International Journal of Plant Pathology and Microbiology

E-ISSN: 2789-3073
P-ISSN: 2789-3065
www.plantpathologyjournal.com
IJPPM 2024; 4(1): 41-47
Received: 12-03-2024
Accepted: 15-04-2024

Desire Hatungimana
Africa University, College of Healthy, Agriculture and Natural Sciences Department of Agriculture and Natural Sciences, P.O. Box: 1320, Mutare, Zimbabwe

Mtaita Tuarira Abduel
Africa University, College of Healthy, Agriculture and Natural Sciences Department of Agriculture and Natural Sciences, P.O. Box: 1320, Mutare, Zimbabwe

Sebastian Chakeredza
Africa University, College of Healthy, Agriculture and Natural Sciences Department of Agriculture and Natural Sciences, P.O. Box: 1320, Mutare, Zimbabwe

Munashe Kurehwatira
Africa University, College of Healthy, Agriculture and Natural Sciences Department of Agriculture and Natural Sciences, P.O. Box: 1320, Mutare, Zimbabwe

Correspondence
Desire Hatungimana
Africa University, College of Healthy, Agriculture and Natural Sciences Department of Agriculture and Natural Sciences, P.O. Box: 1320, Mutare, Zimbabwe

Effect of vermicompost and compost tea on the growth and yield of onions

Desire Hatungimana, Mtaita Tuarira Abduel, Sebastian Chakeredza and Munashe Kurehwatira

DOI: https://doi.org/10.22271/27893065.2024.v4.i1a.76

Abstract
Relatively low onion yield in Sub Saharan Africa is attributed to several limitations such as poor soil fertility. For that reason, the field experiment was conducted to test the effectiveness of vermicompost and compost tea on onion growth and yield. The soil used had 52% sand, 30% silt, 18% clay and a pH of 7.17. Complete Randomized Design (CRD) with 3 replications was used. The results indicated that the organic and inorganic fertilizers significantly affected the height of the plant, leaf length, number of leaves, and marketable yield. Among the treatments, vermicompost tea was found to achieve the best marketable bulb yield of 48.3 tons/Ha. Compost tea produced 28.7 tons/Ha, while inorganic fertilizer attained 21.6 tons/Ha and the control produced the lowest yield of 2.2 tons/Ha. Therefore, vermicompost and compost tea can be used to boost the yield of onions.

Keywords: Vermicompost tea, compost tea, and onion, inorganic fertilizers

Introduction
Scarcity of inorganic fertilizers is one of the main contributors to the low yield of onions in developing countries. Low soil fertility, among other factors, limits onion production. To increase onion yield, organic fertilizers need to be tried in different forms because synthetic fertilizers are becoming costly and scarce. As in the developing countries Onion (*Allium cepa* L.) is one of the most frequently cultivated species of Allium (Bindu B. *et al*., 2015) [3] ranking second place after tomatoes in terms of annual global production (Anisuzzaman M. *et al*., 2009) [2], practically used every day in every home (Hussaini *et al*., 2000) [2] it is important to look for different ways of increasing yield.
Some of the essential nutrients needed for high yield of onions come from organic manure that enhances the physical and chemical qualities of the soil (Snyman *et al*., 1998) [8]. Due to their unbranched shallow root system, onions are the most vulnerable agricultural plants in terms of nutrient uptake. As a result, they require fertilizer and frequently respond favorably to its addition (Rizk *et al*., 2012) [7]. The decline in yields of onions and other food crops has pushed farmers in developing countries to amend the soils with various organic materials to offer the nutrients required to improve the growth and yield (Adepetu, 1997) [1].
Organic fertilizers are made from a variety of plant-derived materials, including fresh or dried plant materials, animal manure and litter, and agricultural waste (Kumar *et al*., 2004) [1]. The advantage of these fertilizers ranges from being affordable, enhancing soil structure, texture, and airing, increasing the capacity of soils to retain water, and encouraging the growth of strong roots (Twarg, 2006) [9]. When compared to artificial fertilizers, compost, and conservation tillage can provide higher and comparable yields (Hemmat *et al*., 2001) [4]. According to Yai and Yadav (2004) [10], crops cultivated using organic manures, are not only free of dangerous chemicals but also have greater nutritional quality and are free of pollutants that result from the use of inorganic fertilizers. This investigation mainly evaluated the effects of vermicompost and compost tea as compared to inorganic fertilizers in onion production.

