

Original Research Article

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## Effect of Different Levels of NPK and Vermicompost on Physico-Chemical Properties of Soil, Growth and Yield of Okra [*Abelmoschus esculentus* L.] var. Rohini

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### ABSTRACT

The field experiment was carried out at soil science research farm of Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad, during Rabi season 2016-17. The design applied was 3x3 factorial randomized block design having three factors with three levels of N, P, K @ 0, 50, and 100 % ha<sup>-1</sup>, three levels of vermicompost @ 0, 50 and 100% ha<sup>-1</sup> respectively. The result obtained with treatment T<sub>5</sub>-[NPK@ 50% + Vermicompost @ 100%] that showed the highest yield regarding, gave the best results with respect to plant height 115.69 cm, number of leaves per plant 49.33, Number of branch 48.50, Number of Fruit per plant 20.71, it gave highest yield, 199.21 q ha<sup>-1</sup>. The maximum cost benefit ratio was recorded 1: 8.55 and net profit. Rs. 37,154.6 ha<sup>-1</sup> in treatment combination T<sub>5</sub>-L<sub>1</sub>V<sub>2</sub> [@ 50% N P K ha<sup>-1</sup> + 100% Vermicompost ha<sup>-1</sup>] combined use of N, P and K resulted in significant increase on enrichment of soil fertility status. Vermicompost in combination resulted in a slight increase in pH 7.40, EC 0.52 dSm<sup>-1</sup>. In post soil of N, P, and K fertilizers observations were resulted in significant increase in OC 0.84 %, particle density 2.73 M gm<sup>-3</sup>, bulk density 1.46 M gm<sup>-3</sup>, pore space 53.06% and available N 229.48 kg ha<sup>-1</sup>, P 24.03 kg ha<sup>-1</sup>, K 147.87 kg ha<sup>-1</sup>, significant increase in case of nitrogen (kg ha<sup>-1</sup>), phosphorus (kg ha<sup>-1</sup>), potassium (kg ha<sup>-1</sup>), vermicompost (t ha<sup>-1</sup>) was found to be significant among other treatments in okra cultivation and soil quality improvement. It was also revealed that the application of NPK with Vermicompost were excellent source for fertilization than fertilizers. The treatment (T<sub>5</sub>) also showed greater benefit cost ratio followed by other treatments.

#### Keywords

Yield attributes, Okra NPK and Vermicompost Physico-chemical properties content, etc.

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### Introduction

Okra is one of the most important vegetable crop grown in tropical and sub-tropical region and is said to be native of South Africa and Asia. In India, it is cultivated almost in all states throughout the year and consumed by bulk of the people. Major okra growing states in India are Uttar Pradesh, Bihar and Orissa. The total area under okra crop in India is about 533'000 ha with production of

6346'000 metric tonnes with productivity 11.90 metric tonnes. In Maharashtra it is grown on an area about 23,000 ha with production of 242'000 metric tonnes with productivity 10.500 metric tonnes in year 2013-14 (Anonymous, 2014).

Bhendi being a short duration crop, its growth, yield and quality are largely

influenced by the application of fertilizers (Somkumar *et al.*, 1997).

Okra is popular and favorable vegetable, grown for tender fruits and fresh market consumption. It is one of the most nutritious vegetables which contains on an average 36 calories energy, 2.4 g protein, 89 per cent moisture, 0.3 g fat, 7.6 g carbohydrates, 92 mg Ca, 51 mg P, 1.5 mg Fe, 3 mg Na and 103 mg K per 100 g of fresh fruits (Bose *et al.*, 1985).

Fertilizers and organic manures play an important role in increasing production, improving quality of vegetables and sustaining soil fertility. Organic manures contain all nutrients which are required for healthy growth of crop and help to improve physical, chemical and biological properties of soil (Halkatti *et al.*, 1997).

Ever increasing cost of energy would be an important constraint for increased use of chemical fertilizers in crop production, use of organic manures to meet the requirement of crop would be an inevitable practice in years to come for sustainable agriculture (Vennila and Jayanthi, 2008).

