaraj et al., (2011) suggested rate of application of these

vermicompost and the significance of vermicompost in the field of agriculture and food production, which is of prime importance for a developing country and have shown growth and yield attributes for horticultural crops. Moreover, Reshid et al., (2014) reported that 20% and 40% (w/w) of vermicompost added during pot based tomato production showed to increase used soil pH from 5.5 to 8.07 which may be due to the production of usable form of more nitrate in the vermicompost and the purchasable yield of tomato products began to decrease by addition of 30% and 40% of vermicompost which may be due to the rise of the pH above neutral state of base media used. In addition, soil analyses after the vermicompost applications showed marked improvements in the overall physical and biochemical properties of the soil.
The literature survey revealed that the study on the influence and optimum rate of vermicompost is scanty. Hence, in the present investigation, an attempt was made to study the influence and optimum rate of vermicompost on growth parameters of maize and soil fertility enhancement which is a very important food plant around the world.

MATERIAL AND METHODS

To evaluate vermicompost on maize productivity and soil fertility enhancement, on-farm experiment was conducted during 2014 cropping season at kersa wareda located 20km east of jimma town. Jimma zone is located 363 km away from Addis Ababa, in South Western Ethiopia, Oromiya Regional State.
Seed of Maize (BH 660 hybrid)**,** a well adapted maize cultivar in the area with 99% viability, was obtained from Malkasa Agricultural Research Center and used as a test crop.
The experiment was carried out in a Complete Randomized Block Design (CRBD) with seven treatments and three replications. Before commencement of the experiment physical and chemical characteristics of vermicompost and soil used were examined. The basic chemical properties of media used, the vermicomposts and the soils are summarized in Table 1.

Table 1. Characteristics of the soil and vermicompost before the experiment.

Measured indexes	**Chemical properties of the soil**	**Chemical properties of the vermicompost**
PH	4.94	8.54
N	0.15 (1gm %N)	1.70 (1gm %N)
P	1.702(ppm)	235.49 ppmP(Olsen)
K	2.10((Meq K/100gm))	98.74 ((Meq K/100gm))
Exchangeable acidity(meq/100g)	0.49(Meq K/100gm))	
Organic matter (%)	7.50	63.85
Organic Carbon (%)	1.48 (Walk& black)	37.04 (Walkley &black)

Vermicompost and soil texture was determined by the Hydrometer principle whereas soil pH was measured from the suspension of 1: 2.5 soils: H_2O by pH meter. Soil organic carbon was determined by the Wakley and Black (1934) and FAO (2008) method. Available phosphorus in the soil was determined based on Bray II procedure (Bray and Kurtz, 1945; FAO, 2008) and available phosphorus in the vermicompost was determined based on (Olsen et al. 1954**)** (Tables1). The impact of vermicomposted cow solids at 7 levels (T_o =as a -ve control, T_1 = +ve Control, T_2 = 2.75t/hac, T_3 = 5.5t/hac, T_4= 8.25t/ hac $T_{5=}$ 11t/hac and

$T_{6=}$13.75t/hac were studied._4m X 4m Plot size; 80cm between rows, 50cm between plants, 1.5 between raps and 1m between plots were established.

The area was thoroughly prepared prior to planting. Land preparation and plowing was done by the farmer for the incorporation of farmer practice crop production and left idle for three weeks to allow weeds to decay and suppress its germination after which second plowing and harrowing at a week interval was done.

Hill application of recommended DAP fertilizer and furrow application of vermicompost was done prior to planting and side dressing of urea was also done at 35 days after sowing. Two seeds per hill were planted after application of basal fertilizers at 50 centimeters apart and 80 centimeters between rows. The seeds were covered with thin soil and foot-pressed, so that there will be direct contact of seeds with the soil for better and uniform germination. Manual weeding was done to prevent the growth of weeds especially between hills.

The yield components such as, leaf area, fresh stem and dry weight, stem height and diameter were determined from each harvestable plots size. The fresh stem samples were oven dried at 70ºC for 48hr and the dry weights of shoot was determined.

DATA COLLECTION AND ANALYSIS

Plant height, Ear height, Internodes height, Girth, leaf area, Sterile plants, number of cobs harvested, number of bare cobs, grain yield per plot, grain yield Quintal ha^{-1}, fresh stalk wt $plot^{-1}$, dry stalk wt $plot^{-1}$, biomass tone ha^{-1} were recorded. Analysis of variance was conducted using the General Linear Model procedure of Statistical Analysis System (SAS) T-test and Least Significant Difference (LSD) method at 0.05 probability level was used for mean separation (Gomez and Gomez, 1984). However, any values mentioned in this section refer to the original data of present experiment.

RESULTS

Plant height

The present results have indicated that plant heights were affected by the application of vermicompost and showed dramatically increased as concentration of vermicompost increased. . The highest plant height (310.3cm) was obtained by using 13.75 t ha^{-1} vermicompost (Table 2) (Figure 1).