Materials and Methods
The investigation was conducted at 17.6707° S latitude and longitude of 31.1238° E at an altitude of 1572 meters above sea level. The area receives an average annual rainfall of 538 mm with an average temperature ranging from 12 °C to 28 °C. The experiment was laid out in a Complete Randomized Design (CRD) with three (3) replications.

The four (4) treatments were Vermicompost tea, Compost tea, Synthetic fertilizer, and no fertilizer. The Forty days-old onion seedlings were transplanted in beds consisting of five (5) rows each. A wheelbarrow full of compost per meter square was broadcasted to the vermicompost and compost tea treatments. Basal inorganic fertilizers were applied at the rate of 100 g per square meter to the inorganic treatment. Seedlings were spaced at 18.75 x 10 cm. Irrigation was done daily for two weeks after transplanting and twice a week for the rest of the crop's growing cycle. Vermicompost, compost tea and NPK) were applied three weeks after transplanting. The dilution of vermicompost tea was 1 liter to 20 liters of water. A 100 g of NPK top dressing fertilizers was applied per meter square. The mixture of one watering can of vermicompost tea and water was enough to be applied to each vermicompost plot treatment and one watering can of compost had to be applied to each compost tea treatment plot. The top dressing of each fertilizers was applied at 3 weeks' interval. Weeding was done weekly to minimize weed competition.

Data collection: At seven (7) days intervals, data was collected as follows.

Plant height (cm): The height of plant was measured from the neck of the bulb to the tip of the longest leaf using a metric ruler.

Leaf length (cm): The length of leaf was measured from the pseudo-stem to the tip of the leaf using a metric ruler.

The number of leaves: The number of leaves per plant from each treatment was counted at random and averaged.

Yield per treatment: A scale was used to weight the onion bulbs.

Data analysis model

Data was evaluated according to the CRD model as follows

Yi $=\sum_{i=1}^{n} yij$ = Treatment total when n = number of observations in a treatment

$\bar{Y}i = Yi/n$ = Treatment mean

Y = i=1aj=1nyij= Experimental total, where a is the number of treatments

$\bar{Y} = Y/N$ = Experimental mean, where N = the total number of observations in the experiment.

Data was inspected and presented in tables and graphs.

Results

As indicated in Table I and 2, the soil was acceptable for onion production as onions can be cultivated in a variety of soils, but it does well under well-drained soils with a pH range between 6 and 7.