Nitrogen, phosphorus and potassium are among the common major nutrients, which are essential for the growth and development of all plant species. Nitrogen is the important part of plant parts such as chlorophyll, amino acid, proteins and pigments. Nitrogen makes leafy vegetables and fodder more succulent. It also increases the protein content of food and feed. Therefore proper attention must be given to these nutrients while planning a project on plant nutrition (Khalil, 2006).

Phosphorus is a key element in the formation of high energy compounds, such as AMP, ADP and ATP, which play essential role in photosynthesis and respiration. It is a vital

component of nucleic acids and phospholipids. Plants take up phosphorus in the inorganic form, mainly as the orthophosphate  $H_2PO_4$  ion. Phosphorus supports early phase of crop development, synchronizes the germination process and leading to enhance the final yield, especially in P deficient soil (Arif *et al.*, 2015).

It increases crop resistance to diseases. In contrast to N, deficiency symptoms of P most often, occur in seedlings and young plants. Since P is mobile within the plant, symptoms appear on the lower leaves/parts of the plants (Khalil, 2006).

Vegetable seed production is unique from most agronomic crops as they must develop sufficient vegetative growth prior to cool temperature exposure in order that vernalization may successfully induce flower formation in the following season such as that in Okra.

Its seed production is affected by climatic factors and various agronomic practices including fertilizer application and planting density (Asgedom and Becker, 2001).

Among macronutrients, Phosphorus (P) is an essential macronutrient that can limit plant growth if not provided in sufficient quantities by the soil or external sources.

For soils low in available P, the nutrient must be applied in either organic or inorganic P sources to obtain optimal crop yield. However, excessive use of applied P sources can cause eutrophication in water bodies from surface runoff of sediments carrying P or leaching of P in sandy soils (Chien *et al.*, 2011).

Many researchers reported the effect of phosphorus application on green pod yield of okra, which also improves root growth,

hastens seed maturity and increases fruit yield especially when applied in combination with nitrogen (Sadat, 2000).

## Materials and Methods

A field Experiment was conducted on research farm of department of Soil Science, Allahabad School of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad, (U.P.) India. The soil of experimental area falls in order Inceptisol and the experimental field is alluvial in nature.

The design applied for statistical analysis was carried out with  $3^2$  factorial randomized block design having three factors with three levels of NPK @ 0, 50, and 100% ha<sup>-1</sup>, three levels of Vermicompost @ 0, 50 and 100% ha<sup>-1</sup> respectively. Treatments were T<sub>0</sub> - (L<sub>0</sub> V<sub>0</sub>) @ 0% NPK ha<sup>-1</sup> + 0% Vermicompost ha<sup>-1</sup>, T<sub>1</sub> - (L<sub>0</sub> V<sub>1</sub>) @ 0% NPK ha<sup>-1</sup> + 50% Vermicompost ha<sup>-1</sup>, T<sub>2</sub> - (L<sub>0</sub> V<sub>2</sub>) @ 0% NPK ha<sup>-1</sup> + 100% Vermicompost ha<sup>-1</sup>, T<sub>3</sub> - (L<sub>1</sub> V<sub>0</sub>) @ 50% NPK ha<sup>-1</sup> + 0% Vermicompost ha<sup>-1</sup>, T<sub>4</sub> - (L<sub>1</sub> V<sub>1</sub>) @ 50% NPK ha<sup>-1</sup> + 50% Vermicompost ha<sup>-1</sup>, T<sub>5</sub> - (L<sub>1</sub> V<sub>2</sub>) @ 50% NPK ha<sup>-1</sup> + 100% Vermicompost ha<sup>-1</sup>, T<sub>6</sub> - (L<sub>2</sub> V<sub>0</sub>) @ 100% NPK ha<sup>-1</sup> + 0% Vermicompost ha<sup>-1</sup>, T<sub>7</sub> - (L<sub>2</sub> V<sub>1</sub>) @ 100% NPK ha<sup>-1</sup> + 50% Vermicompost ha<sup>-1</sup>, T<sub>8</sub> - (L<sub>2</sub> V<sub>2</sub>) @ 100% NPK ha<sup>-1</sup> + 100% Vermicompost ha<sup>-1</sup> having the treatments was replicated thrice.

