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APPRAISAL OF SOIL PROPERTIES OF *SOLANUM MELONGENA* L. TO DIFFERENT GROWTH CONDITIONS

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ABSTRACT The response of brinjal plants to organic fertilizers and inorganic fertilizers under pot experiment investigated. This in-vivo experiment did in the Genetics and Plant Breeding Division of the Department of Botany, University of Calicut. Brinjal plants treated with three sources of organic fertilizers (vermicompost, groundnut cake and bonemeal), three sources of inorganic fertilizers (NPK 16:16:16, NPK 10:5:20 and urea) compared with control. The experimental design followed was a Randomized Complete Block Design (RCBD) with twenty-five replicates. Soil properties were analyzed by collecting the soil from nine representative samples from each treatment. The soil parameters such as the pH, electrical conductivity (mhos/cm), total organic carbon (%), total organic matter, total nitrogen, phosphorus (kg/ha), potassium (g/ha), manganese, sulphur, iron, zinc, copper and boron were analyzed. The results showed that the macro and micronutrient availability increased in organic fertilizer treatments. Vermicompost increased soil properties significantly. The percentage of organic carbon increased in organic fertilizer treatments. The same result showed in the case of total organic matter. Groundnut cake treatment gave the highest organic matter (4.75). Total nitrogen was highest in bonemeal (0.95) and potassium was highest in vermicompost (330kg/ha). Phosphorous (48.33kg/ha) and sulphur (43.1mg kg-1) were recorded highest in bonemeal. The highest values of trace elements (25 mg kg-1for Fe in groundnut cake; 0.96mg kg-1Cu, 14mg kg-1 Mn, 5.1mg kg-1 Zn and 0.98 mg kg-1 B in vermicompost observed. Therefore, 38% of the increase in iron, 17.0% off copper,14.75% increase in manganese, 2.82% increase in zinc and 20.99% increase seen in boron.

KEYWORDS : brinjal, organic fertilizer, inorganic fertilizer, RCBD, vermicompost, groundnut cake, bonemeal and NPK.

INTRODUCTION

Vegetable cultivation is a customary practice all over the world. In India, brinjal is a staple vegetable and its nutritional value differs among varieties. It is the member of the family Solanaceae. It is known as the 'King of vegetable.' Fertilizer is one of the influential factors of crop production. These amendments were used to increase nutrition to plants. Expansion of technology needed to supply plant nutrients through organic resources. Their balanced application maintains the productivity of the soil. Soil may vary from place to place by its structure, components and properties. The physicochemical analysis of soil enables one to reach plants' nutritional requirements and their proper growth pattern. The performance of particular soil in plant growth largely determines the fertility that plants will grow in it (Anderson, 2002). Organic farming demonstrates many advantages for soil and upgrades the health of flora and fauna. It also recycles and regenerate the waste into wealth and abolishes the use of chemicals in fertilizers and pesticides. It builds a balanced, sustainable model for the ecofriendly environment.

Along with uprising nutrients, organic fertilizer breaks down and improves the soil structure and increase its ability to hold water and nutrients. Organic fertilizers create the soil and plants healthy and robust. Growth promoting constituents like enzymes and hormones present in organic manures make them improve soil fertility and productivity. Therefore, some efforts are needed to fulfill a part of nutrients and improve the soil's physical, chemical, and biological traits by applying organic fertilizers.

MATERIALS AND METHODS

The present study was conducted in the Plant Breeding Division of the Department of Botany, University of Calicut (75°46' E longitude and 11° 15' N). Different growth conditions created by applying fertilizers such as vermicompost (VM), groundnut cake (GNC) and bonemeal (BM); three chemical fertilizers such as NPK 16:16:16(N16) and NPK 10:5:20(N10) and Urea (UR). Fertilizer application did by following the Package of Practices Recommendations of Kerala Agricultural University. Randomized Complete Block Design (RCBD) with twenty-five replicates of each treatment selected as the experimental design. Nine representative soil samples were collected from each treatment. The soil samples were preserved in a polythene bag for physicochemical analysis. AR grade chemicals and reagents were used. All organic fertilizers used for the experiment were analyzed for the basic composition and to fix it. Organic fertilizers such as vermicompost, groundnut cake and bonemeal; chemical fertilizers such as NPK 16:16:16 and NPK 10:5:20 and urea were selected for the experiment. The plant only with potting mixture treated as control. Before experimenting, the organic fertilizer and water were chemically analyzed (Table: 1 and Table 2, respectively).

Table 1: Composition of organic fertilizers

Sl.No	Parameters Tested	Fertilizers		
		VM	GNC	BM
1.	pH	5.96	6.54	5.86
2.	Electrical conductivity (dSm^{-1})	0.01	0.02	0.14
3.	Moisture (%)	73.5	2.6	4.6
4.	Carbon (%)	36.85	55.17	43.23
5.	Nitrogen (%)	3.92	1.8	3.8
6.	Phosphorus (%)	1.6	0.6	23.53
7.	Potassium (%)	1.06	1.6	0.45
8.	Iron (mg/kg)	3462	741.2	4520
9.	Manganese(mg/kg)	59.6	73.8	88.2
10.	Zinc	35.6	39.8	55.6
11.	Copper	*BDL	11.00	32.4