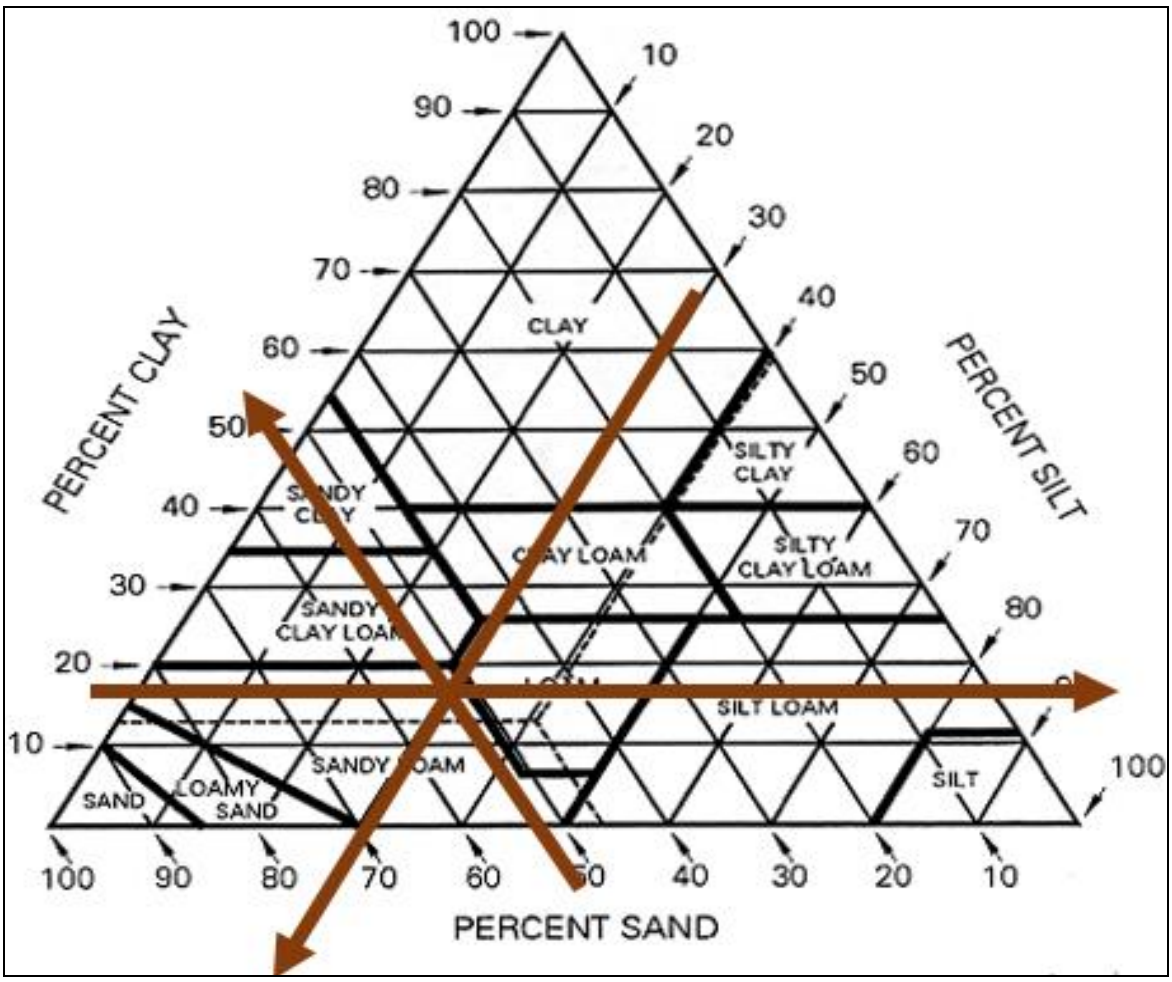

Fig 1: Soil texture triangle

Table 1: Results of soil analysis by using a hydrometer procedure

Hydrometer method STO					
Sample #	**FFS**	**CK 204**	**CK 208**	**Blank**	**Blank**
Wt of Sampl	50g	50g	50g	0	0
Hydro Rdgs @	27	25	6	3	3
Temp Rdgs @	24	24	24	24	24
Temp Corr Ca	1.38	1.38	1.38	1.38	1.38
Temp.Corr H	28.38	26.38	7.38	4.38	4.38
%Silt + %Clay	47.96	43.96	5.96	4.4	
Hydro Rdgs @	10	13	3	1	1
Temp Rdgs @	24	24	24	24	24
Temp Corr Ca	1.38	1.38	1.38	1.38	1.38
Temp.Corr H	11.38	14.38	4.38	2.38	2.38
					2.4
% Clay	18.0	24.0	4.0		
% Silt	30.0	20.0	2.0		
% Sand	52.0	56.0	94.0		
Texture Cla	SL				
Sample #	FFFS	CK 204	CK 208	Blank	Blank

Table 2: Analytical data of the soil nutrients composition of vermi-compost and compost tea

Parameters	**Parameters**	**Parameters**
pH	7.17	%
Clay	18	%
Silt	30	%
Sand	52	%
Organic matter	6.9	%
Total nitrogen (N)	28.65	%
Total Phosphorus (P)	80.22	ppm

Results of the soil analysis indicated the suitability for onion production as onion can be cultivated in any type of soil though it does well in well drained the soils with a pH range between 6 and 7. The soil used for the experimental trial was sandy loam with 52% of sand, 30% of silt, and 18% of clay and a pH of 7.17. As indicated in Table 2, the soil had a high level of nitrogen and phosphorus.

Nutrients composition of vermi-compost and compost tea nitrogen

The nitrogen concentration of vermicompost and compost tea used in this investigation differed from 0.38% to 0.92%. As indicated in Table 3, the vermi-compost tea had the highest (0.92%) concentration while compost tea had the lowest value (0.38%).