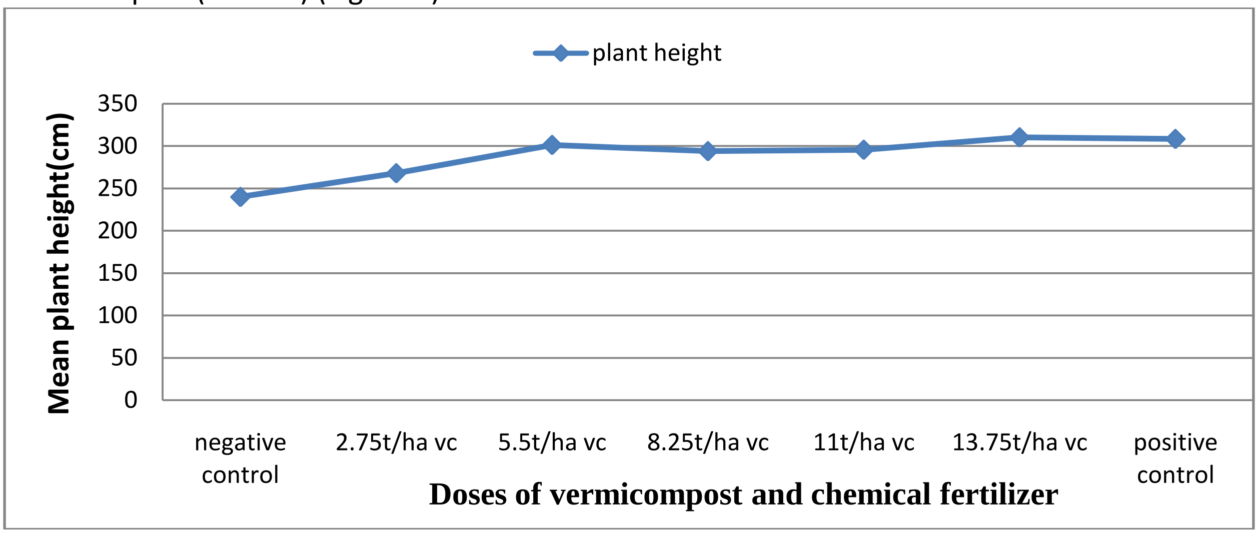

Figure 1. Mean maize plant height in function of doses of organic and chemical fertilization.

Figure 1 presents the mean height of maize in centimeters as affected by application of varying concentration of vermicompost and recommended inorganic fertilizers as positive control.

Generally, the treatment that exhibited the highest plant height was 13.75 tons ha^{-1} vermicompost while 2.75 tons vermicompost consistently obtained the lowest plant height. However, statistical analysis at concentration 5.5 tons and 11tons of vermicompost showed no significant differences among the treatments. While in concentration 2.75, 8.25 and 13.75 tons of vermicompost and negative control, statistical analysis showed that treatments were significantly different. Inorganic fertilizers are known to have the peculiarity of fast release of their nutrient contents; and hence inorganic fertilization treatments seemed enough to have plants not significantly shorter than plants treated with 13.75 tons of vermicompost.

Ear height

The results have demonstrated that ear height was influenced by the application of vermicompost significantly. Also, interaction between treatments had significant effects on ear height (Table2) (Figure 2). Among the different levels of vermicompost, the highest ear height (197.33cm) was obtained by using 13.75 ton vermicompost per hectare.

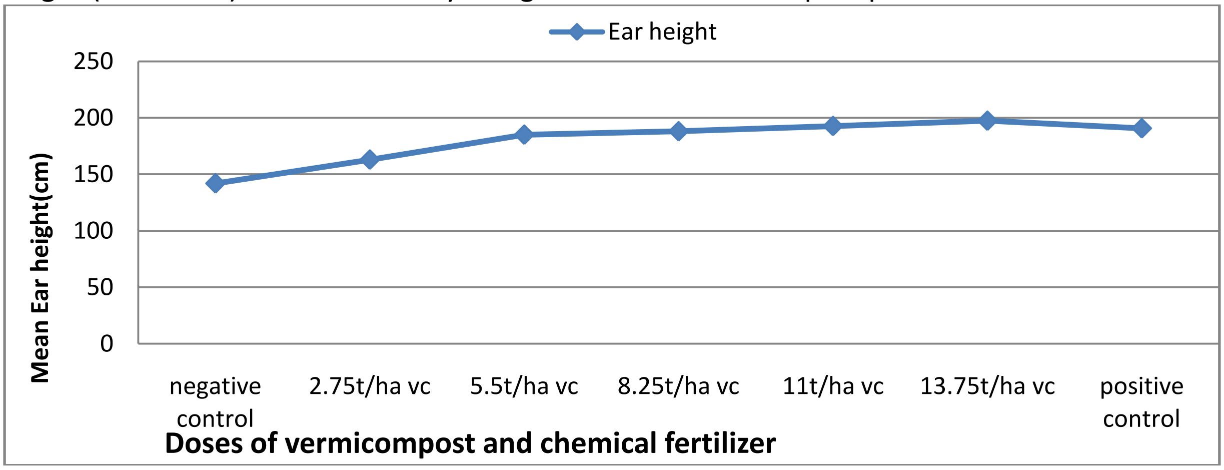

Figure 2. Mean maize plant ear heights in function of doses of organic and chemical fertilization.

Before harvesting, data on ear height were gathered. The treatment that obtained the highest ear height mean was at concentration of vermicompost 13.75 tons with an average of 197.33 cm, and the least was at 2.75 tons with 163cm. However, statistical analysis as shown in Table 3 revealed that the different treatments at 5.5, 8.25 tons, 11tons and 13.75 tons of vermicompost and recommended chemical fertilizer did not show any significant difference in terms of ear height.

Internodes height

All different concentrations of vermicompost cow solids produced varied internodes height of maize plants. However, even though there is no significant differences between 13.75 tons per hectare of vermicompost treated and recommended NP chemical fertilizer treated(Table2) (Figure 3), internodes height measured at 13.75 tons per hectare doses of vermicompost had higher internodes height (17.9cm). The rest 2.75 tons, 5.5 tons, 8.25 tons and 11 tons of vermicompost statistically did not show any significant difference in terms of internodes height.