The source of inorganic nutrients sources as Urea, SSP, MOP, and organic nutrients sources as Vermicompost respectively. Basal dose of fertilizer was applied in respective plots according to treatment allocation unfurrows opened by about 5cm. depth before sowing seeds in soil at the same time sowing of seeds was shown on well prepared beds in shallow furrows, at the depth of 5cm, row to row distance was maintained at 30cm and plant to plant distance was 45cm, during

the course of experiment, observations were recorded as mean values of the data.

## Results and Discussion

### Plant height (cm)

At 30 DAS, the maximum plant highest 25.85 cm in T<sub>5</sub>-[NPK @50% +Vermicompost @ 100%], followed by T<sub>3</sub>-[NPK@ 50% + Vermicompost 0%] was 24.53 cm and minimum plant height was observed in T<sub>0</sub> (control) that is 21.52 cm.

At 60 DAS, the maximum 90.74 cm in T<sub>5</sub>-[NPK @50% + Vermicompost@100%], followed by T<sub>3</sub>-[NPK@ 50% + Vermicompost @0%] was 88.23 cm and minimum plant height was observed in T<sub>0</sub> (control) that is 81.40 cm.

At 90 DAS the maximum 115.69 cm in T<sub>5</sub>-[NPK@ 50% RDF + Vermicompost@100%], followed by T<sub>8</sub>-[NPK@100% + Vermicompost@50%] the plant height was 113.53 cm and minimum plant height was observed in T<sub>0</sub> (control) that is 105.71 cm (Mahapatra *et al.*, 2013).

### Number of leaves

At 30 DAS, the maximum number of leaves 13.33 in T<sub>5</sub>-[NPK@50% + Vermicompost@100], followed by T<sub>8</sub>-[NPK@ 100% + Vermicompost@ 100%] the number of leaves was 12.41 and minimum number of leaves was observed in T<sub>0</sub> (control) that is 9.06.

At 60 DAS, the maximum 43.13 in T<sub>5</sub>-[NPK @50% + Vermicompost@100%], followed by T<sub>7</sub>-[NPK@ 100% + Vermicompost@ 50%] the number of leaves was 42.86 a minimum number of leaves was observed in T<sub>0</sub> (control) that is 32.13. At 90 DAS the maximum 49.33 in T<sub>5</sub>-[NPK@ 50% +

Vermicompost @100%], followed by T<sub>6</sub>- [NPK @100% + Vermicompost @0%] the number of leaves was 39.83 and minimum number of leaves was observed in T<sub>0</sub> (control) (Muhammad and Khan, 2015).

### **Number of branch per plant**

At 30 DAS, the Number of Branch per plant 22.43 in T<sub>8</sub>-[NPK@100% + Vermicompost@100], followed by T<sub>7</sub>- [NPK@ 100% + Vermicompost@ 50%] the Number of Branch per plant was 19.27 and Number of Branch per plant was observed in T<sub>0</sub> (control) that is 14.77.

At 60 DAS, the maximum 47.20 in T<sub>8</sub>- [NPK@100% + Vermicompost@100%], followed by T<sub>7</sub>- [NPK@ 100% + Vermicompost@ 50%] the Number of Branch per plant was 44.77 and minimum Number of Branch per plant was observed in T<sub>0</sub> (control) that is 38.37.

At 90 DAS the maximum 48.50 in T<sub>8</sub>-[NPK@ 100% + Vermicompost@100%], followed by T<sub>7</sub>- [NPK @100% + Vermicompost@ 50%] the Number of Branch per plant was 45.60 and minimum Number of Branch per plant was observed in T<sub>0</sub> (control) (Wagh *et al.*, 2014).

### **Number of fruit per plant**

At 90 DAS, the maximum 20.71 in T<sub>4</sub>- [NPK@50% + Vermicompost@50], followed by T<sub>3</sub>- [NPK@ 100% + Vermicompost@ 0%] the number of leaves was 19.86 and minimum No of fruits was observed in T<sub>0</sub> (control) that is 15.56 (Firoz, 2009).