Table 3: Analytical data of nitrogen in vermicompost and compost tea

Sample	**Volume**	**Final volume**	**Initial volume**	**Titer**	**Weight of sample**
Blank	50	0	0	0	0
Compost tea	50	0.3	0	0.3	1.097
Vermicompost	50	1	0.3	0.7	1.065

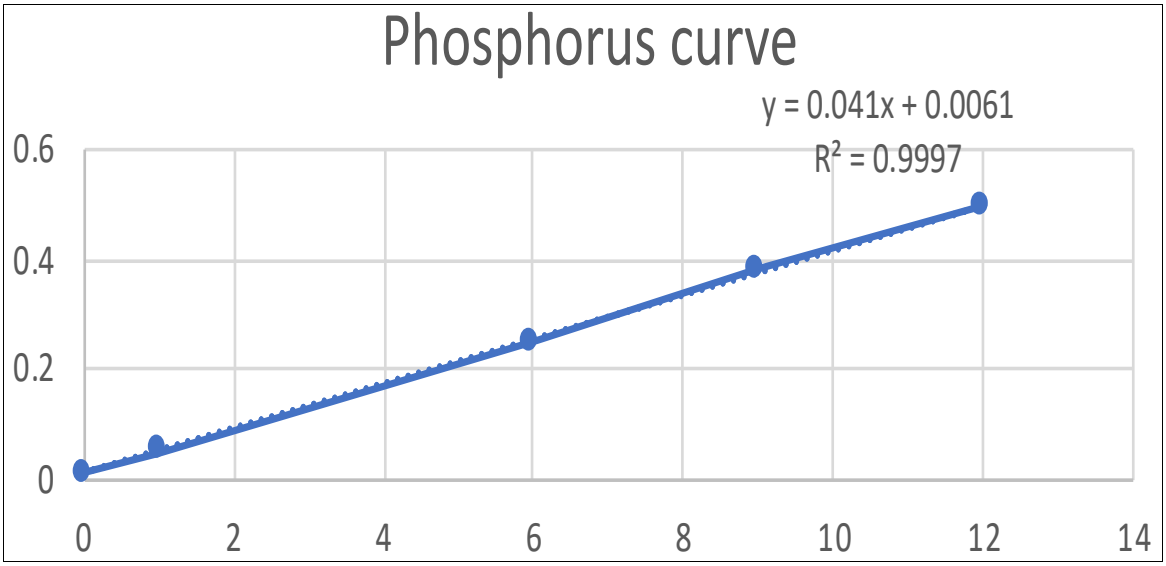

Fig 2: Phosphorus curve where X= (Y-0.0061)/0.041

The following formula was used to calculate the nitrogen percentage:

N%= [(Titer-blank) x0.1x 0.14 x 100]/weight of sample
Phosphorus

The phosphorus concentration of Vermicompost and compost tea used varied from 40 to 70 percent (Fig 1). The phosphorus content detected in Vermicompost tea was 48.51% while compost tea had a P content of 79.49%. The lowest value of phosphorus was found in Vermicompost tea whereas compost tea had the highest content. The phosphorus curve is shown in Figure 3.

Plant growth parameters

The plant growth parameters included the number of leaves, leaf length, plant height, and yield. Vermicompost and compost tea had a significant effect on these growth parameters. Where the two were used, the onions appeared healthier with dark green vigorous leaves than where synthetic and no fertilizers were used. Plants fed with Vermicompost and compost tea were tallest with more leaves than those under inorganic fertilizers and control. Vermicompost tea treatment achieved the highest yield followed by compost tea, inorganic fertilizer and the control (Table 4).

Plant growth parameters

The plant growth parameters included the number of leaves, leaf length, plant height, and yield. Vermicompost and compost tea had a significant effect on these growth parameters. Where the two were used, the onions appeared healthier with dark green vigorous leaves than where synthetic and no fertilizers were used. Plants fed with vermicompost and compost tea were tallest with more leaves than those under inorganic fertilizers and control. Vermicompost tea treatment achieved the highest yield followed by compost tea, inorganic fertilizer and the control (Table 4).