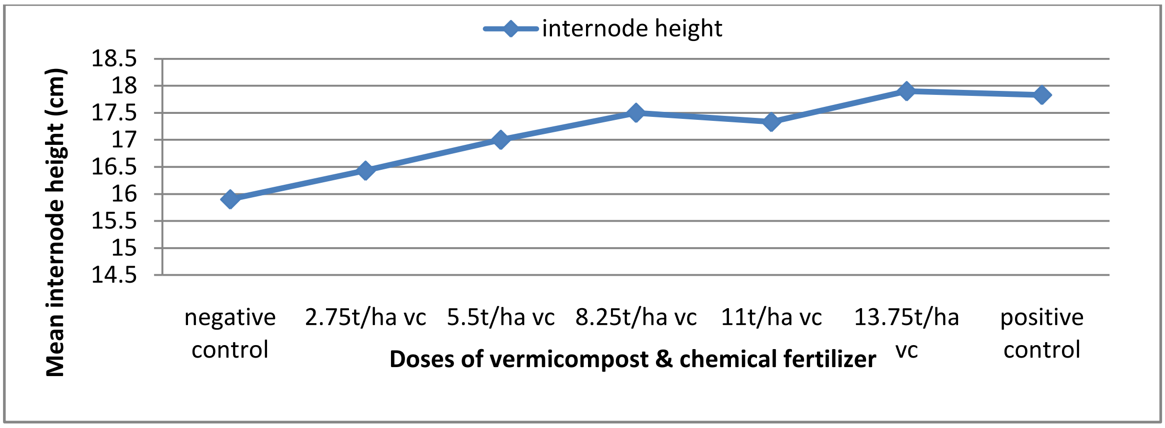

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Figure 3. Mean maize plant internodes heights in function of doses of organic and chemical fertilization.

Stem diameter

Before harvesting, diameters of maize stem 40cm above the top soil were measured using Vernier caliper. As concentration of vermicompost increased the diameter of plant stems increased exponentially (Table2) (Figure 4)..

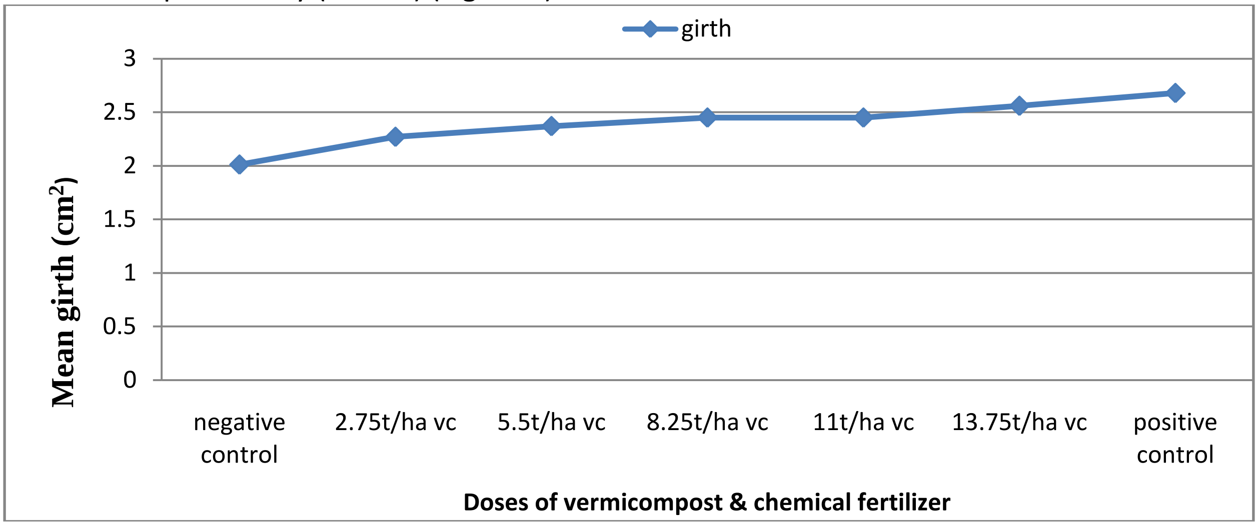

Figure 4. Mean maize plant stem diameter in function of doses of organic and chemical fertilization.

Figure 4 shows the mean Stem diameter of maize plants as influenced by the application of different levels of vermicompost and inorganic fertilizers. Based on data gathered, the treatment that obtained the highest treatment mean was 13.75 tons (2.56cm), followed by 11 tons (2.45 cm); 8.25 (2.45 cm); 5.5 tons (2.37 cm); and the least was 2.75 tons per hectare with 2.27cm. Result of the statistical analysis as shown in Table 2, however, revealed that the effects of treatments at 8.25 tons per hectare and 11tons of vermicompost per hectares on the Stem diameter are not significant.

Biomass

Biomass weight was obtained during harvesting. Statistical analysis as shown in Table 2 and Figure 5 revealed that the different treatments at 5.5 tons, 8.25 tons, 11tons and 13.75 tons of vermicompost did not show any significant difference in terms of biomass weight. Plants that obtained the lightest biomass were 2.25 tons per hectare which gained a mean weight of 4.05 tons per hectare.