### **Yield (q ha<sup>-1</sup>)**

At 90DAS, the maximum Fruit yield 199.21 in T<sub>5</sub>-[NPK@50% + Vermicompost@100%], followed by T<sub>4</sub>- [NPK@ 50% + Vermicompost@ 50%] the fruit yield was

166.04 and minimum grain yield was observed in T<sub>0</sub> (control) that is 107.81(qha<sup>-1</sup>) (Wagh *et al.*, 2014) (Table 1).

### **Soil pH**

The data showed that there was significant difference between treatments.

The significantly of maximum pH (dSm<sup>-1</sup>) of soil (7.40) was observed in T<sub>5</sub> (N P and K @ 50% + Vermicompost @ 100%) followed by (7.29) with treatment T<sub>2</sub> (N P and K @ 0% + Vermicompost@ 100%) and the minimum (7.10) was recorded with T<sub>0</sub> (N P and K @ 0% + Vermicompost@ 0%).

Similar finding has been recorded by followed by Salvi *et al.*, (2015) (Table 2).

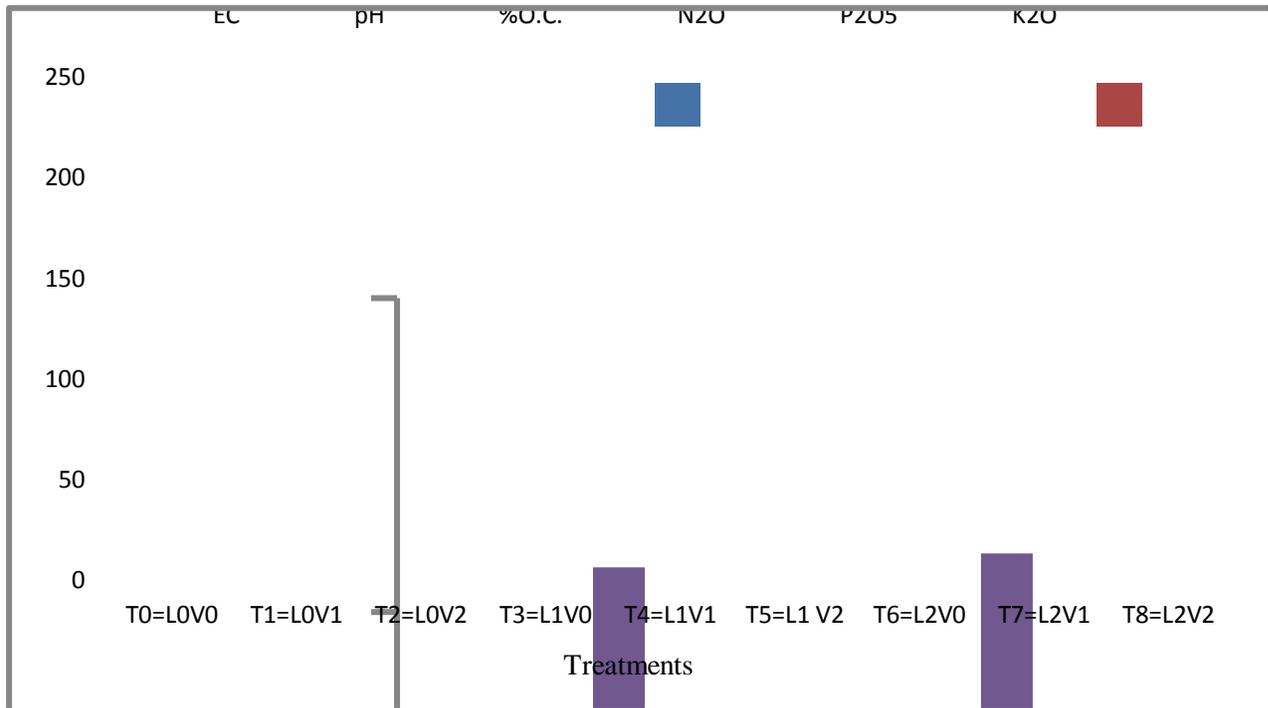
### **EC (dSm<sup>-1</sup> at 25°C)**

The data showed that there was significant difference between treatments. The significantly of maximum EC (dSm<sup>-1</sup>) of soil (0.52) was observed in T<sub>5</sub> (N P and K @ 50% + Vermicompost @ 100%) followed by (0.48) with treatment T<sub>7</sub> (N P and K @ 100% + Vermicompost @ 50%) and the minimum (0.28) was recorded with T<sub>0</sub> (N P and K @ 0% + Vermicompost @ 0%) Simillar finding reported (Salvi *et al.*, 2015).