Table 4: Average height, number of leaves, leaf length 12 weeks after transplanting, and yield attained

	TREATMENTS						
Growth parameters	Vermicompost Tea	Compost Tea	Synthetic Fertilizer	Control	LSD	Mean	CV%
Leaf length 12 weeks after transpl	73.33^{a}	71.00t^{a}	62.00^{c}	38.67^{b}	3.95	61.25	3.4
Number of leaves 12 weeks after transpl	14.33^{a}	13.00^{b}	12.67^{c}	8.00^{d}	1.21	12	5.4
Plant height	85.33^{a}	81.33^{b}	74.00^{c}	41.65^{d}	3.39	70.58	2.6
Yield (kg)	10.63^{a}	6.3^{b}	4.77^{b}	0.5^{c}	2.08	5.56	19.9

***Note:** Means followed by same letter in the same column are not significantly different at p< 0.05

Number of leaves

It is a common knowledge that leaves are the major component of onions because they are the food reserves and allows the onion bulbs to restart its active growth when inappropriate conditions prevail. The modified leaves consist of layers that store energy for the plant in order to survive during the onion growth and development.

Applying organic and inorganic fertilizers as top-dressing two weeks after transplanting and every two weeks during the crop development increased the number of leaves. Vermicompost tea, compost tea, and synthetic fertilizers increased the plant growth that also affected the number of leaves. The control produced fewer leaves than the other treatments. The treatments with vermicompost and compost tea produced dark, green and more leaves than synthetic fertilizer. Onions planted in vermicompost and compost tea, as well as artificial fertilizer treatments produced one leaf per week while one leaf emerged after two weeks in the control treatment. Onions growing in the control had an average of 8 leaves while the synthetic fertilizer and compost tea produced 13 leaves and the vermi-compost tea recorded 14 leaves in 3 months.

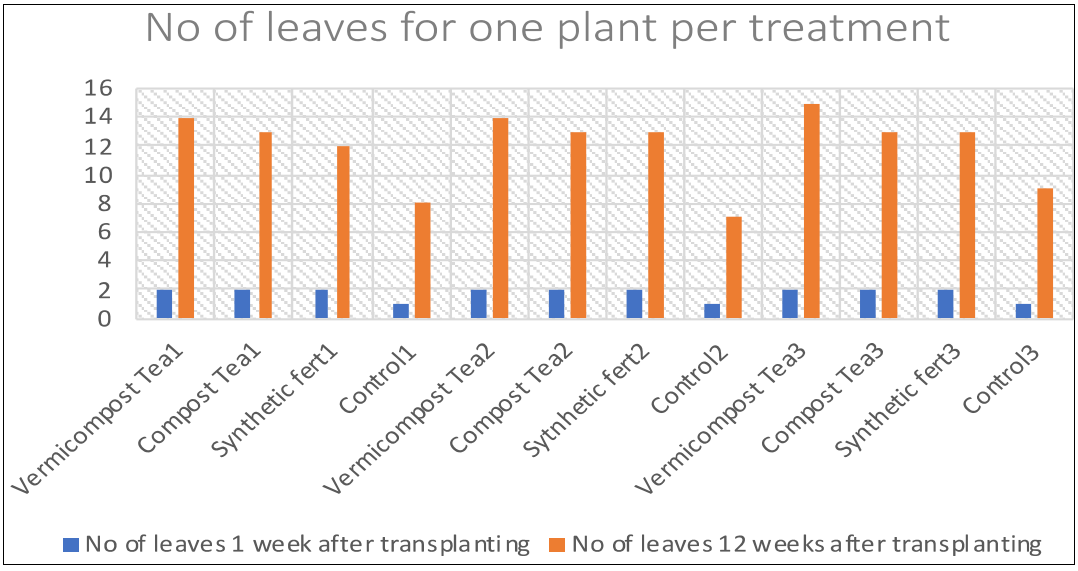

Fig 3: Performance of number of leaves one and twelve weeks after transplanting

Leaf length(cm)

Leaf length was significantly affected by various applications of fertilizers. The highest leaf length was obtained from the vermicompost tea treatment compared to other treatments. Vermicompost tea treatment recorded 75 cm followed by compost tea 73 cm and synthetic fertilizer 65 cm while the control recorded the shortest leaf length of 37 cm. The vermi-compost and compost tea application had a high influence on the leaf length. When comparing the data obtained in one week and week 12 after transplanting among the treatments, the organic fertilizers recorded the highest leaf length (Fig 4).