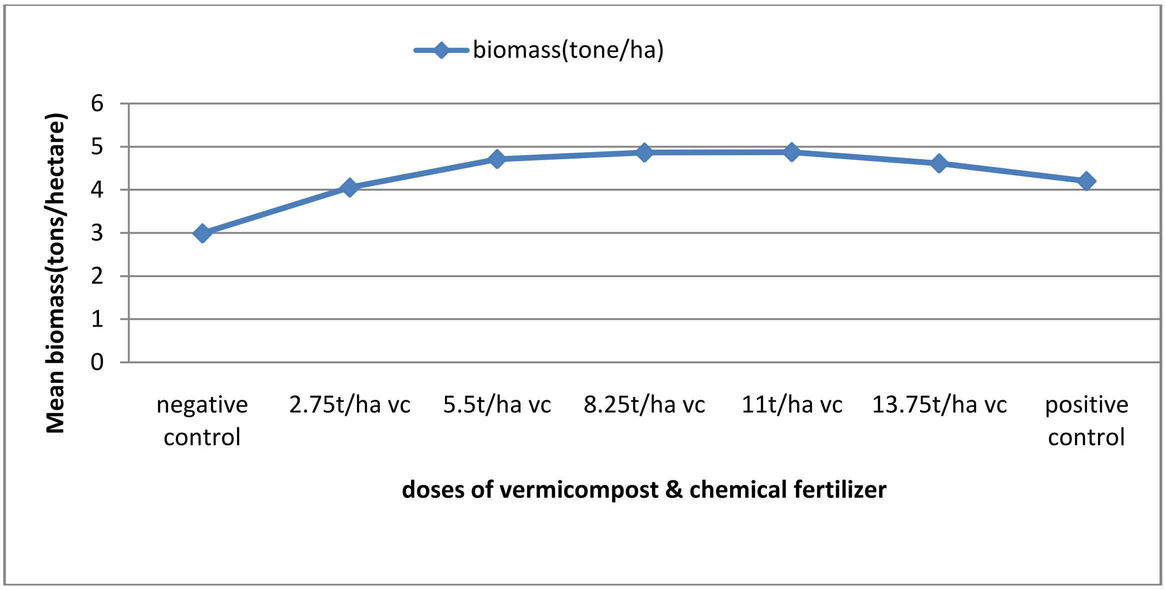

Figure 5. Mean maize plants biomass weight in function of doses of organic and chemical fertilization.

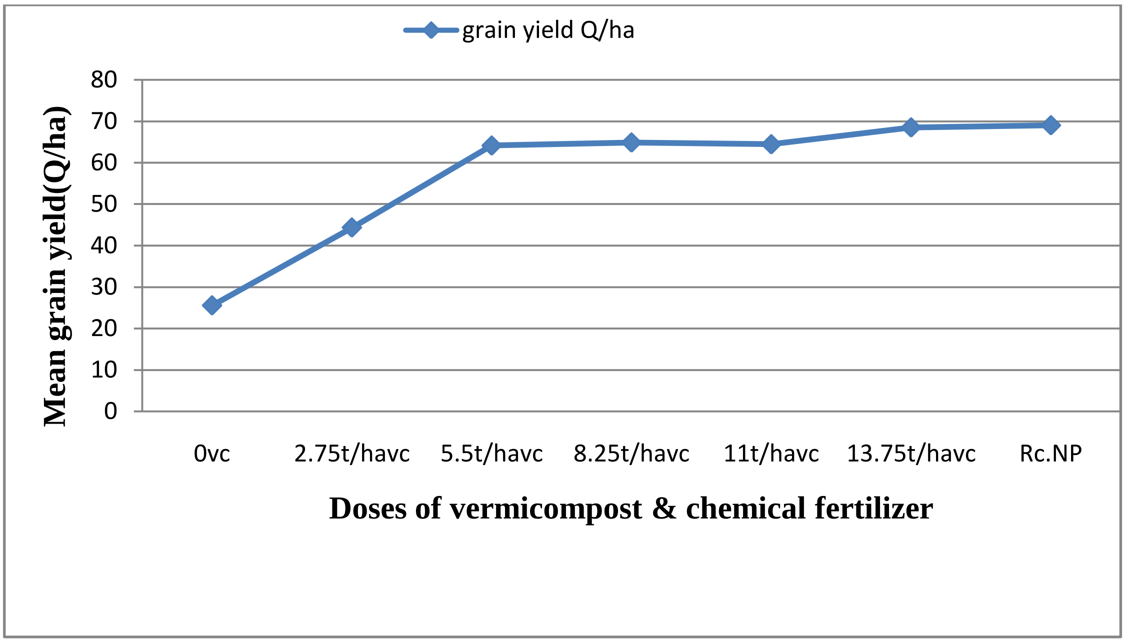

Figure 6. Mean Grain yield of maize obtained from on-farm application of different rates of vermicompost and chemical fertilization.

Data revealed that higher values in biological yield (6853kg ha-1) were observed by using 13.75 ton per hectare vermicompost.

Number of sterile plants, number of harvested cobs and bare cobs harvested

In generally speaking, data gathered concerning number of sterile plants, bare cobs harvested and number of cobs harvested indicated that as doses of vermicompost increased from 2.25 tons per hectare to 13.75 tons per hectare number of sterile plants and bare cobs harvested decreased and number cobs harvested increased and vice-versa (Table 2) (Figure 7). Data gathered revealed that higher mean values for sterile plants and bare cobs harvested were recorded in application of 2.75 and 11 tons per hectare respectively which was statistically at far with the value recorded by chemical fertilizer treatments. Lower sterile plants and bare cobs harvested were recorded in 8.25 tons per hectare. Overall data represents that organic fertilizers are effective in increasing the productivity of maize.