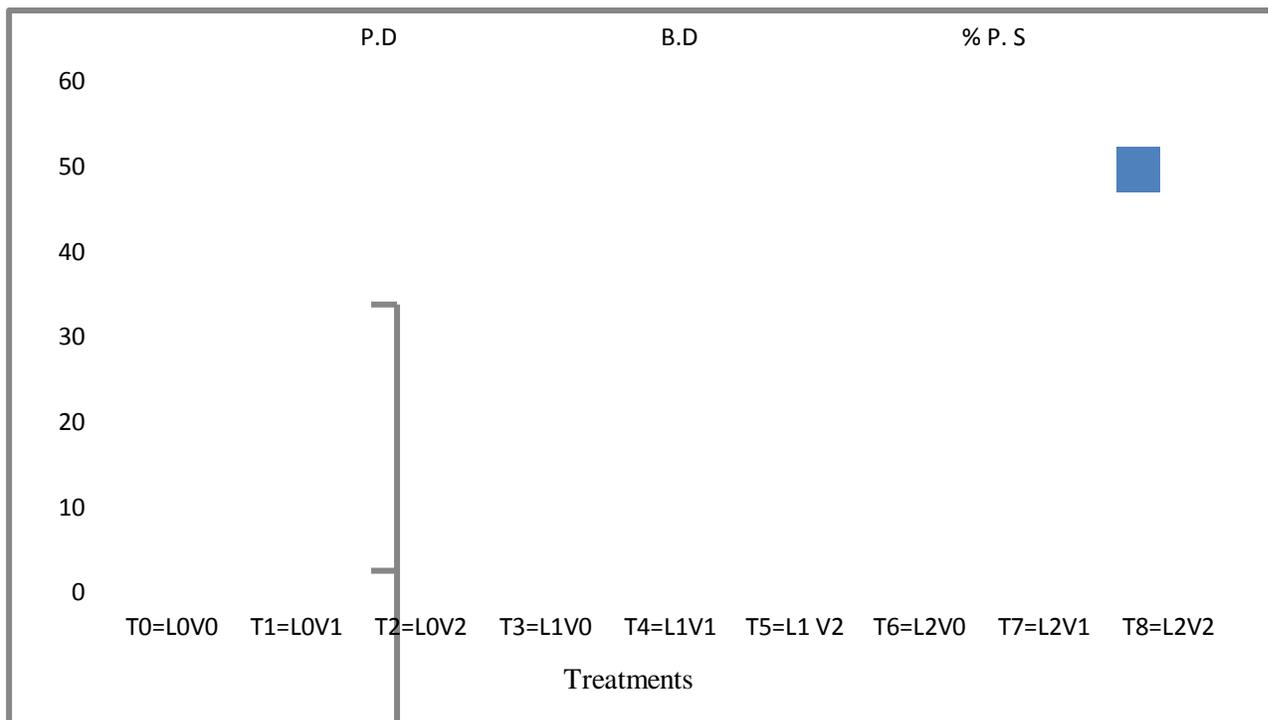
### **% Organic carbon**

The data showed that there was significant difference between treatments. The significantly of maximum soil organic carbon (0.84 g cm<sup>-3</sup>) was observed in T<sub>5</sub> (N P and K @ 50% + Vermicompost @ 100%) followed by (0.75g cm<sup>-3</sup>) with treatment T<sub>7</sub> (N P and K @ 100% + Vermicompost @ 50%) and the minimum (0.60g cm<sup>-3</sup>) was recorded with T<sub>0</sub> (N P and K @ 0% + Vermicompost@ 0%). Similar results have also been recorded by Salvi *et al.*, (2015).