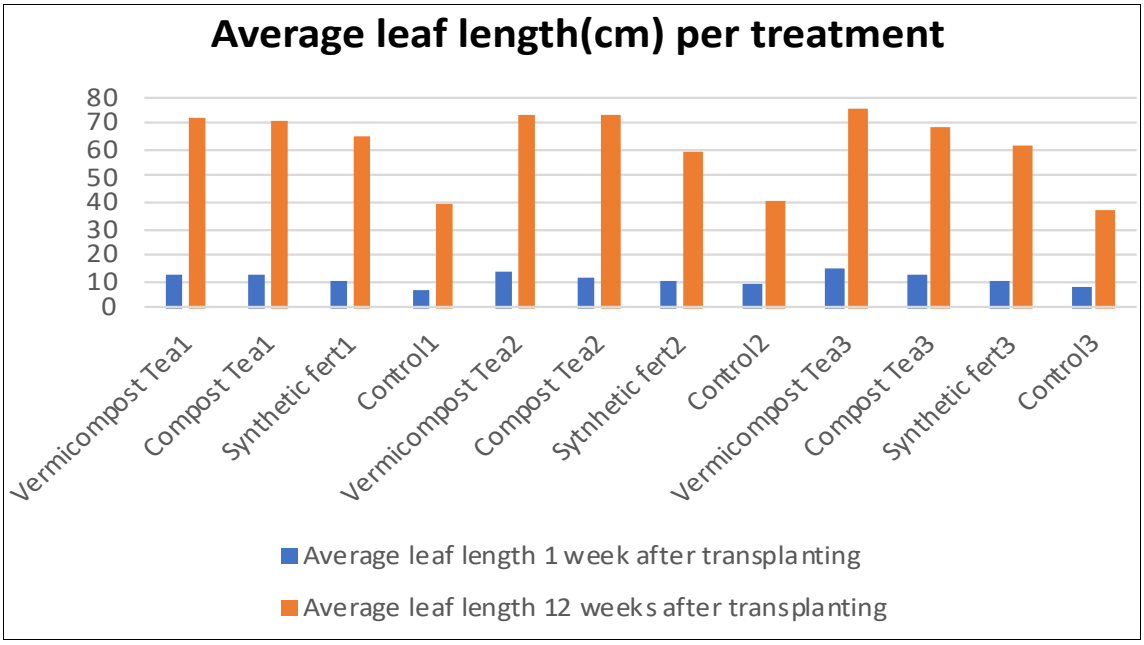

Fig 4: Average of leaf length per treatment in one week and 12 weeks after transplanting

Plant height (cm)

Onion plant height varies depending on the variety of onions. Results indicated, the plant height was significantly influenced by the application of different fertilizers (Figure 5). The plant height ranged from 40 cm to 85 cm among the treatments with an average of 70.58 cm (Table 4). The maximum plant height (85 cm) was recorded from the onions planted in the vermicompost tea treatment, followed by compost tea and synthetic fertilizer, and the shortest plant was observed in the control treatments. The highest increase in plant height took place between weeks five and nine after transplanting.