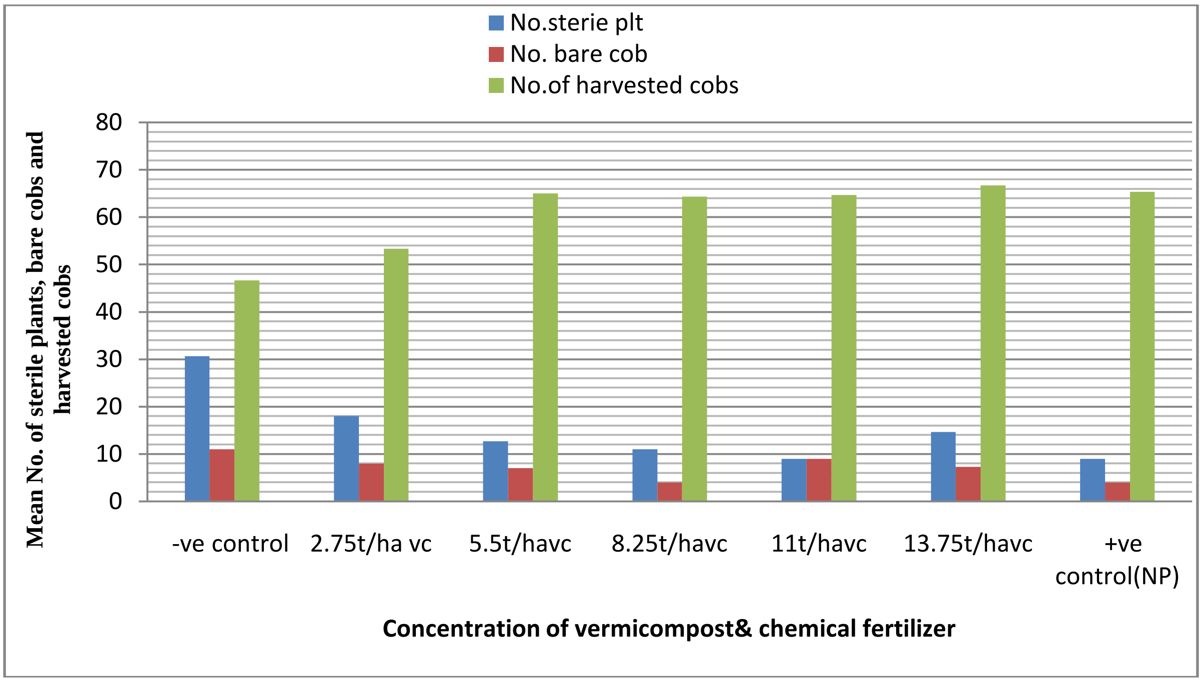

Figure 7. Mean numbers of sterile plants and bare cobs harvested in function of doses of organic and chemical fertilization.

Maize plant biomass can be used in many ways including as animal feed that can be beneficial to small-scale farmers, who strive to become more sustainable and to increase their income. Fresh biomass data gathered indicated that application of vermicompost fertilizer (8.25 tons and 11 tons per hectare) significantly affected the fresh biomass of maize plant. Data revealed that higher values for fresh biomass (17366.67 and 17433.33 grams) were recorded in application of 8.25 and 11 tons per hectare respectively which was statistically at far with the value recorded by chemical fertilizer treatments(15100gms). Lower fresh biomass (11500grams) was recorded in control. Overall data represents that organic fertilizers are effective in increasing the fresh biomass of maize.

Biological Yield

Figure 6 shows the maize yield as affected by the application of vermicompost and inorganic fertilizers. Biological yield was affected by vermicompost significantly (Table2, Figure 6). However, different concentration level of Vermicompost resulted in significantly ($P < 0.05$) maize yields and yield components than the control check when 2.75, 5.5, 8.25, 11 and 13.75 tons vermicompost per hectare were applied. However, statistical analysis as shown in Table 3 revealed that the different treatments at 5.5, 8.25 tons, 11tons and 13.75 tons of vermicompost and recommended chemical fertilizer did not show any significant difference in terms of biological yield. 2.75 tons per hectare vermicompost gained the lowest yield with a mean weight of 44.36 quintal per hectare, followed by control with mean weight of 25.55 quintal per hectare.

Table 2. Effects of different concentration level of Vermicompost on growth parameters and yields of maize.

Treatment	Leaf area	girth	Ear height(cm)	Plant ht(cm)	internod ht(cm)	No.sterie plt	No.Cobes hrt	No. bare cob	grainyiel /plot(gm)	Grain yiel Qui/ha	fresh stalk wt/pl(gm	dry stalk wt/pl(gm)	biomass tone/ha
-ve cont	3.81abc	2.01e	142c	240d	15.9b	30.67a	46.67b	11a	2616.53c	25.55c	11500d	4833b	2.99c
2.75t/havc	3.68bc	2.27d	163b	268c	16.43ab	18ab	53.33b	8ab	4542.40b	44.36b	14466.67c	5179.07ab	4.05b
5.5t/havc	4.54ab	2.37dc	185a	301.3ab	17ab	12.67b	65a	7ab	6569.87a	64.15a	16833.33ab	6026.33ab	4.71a
8.25t/havc	3.41c	2.45bc	188a	294b	17.5ab	11b	64.33a	4b	6644.27a	64.89a	17366.67a	6217.27a	4.86a
11t/havc	3.74abc	2.45bc	192.67a	295.67ab	17.33ab	9b	64.67a	9a	6600.59a	64.46a	17433.33a	6240.87a	4.87a
13.75t/havc	4.48ab	2.56ab	197.33a	310.3a	17.9a	14.67b	66.67a	7.3ab	7018.13a	68.53a	16466.67ab	5895.07ab	4.61a
+ve cont(NP)	4.63a	2.68a	190.67a	308.4ab	17.83a	9b	65.33a	4b	7070.8a	69.05a	15100bc	5405.8ab	4.2b
L.S.D:0.05	0.93	0.15	17.84	14.77	1.74	13.86	9.11	4.79	1920.4	20.00	1918.7	1313.1	0.56
CV	12.94	3.47	5.58	2.88	5.72	51.95	8.41	37.48	18.40	18.41	7.06	12.98	7.27

Columns followed by the same letters are not significantly different (p>0.05), LSD: Least significant difference, cont: Control, NP: recommended NP of the crop.

In Figure 1 it can be seen that the dose of 13.75 t ha^{-1} of the vermicompost fertilization was significant and contributes to a higher plant height. However both used levels of vermicompost at 5.5t /ha and 11t ha^{-1} had significantly enhancing the same effects on the plant height (Figure 1) which is equivalent to recommended dose of NP of chemical fertilization.