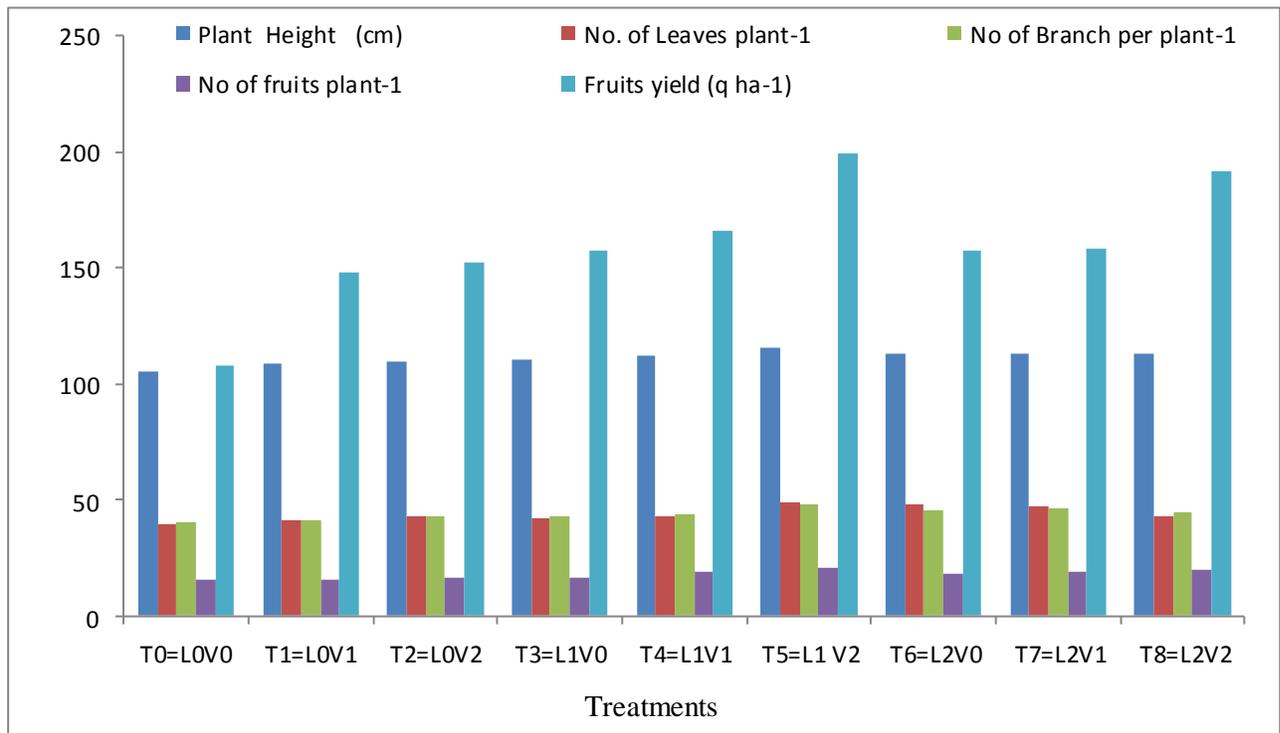
**Fig.1** Estimation of EC, pH, %O.C N<sub>2</sub>O, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O



**Fig.2** Estimation of partical density, bulk density, %pore space



**Fig.3** (1) Plant height (cm); (2) No. of Leaves plant<sup>-1</sup>; (3) No. of Branch per plant<sup>-1</sup>; (4) No. of Fruits plant<sup>-1</sup>; (5) Fruits yield (q ha<sup>-1</sup>)