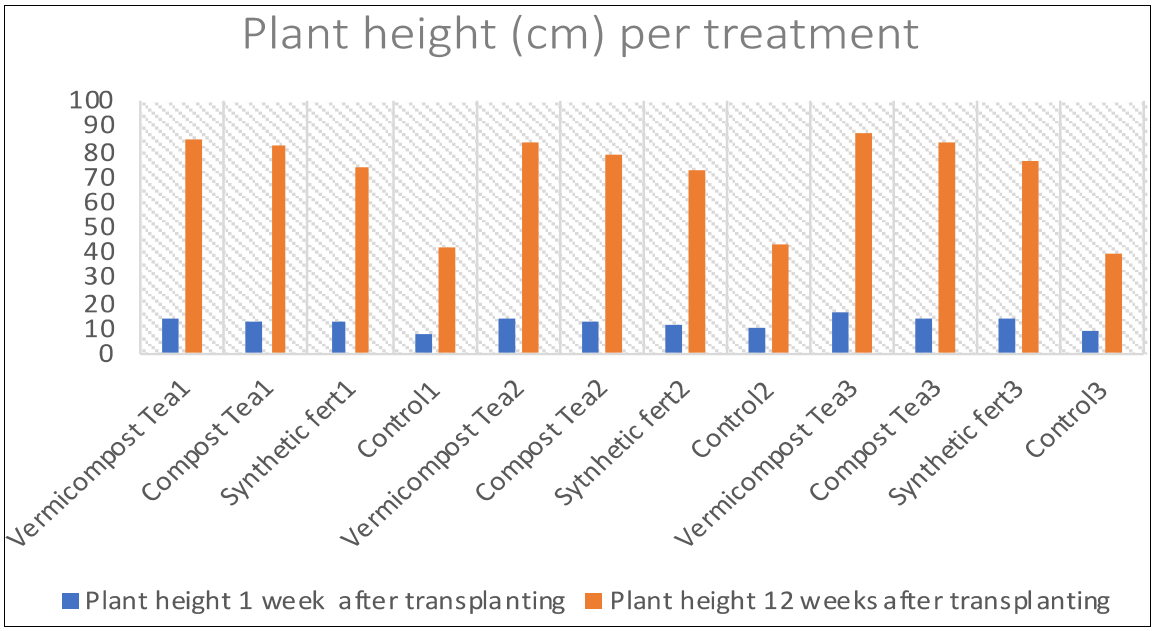

Fig 5: Plant height one and 12 weeks after transplanting per treatment

Yield: Vermicompost and compost tea had a remarkable effect on onion yield. The organic fertilizer treatments had a significant impact on yield when compared to the synthetic fertilizer and control treatments. Vermicompost tea treatment had the best quality of onions. The vermicompost tea treatment produced 48.3 tons/ha while compost tea recorded 21.6 tons/ha. The zero fertilizer treatment produced 2.2 tons/ha.

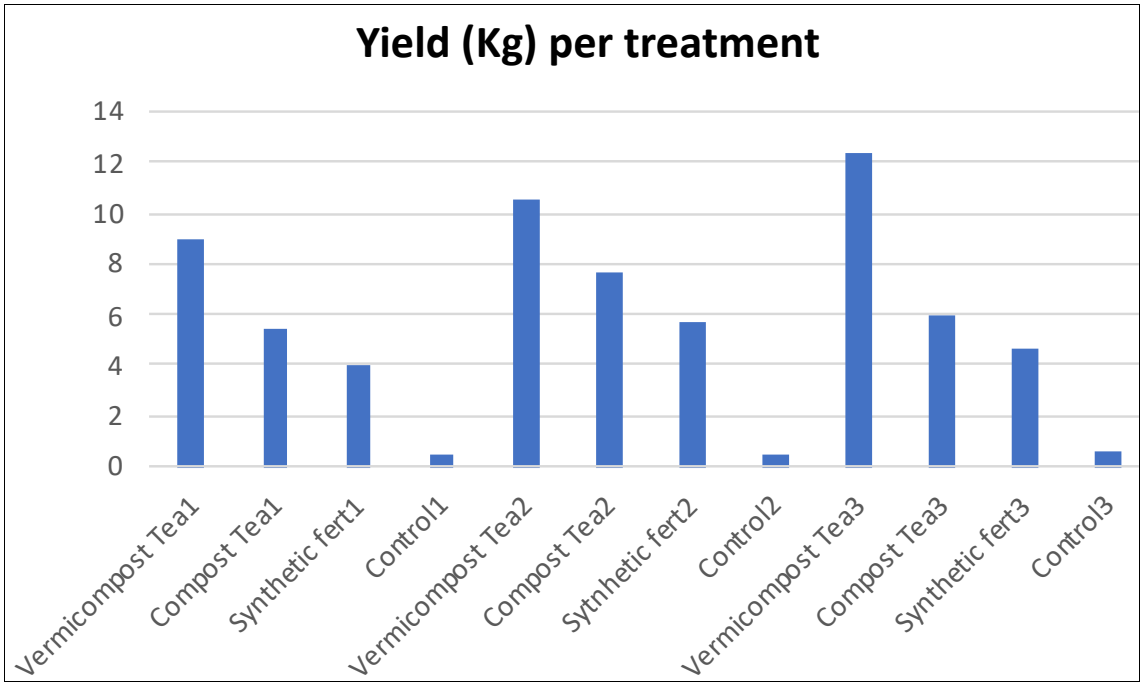

Fig 6: The yield achieved per treatment

Economic Profitability

To attain good yield, onion production requires a high level of cultural management practices. Among the treatments, vermicompost tea was estimated to have a total revenue of $33810 per ha, compost tea with $20009 per ha, synthetic fertilizer with $15120 per ha, and the control had $1540 per ha. As indicated in Table (5), the gross profit per for each treatment was; vermicompost tea 29557 US dollars, compost tea 15532 US dollars, synthetic fertilizer 10549 US dollars, and control with the loss of 559 US dollars.