Leaf Area

Figure 8 has demonstrated that Leaf area was influenced by the application of different doses of vermicompost significantly. Also, interaction between treatments had significant effects on Leaf area (Table 2). Among various treatments, the highest Leaf area was obtained by using 13.75 tons vermicompost per hectare (Figure 8).

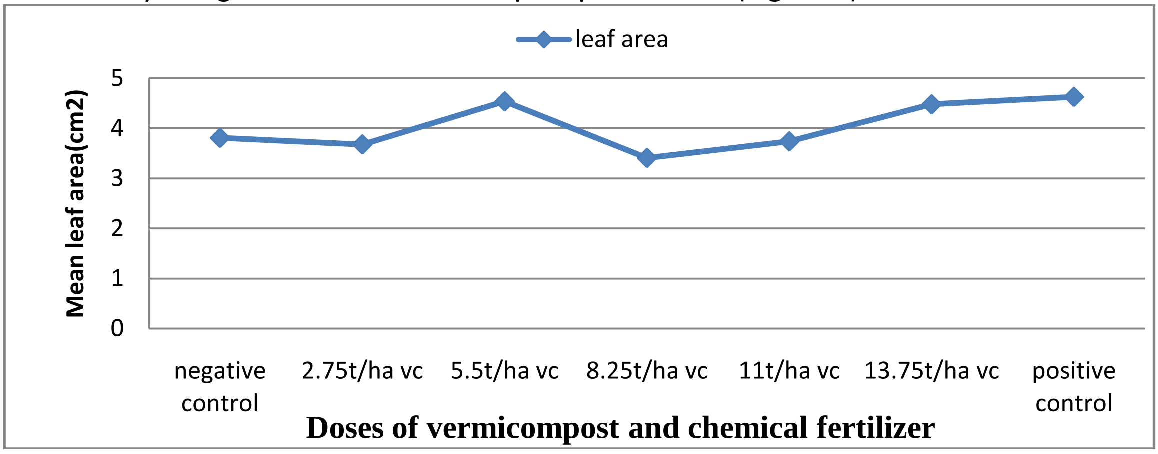

Figure 8. Mean leaf area of maize in function of doses of organic and chemical fertilization.

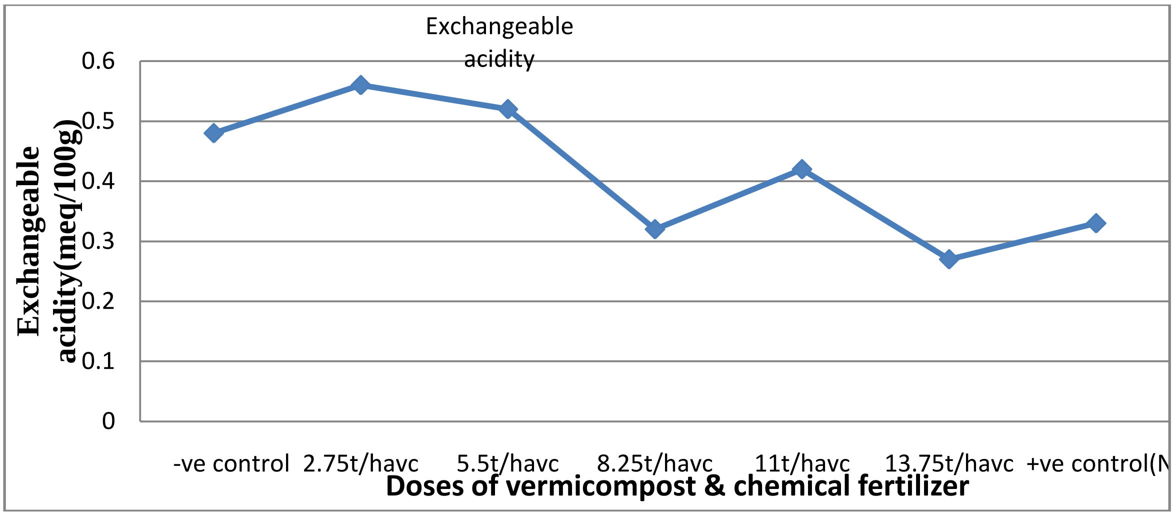

Figure 9. Mean exchangeable acidity of the soil sample taken after harvest.

Physico-chemical changes in soils in response to vermicompost applications

Soil analyses after the vermicompost applications showed marked improvements in the overall physical and biochemical properties of the soil.

In our experiments, amounts of soil nitrogen (N) increased after incorporating vermicompost into soils and the amounts of P available also increased. However, the PO4-content of the soil was significantly higher in the plots to which vermicompost was added than in the plots that received only inorganic fertilizers and negative control (Table 3). There

are also slight improvements in soil pH and a decrease in exchangeable acidity(Figure 9), which can support a release of P available in the soil.
Table 3.Showing improvements for some of the soil physical and chemical properties as they are affected by different vermicompost concentrations and chemical fertilizer applied.

Table 3 Showing improvements for some of the soil physical and chemical properties as they are affected by different vermicompost concentrations.