**Table.1** Effect different levels of NPK and vermicompost on attribute and yield of okra (90 DAS)

TREATMENT	Plant Height (cm)	No. of Leaves plant <sup>-1</sup>	No of Branch per plant <sup>-1</sup>	No of fruits plant <sup>-1</sup>	Fruits yield (q ha <sup>-1</sup> )	Cost Benefit ratio (C:B)
T <sub>0</sub> =L <sub>0</sub> V <sub>0</sub>	105.71	39.83	40.63	15.56	107.81	1:1.71
T <sub>1</sub> =L <sub>0</sub> V <sub>1</sub>	108.43	41.66	41.60	15.98	148.57	1:1.80
T <sub>2</sub> =L <sub>0</sub> V <sub>2</sub>	109.39	43.33	42.60	16.21	152.83	1:0.38
T <sub>3</sub> =L <sub>1</sub> V <sub>0</sub>	110.73	42.06	43.43	16.89	157.91	1:8.54
T <sub>4</sub> =L <sub>1</sub> V <sub>1</sub>	111.93	43.43	43.97	19.49	166.04	1:1.45
T <sub>5</sub> =L <sub>1</sub> V <sub>2</sub>	115.59	49.33	48.50	20.71	199.21	1:8.55
T <sub>6</sub> =L <sub>2</sub> V <sub>0</sub>	113.20	48.16	45.60	18.23	157.81	1:1.53
T <sub>7</sub> =L <sub>2</sub> V <sub>1</sub>	112.87	46.91	46.50	19.21	158.57	1:1.60
T <sub>8</sub> =L <sub>2</sub> V <sub>2</sub>	113.53	42.94	44.37	19.89	191.82	1:2.48
<b>Mean</b>	<b>111.53</b>	<b>44.18</b>	<b>44.13</b>	<b>18.01</b>	<b>160.06</b>	
<b>F- test</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	
<b>S. Em (±)</b>	0.016	0.510	0.236	0.318	0.759	
<b>C. D. at 5%</b>	0.033	1.881	0.501	0.674	1.603	

**Table.2** Effect of different levels of NPK and Vermicompost on Physico-Chemical properties of Soil

TREATMENT	EC	pH	O.C.	P.D	B.D	P. S	N <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
T <sub>0</sub> =L <sub>0</sub> V <sub>0</sub>	0.28	7.1	0.6	2.43	1.16	40.06	207.17	16	115.98
T <sub>1</sub> =L <sub>0</sub> V <sub>1</sub>	0.4	7.14	0.66	2.5	1.37	42.31	209.48	16.61	123.05
T <sub>2</sub> =L <sub>0</sub> V <sub>2</sub>	0.44	7.29	0.73	2.64	1.43	46.31	211.49	17.51	127.83
T <sub>3</sub> =L <sub>1</sub> V <sub>0</sub>	0.46	7.11	0.68	2.62	1.33	47.88	213.48	19	131.11
T <sub>4</sub> =L <sub>1</sub> V <sub>1</sub>	0.43	7.26	0.66	2.57	1.37	47.96	217.19	19.59	127.57
T <sub>5</sub> =L <sub>1</sub> V <sub>2</sub>	0.52	7.40	0.84	2.73	1.46	53.06	229.48	24.03	147.87
T <sub>6</sub> =L <sub>2</sub> V <sub>0</sub>	0.5	7.13	0.69	2.41	1.39	47.02	222.17	21.1	139.95
T <sub>7</sub> =L <sub>2</sub> V <sub>1</sub>	0.48	7.16	0.75	2.57	1.33	48.83	225.2	22.87	144.27
T <sub>8</sub> =L <sub>2</sub> V <sub>2</sub>	0.42	7.11	0.74	2.63	1.34	47.75	219.22	21.21	134.57
<b>Mean</b>	<b>0.436</b>	<b>7.188</b>	<b>0.74</b>	<b>2.566</b>	<b>1.34</b>	<b>46.797</b>	<b>217.208</b>	<b>19.768</b>	<b>132.466</b>
<b>F- test</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>
<b>S. Em (±)</b>	0.029	0.013	0.015	0.078	0.036	0.468	1.588	0.228	2.240
<b>C. D. at 5%</b>	0.062	0.028	0.032	0.166	0.076	0.992	3.367	0.483	4.749

**Particle density (M gm<sup>-3</sup>) of soil**

The data showed that there was significant difference between treatments. The Non-significantly of maximum Soil Particle density (2.73 g cm<sup>-3</sup>) was observed in T<sub>5</sub> (N P and K @ 50% + Vermicompost @ 100%) followed by (2.64g cm<sup>-3</sup>) with treatment T<sub>2</sub> (N P and K @ 0% + Vermicompost@ 100%) and the minimum (2.43g cm<sup>-3</sup>) was recorded with T<sub>0</sub> (N P and K @ 0% + Vermicompost@ 0%). Similar results have also been recorded by Attigah *et al.*, (2013).