Table 5: Gross Profit and net profit analysis of onion production per hectare

Treatment	Yield (Vila)	Returns	Cost of goods sold	Gross profit	Expenses	Net profit
Vermicompost						
Tea	48.3	$33,810	$3,603	$30,207	$650	$29,557
Compost tea Inorganic	28.7	$20,009	$3,857	$16,152	$620	$15,532
Fertilizer	21.6	$15,120	$4,237	$10,883	$334	$10,549
Control	2.2	$1,540	$1,979	($439)	$120	($559)

Discussion

When comparing the effects of organic and inorganic fertilizers, the vermi-compost and compost tea gave better vegetative growth and higher yields. Plants growth was highly stimulated by vermicompost because the latter contains nutrients like phosphorus and potassium necessary for growth. (Rizk, *et al*., 2012, Twarg, 2006; Hemmat, *et al*., 2001 and Adepetu, 1997) [7, 9, 4, 1] reported the same trend where Onion plants treated with organic vermicompost and compost tea recorded superior leaf length, more number of leaves, better plant height and yield when compared to synthetic fertilizer and control indicating the beneficial effects of bio fertilizers in onion cultivation. Hemmat *et al*., (2001) [4] was in opinion that combining organic fertilizers and conservation tillage gives higher and comparable yields when compared to artificial fertilizers as the vermicompost and compost offers nitrogen, phosphorus and other elements required to improve the growth and yield of onion plants.

Using vermicompost tea significantly increased the onion plant height, leaf length yield. More leaves per plant were obtained in the vermicompost tea treatment followed by the compost tea treatment indicating the possibility of using organic fertilizers to produce higher yields that are free from dangerous chemicals. Organic fertilizers are affordable, improves soil structure and supporting the growth of strong roots (Twarg 2006) [9]. High yields were recorded with organic fertilizers because of its favorable effects on the physical, chemical and biological properties of the soil thereby supplying required nutrients in their available form through increasing the microbial population in the soil by providing sufficient energy for them to remain active.

Conclusion

The use of organic fertilizers specifically vermicompost and compost tea applied to onion gardens or fields can be advantageous for smallholder farmers. Organic fertilizers can be an alternative fertilizer to increase the production of onions. The yield obtained when vermicompost and compost tea were used is a clear indication that organic fertilizers can boost onion production.

Reference

1. Adepetu JA. Soil and Nigeria food security. Inaugural Lecture series 119. Obafemi Awolowo University, Ile-Ife. Nigeria; c1997.
2. Anisuzzaman M, *et al*. Planting time and mulching effect on *onion* development and seed production. Afr J Biotechnol. 2009;8(3):412-416.

3. Bindura B, *et al*. Performance evaluation of *onion* (*Allium cepa* L.) varieties for their suitability in Kollam district. Int J Res Stud Agric Sci. 2015;1(1):18-20.
4. Hemat A, *et al*. Grain yield of irrigated winter wheat as affected by stubble-tillage management. Soil Tillage Res. 2001;63(1-2):57-64.
5. Hussaini MA, *et al*. Yield, bulb size distribution and storability of *onion* (*Allium cepa* L.) under different levels of N fertilization and irrigation regime. Trop Agric (Trinidad). 2000;77(3):145-149.
6. Kumar *et al*. Review of nutrient management in freshwater polyculture. J Appl Aquacult. 2004;16:17-44.
7. Rizk FA, *et al*. Effect of different nitrogen plus phosphorus and sulfur fertilizer levels on growth, yield and quality of *onion* (*Allium cepa* L.). J Appl Sci Res. 2012;8(7):3353-3361.
8. Snyman HG, *et al*. The stabilization of sewage sludge applied to agricultural land and the effects on seedling. Water Sci Tech. 1998;38(2):87-95.
9. Twarg. Organic agriculture: A trade and sustainable development opportunity for developing countries; c2006.
10. Yai N, Yadav DS. Advances in vegetable production. Research Book Center, Karol Bagh, New Delhi; c2004. p. 995.