Treatments	pH(1:2.5)	Available P(ppm)	%OC	%Total N	Exchangeable acidity (meq/100g)
control	4.81a	1.43a	1.71a	0.14a	0.48ab
Rec. NP	4.82a	1.53a	1.82a	0.15a	0.56a
2.75t/ha VC	4.76 a	2.39a	1.75a	0.15a	0.52ab
5.5t/ha VC	4.79a	7.023a	1.95a	0.15a	0.32ab
8.25t/ha VC	4.88a	15.86a	1.898a	0.16a	0.42ab
11t/ha VC	4.84a	18.55a	1.88a	0.15a	0.27b
13.75t/ha VC	4.90a	19.098a	1.76a	0.16a	0.33ab
LSD	0.296	19.58	0.29	0.03	0.28

DISCUSSION

Vermicompost contributed to improvements in physico-chemical characteristics of the soil that favored better maize plant growth. Addition of Cow dung vermicompost into soil increased pH and nitrate concentrations in response to increasing concentration of vermicompost. Tyler et al (1993) reported similar results that the changes in pH increases in substrate pH in response to increasing concentrations of composted turkey litter added to a plant container medium. Since most of the mineral nitrogen in vermicompost is usually in the nitrate form (Atiyeh et al., 2001) the amounts of nitrates in the planting media increased with the increasing vermicompost concentrations (Atiyeh et al., 2001). Although with steady increase in concentration of N, P, and K, towards the 13.75tons per hectare vermicompost concentration, the pH of the control is low which resulted in lower yield and yield components. Similar findings were also reported by Sreenivas, (2000). Addition of vermicompost to soil improves the soil environment, encouraging the proliferation of roots, which in turn draw more water and nutrients from larger areas. Treatment had a significant effect on plant height, with a maximum height of 310.3cm recorded after application of *Esenia fotida* compost at 98 days after planting. The significant increase in plant height after applying 13.75 tons per hectare vermicompost agrees with results reported by Singh and Yadav (1990). Channabasanagowda et al. (2008) have shown that the differential action of vermicompost may be because of the fact that the vermicompost has slow release of nitrogen due to slow mineralization of vermicompost, which helps in availability of nutrients to the plants throughout the growth of the plant and thus resulting in higher yields. This finding is in accordance with the previous observations (Anwar et al. 2005) which stated as vermicompost increases the growth rate because of the water and mineral uptake such as; nitrogen and phosphorus (Atiyeh et al., 2002; Arancon et al., 2004), which leads to the biological yield improvement. Higher yield and yield components such as in plant height, ear height, and internodes distance, stem diameter, plant biomass and leaf area were seen when they were exposed to different concentrations of vermicompost than the control plants (Ismail, 1995). These experiments, together with others reported in the literature, demonstrate that vermicompost has considerable potential for improving plant growth significantly and yields, when used as components of horticultural soil amendments.

Nevertheless, there appear to be major differences between the effects of the vermicompost that were used in our study, in terms of their influence on plant growth, depending upon the rates and concentrations of the organic amendments. Addition of vermicompost to soil improves the soil environment, encouraging the proliferation of roots, which in turn draw more water and nutrients from larger areas. Treatment had a significant effect on plant height, with a maximum height of 310.3cm recorded at application of 13.75ton per hectare during planting. The same findings were reported that vermicompost, with high water-holding capacity and proper supply of macro- and micro-nutrients (Atiyeh et al., 2002; Arancon et al., 2004), has a positive effect on biomass production and subsequently the enhanced plant height. However, the control plants showed lower grain yield compared to vermicompost treated plants

Similar trend of results was also noticed in leaf area, girth, ear height, and internodes height, number of cobs harvested, biomass and total grain yield weight of the maize plant exposed to different vermicompost concentration. Improved growth, development and height of medicinal plants and other crops have previously been reported in the presence of optimal amounts of vermicompost (Atiyeh et al., 2000; Arguello et al., 2006; Darzi et al., 2007; Azizi et al., 2009; Haj Seyed Hadi et al., 2011).

From this experiment, application of vermicompost fertilizer showed better performance than the control. It can be stated that the increase in growth parameters of maize are due to greater availability of nitrogen in full organic treatments. In addition, high porosity and water holding capacity of vermicompost that helps in better aeration and drainage. On the other hand, increase in growth parameters may be attributed to presence of growth hormones, enzymes, and other secretions of earthworms which could stimulate the growth and development of maize plants. It has been demonstrated that vermicompost contains many humic acids which improves morphological traits of the crop and thus increases the leaf area, stem diameter, plant height and reduces the period of slow growth (Atarzadeh *et al*., 2013).

In conclusion our study clearly showed that the addition of vermicompost to soil enhanced grain yield in maize. Similar strategy can be followed by farmers to increase productivity.

CONCLUSION

It is clear from the present study that vermicompost successfully manipulate the growth of maize, resulting in beneficial changes in morphological traits and biological yield. The highest biological yield was obtained by using 13.75ton vermicompost per hectare. The obtained results suggest that the impact of vermicompost application on the yield and plant height of maize depended on the vermicompost application dose. A bigger dose had a more positive impact than a smaller dose. The rationality of common organic-mineral fertilization of plants was confirmed. Therefore, vermicompost was found to be effective in improving soil physical, chemical and biological properties.

To sum up, it can be concluded that optimum rate of vermicompost as growing media can meet the crop nutrient demand throughout the growth stages for increasing yield and quality of the maize through improvement of soil physical, chemical and biological properties.

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REFERENCES

Anwar, M., Patra, D.D., Chand, S., Alpesh, K., Naqvi, A.A. and Khanuja, S.P.S. (2005). Effect of organic manures and inorganic fertilizer on growth, herb and oil yield, nutrient accumulation, and oil quality of French basil. Communications in Soil Science and Plant.

Arancon, N.Q., Edwards, C.A., Atiyeh, R. and Metzger, J.D. (2004). Effects of vermicomposts produced from food waste on the growth and yields of greenhouse peppers. *Bioresour Technol* 93:139–144.

Arguello, J.A., Ledesma, A., Nunez, S.B., Rodriguez, C.H. and Goldfarb, M.D.D. (2006). Vermicompost effects on bulbing dynamics, nonstructural carbohydrate content, yield, and quality of Rosado paraguayo garlic bulbs. **Hort. Sci. 41 (3),** 589-592.