**Bulk density (M gm<sup>-3</sup>) of soil**

The data showed that there was significant difference between treatments. The significantly of maximum Soil Bulk density (1.46g cm<sup>-3</sup>) was observed in T<sub>5</sub> (N P and K @ 50% + Vermicompost @ 100%) followed by (1.43g cm<sup>-3</sup>) with treatment T<sub>2</sub> (N P and K @ 0% + Vermicompost @ 100%) and the minimum (1.16g cm<sup>-3</sup>) was recorded with T<sub>0</sub> (N P and K @ 0% + Vermicompost@ 0%).

Similar results have also been recorded by Attigah *et al.*, (2013).

**% pore space of soil**

The data showed that there was significant difference between treatments. The significantly of maximum Soil Pore space (53.06%) was observed in T<sub>5</sub> (N P and K @ 50% + Vermicompost @ 100%) followed by (48.83%) with treatment T<sub>7</sub> (N P and K @ 100% + Vermicompost@ 50%) and the minimum (40.06%) was recorded with T<sub>0</sub> (control). Similar results have also been recorded by Attigah *et al.*, (2013) (Fig. 2).

**Available nitrogen (kg ha<sup>-1</sup>)**

The data showed that there was significant difference between treatments. The significantly of maximum Available Nitrogen (229.48 kg ha<sup>-1</sup>) was observed in T<sub>5</sub> (N P and K @ 50% + Vermicompost @ 100%) followed by (225.20 kg ha<sup>-1</sup>) with treatment T<sub>7</sub> (N P and K @ 100% + Vermicompost @ 50%) and the minimum (207.17 kg ha<sup>-1</sup>) was recorded with T<sub>0</sub> (control).

Similar results have also been recorded by Salviet *et al.*, (2015).

### Available phosphorus (kg ha<sup>-1</sup>)

The data showed that there was significant difference between treatments. The significantly of maximum Available phosphorous (24.03 kg ha<sup>-1</sup>) was observed in T<sub>5</sub> (N P and K @ 50% + Vermicompost @ 100%) followed by (22.87kg ha<sup>-1</sup>) with treatment T<sub>7</sub> (N P and K @ 100% + Vermicompost @ 50%) and the minimum (16.00kg ha<sup>-1</sup>) was recorded with T<sub>0</sub> (control). Similar results have also been recorded by Salvi *et al.*, (2015).

### Available potassium (kg ha<sup>-1</sup>)

The data showed that there was significant difference between treatments. The significantly of maximum Available potassium (147.87 kg ha<sup>-1</sup>) was observed in T<sub>5</sub> (N P and K @ 50% + Vermicompost @ 100%) followed by (144.27 kg ha<sup>-1</sup>) with treatment T<sub>7</sub> (N P and K @ 100% + Vermicompost@ 50%) and the minimum (115.98 kg ha<sup>-1</sup>) was recorded with T<sub>0</sub> (control). Similar results have also been recorded by Salvi *et al.*, (2015).

It is concluded from trail that the various levels of nutrients used from different sources in the experiment. The combined application of NPK fertilizers @ N<sub>20</sub>P<sub>50</sub>K<sub>30</sub> kg ha<sup>-1</sup> + Vermicompost@ 5t ha<sup>-1</sup> was found to be the best in the plant height (115.69cm), no. of leaves per plant (49.33), Fruits yield (199.21 q ha<sup>-1</sup>) (Fig. 3). The physical and chemical properties of soil such as bulk density (1.46 Mgm<sup>-3</sup>), particle density (2.73 Mgm<sup>-3</sup>), pore space (48.83%) and EC (0.52 dSm<sup>-1</sup>), pH (7.40), % organic carbon (0.84), available N (229.48kg ha<sup>-1</sup>), P (24.03 kg ha<sup>-1</sup>), K (147.87 kg ha<sup>-1</sup>), was found to be the best in the treatment combination of T<sub>5</sub> (Figs. 1–3). The maximum net return (37,154.6 ₹ /ha<sup>-1</sup>) was achieved in the treatment combination of T<sub>5</sub>. Since the result is based on one season

experiment. Therefore, further trial is needed to substantiate the results.

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