Asghar, H.N., Ishaq, M., Zahir, Z.A., Khalid, M. and Arshad, M. (2006). Response of radish to integrated use of nitrogen fertilizer and recycled organic waste. *Pak J Bot* 38: 691-700.

Atarzadeh, S.H., Mojaddam, M. and. Saki Nejad, T. (2013). The interactive effects of humic acid application and several of nitrogen fertilizer on remobilization star wheat. *Int. J. Biosci, 3(8): 116-123.*

Atiyeh, R.M., Dominguez, J., Subler S. and Edwards, C.A. (2000). Chnages in biochemical properties of cow manure processed by earthworms (*Eisenia andreii*) and their effects on plant-growth. *Pedobiologia*. 44: 709-724.

Atiyeh, RM., Edwards, C.A., Subler, S. and Metzger, J.D. (2001). Pig manure vermicomposts as a component of a horticultural bedding plant medium: effects on physicochemical properties and plant growth. *Bioresource Technology*, 78: 11-20.

Atiyeh, R.M., Lee, S., Edwards, C.A., Arancon, N.Q. and Metzger, J.D. (2002). The influence of humic acids derived from earthworms- processed organic wastes on plant growth. *Bioresource Technology* 84: 7-14.

Azizi, M., Rezvani, F., Hassan, Z.K.M., Lekzian, A. and Nemati, A. (2009). Effects of vermicompost and irrigation on morphological traits and essential oil of chamomile. *Iran. J. Med. Plants Spices Res., 24 (1):82-93.*

Bray, R.H. and Kurtz, L.T., (1945). Determination of total organic and available forms of phosphorus in soils*. Soil Sci. 59:9-45*.

Channabasanagowda, N.K., Patil, B.N., Patil, J.S., Awaknavar, B.T. and Ninganur Ravi, H. (2008). Effect of Organic Manure on Growth, Seed Yield and Quality of Wheat. Karnataka *J. Agric. Sci.; 21:366-368.*

Chaoui, I., Zibiliske, M. and Ohno, T. (2003). Effects of earthworm casts and compost on soil microbial activity and plant nutrient availability. *Soil Biology and Biochemistry* 35: 295-302.

Darzi, M.T., Ghalavand, A., Rejali, F. and Sephidkon, F. (2007). Effects of Biofertilizers Application on yield and yield components in fennel (Foeniculum vulgare Mill.). *Iran. J. Med. Aroma.Plants*. 22(4), 276-292.

Domínguez, J., Aira, M. and Gómez Brandón, M. (2010). *Vermicomposting: earthworms enhance the work of microbes*. In: H. Insam, I. Franke-Whittle and M. Goberna, (Eds.), Microbes at Work: From Wastes to Resources (pp. 93-114). Springer, Berlin Heidelberg,

Dominguez J., (2004). State of the art and new perspectives on vermicomposting research, in *Earthworm Ecology*, Edwards C. A., Ed., pp. 401–424, CRC Press, 2nd edition.

FAO. (2008). FAO Fertilizer and Plant Nutrition Bulletin.FAO,Rome, Italy. p.220.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research.2nd edition. John Wiley and Sons, Inc.pp. 84-118.

Haj Seyed Hadi, M.R., Darzi, M.T., Ghandehari, Z. and Riazi, G.H. (2011). Effects of vermicompost and amino acids on the flower yield and essential oil production from Matricaria chamomile L*. J. of Med. Plants Research. 5(23): 5611-5617*.

Ismail, S.A. (1995). Earthworm in soil fertility management in Organic agriculture. (Ed: Thampan P.K.). 77-100.

Mahdavi Damghani, A., Deihim Fard, R. and Mirzaei Talar Poshti, R. (2007). Sustainable soils: role of organic matter in sustaining soil fertility. Martyr Beheshti University. P. 91-95 (in Persian).

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954). Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate. U. S. Department of Agriculture Circular No. 939. Banderis, A.D.,Barter, DH.and Anderson K., Agricultural and Advisor.

Reshid Abafita, Tesfaye Shimbir and Tesfu Kebede (2014). Effects of different rates of vermicompost as potting media on growth and yield of tomato (*Solanum lycopersicum* L.) and soil fertility enhancement. *Sky J. of Soil Sci. and Environ. Management* Vol. 3(7), pp. 073 – 077.Available online http://www.skyjournals.org/SJSSEM.

Saadatnia, H. and Riahi, H. (2009). Cyanobacteria from paddy fields in Iran as a biofertilizer in rice plants. *Plant Soil Environ*. 55:207-212.

Saha, S., Mina, B.L., Gopinath, K.L., Kundu, S. and Gupta, H.S. (2008). Relative changes in phosphatase activities as influenced by source and application rate of organic composts in field crops. *Bio resour. Technol*., 99: 1750-1757.

Singh, T. and Yadav, K. (1990). Role of bio-fertilizers in nutrient economics. In: Proc. Summer Inst. Integrated nutrient management for sustainable agriculture, pp. 258–277

Sreenivas, C., Muralidhar, S. and Rao, M.S. (2000). Vermicomposts: a viable component of IPNSS in nitrogen nutrition of ridge gourd. *Annals of Agricultural Research*. 21: 108-113.

Tharmaraj, K., Ganesh, P., Suresh Kumar, R., Anandan, A. and Kolanjinathan, K. (2011). Vermicompost - A soil Conditioner cum Nutrient Supplier. *International J. of Pharmaceutical & Biol. Archives;* 2(6): 1615-1620

Tyler, H.H., Warren, S.L., Bilder Back, T.E., and Fonteno, W.C., (1993). Composted turkey litter: I Effect on physical and chemical properties of pine bark substrate. *J. of Environ. Horticulture*. 11: 131-136.

Wakley, A. and Black, I.A. (1934). An Examination of the degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci., 37:29-38.

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