Table 2: Physicochemical parameters of water

Sl. No.	Characteristics	Unit	Actual contents per Sample
Physical parameters			
1	Turbidity	NTU	0.7
2	Electrical conductivity	Micro mhos/cm	109
3	pH	-	6.7
4	Total Dissolved Solids		59.9
Chemical parameters			
5	Acidity	mg/litre	20
6	Alkalinity	mg/litre	28
7	Total Hardness	mg/litre	26
8	Calcium	mg/litre	6.4
9	Magnesium	mg/litre	2.4
10	Chloride	mg/litre	20
11	Fluoride	mg/litre	0.40
12	Iron	mg/litre	BDL
13	Nitrate	mg/litre	0.85
14	Sulphate	mg/litre	2.11

Physicochemical analysis of soil

Pre-planting soil samples were collected from the site and then bulked separately, while post-planting soil samples were collected from the nine replicates according to the treatments and bulked. The air-dried soil samples were allowed to pass through a 2 mm sieve. Physical and chemical analysis of soil was then carried out.

Table 3: Pre and post-harvest physicochemical analysis of soil

	Parameters		POST ANALYSIS OF SOIL						
Sl.No		Pre-analysis-of soil	STD	VM	GNC	BM	N16	N10	UR
1.	p^H	5.9	5.1	5.2	5.4	**5.6**	4.3	4.5	5.2
2.	Electrical conductivity (mhos/cm)	0.1	0.2	0.2	0.1	0.2	0.1	0.4	0.3
3.	Total organic carbon (%)	1.38	1.43	**1.55**	1.53	1.51	1.10	1.27	1.18
4.	Total organic matter	3.22	3.23	4.27	**4.75**	3.96	3.22	3.11	2.69
5.	Total Nitrogen	0.63	0.63	0.69	0.74	**0.95**	0.69	0.69	0.64
6.	Phosphorus (Kg/ha)	36	36	47.8	44.5	**48.3**	40.5	39.2	36.1
7.	Potassium (Kg/ha)	261	209	**330**	253	264	198	200	204
8.	Manganese	12.2s	11.39	**14**	12.0	12.0	9.0	12.0	11.0
9.	Sulphur	12s	16.93	19.3	28.4	**43.1**	18.7	30.1	23.8
10.	Iron	34.5s	24.71	14.0	**25.0**	13.00	15	23.00	11
11.	Zinc	4.96s	3.94	**5.1**	3.47	2.65	2.62	3.05	2 .41
12.	Copper	0.82s	0.6	**0.96**	0.70	0.5	0.70	0.4	0.4
13.	Boron	0.81s	0.89	**1.4**	1.01	0.97	0.98	0.96	0.94

pH

The pH of the soil samples was determined by following Jackson (1958). The oven-dried soil sample weighing 12.5g was suspended in 25 ml of distilled water and stirred continuously. The pH was measured using a calibrated pH meter.

Electrical conductivity (mhos/cm)

The soil sample's electrical conductivity was measured in 1:2 (soil: water suspension) at 25^{0}C using a conductivity meter (Bower and Wilcox, 1965).

Total organic carbon (%)

The Walkley-Black procedure was followed. This involves wet combustion of soil with a mixture of Potassium dichromate and Sulphuric acid at about 125^{0}C. The residual dichromate is titrated against Ferrous sulphate (Nelson and Sommers, 1982).

Total organic matter

The soil samples' total organic content was estimated by using the Walkley-Black (1934) Rapid titration method. Two grams of soil was taken in a conical flask, and10 ml of 1N $K_2Cr_2O_7$ solution was added and mixed thoroughly. Then 20 ml of concentrated H_2SO_4 was added by continuously swirling the flask. The contents were allowed to cool and then added 10 ml of Orthophosphoric acid and 100 ml of distilled water. Ten drops of Diphenylamine indicator were added, which gives violet colour to the suspension. Titration was done with Ferrous ammonium sulphate (FAS) solution. The endpoint in this titration changes the colour from violet to bright green. The volume of Ferrous ammonium sulphate solution used was noted and thus calculated.

Total Nitrogen

The sample was digested in boiling concentrated sulfuric acid. Add surplus of sodium hydroxide solution, the ammonium ion released in ammonia form, distilled and received on a boric acid solution or a sulfuric or hydrochloric acid volumetric solution. The Ammonia is determined with a volumetric acid solution or by back titration with sodium hydroxide solution of a known concentration if received on hydrochloric or sulfuric acid. The results can be expressed in % N, % NH_3, or protein (%N x-factor) (Michael and Dean, 2014).

Phosphorus (kg/ha)

Available phosphorus was estimated by Olsen's method (Olsen *et al*., 1954). 100 ml of 0.5 M sodium bicarbonate (pH 8.5) added to 5g of soil in a 250 ml conical flask. One teaspoonful of carbon black and shaken for 30 minutes and filtered through filter paper (No. 40). 10 ml of the filtrate was pipetted out into a 50 ml volumetric flask. Addition of a drop of p-nitrophenol indicator and the pH was adjusted to 3.0 with 4N HCl. Then five drops of 0.1 N stannous chloride were added and it was continuously shaken. The colour intensity was read photometrically after 5 min with a 660 light red filter in a photoelectric calorimeter. The quantity of phosphorus was calculated as mg/L.

Potassium (kg/ha)

Out of the total non-exchangeable form (fixed K) of potassium present in soil samples, a small amount of potassium is held in an exchangeable form (available K). The available potassium in soil samples was estimated by Flame photometric method 25 ml of 1N Ammonium acetate was added to a 150 ml conical flask with a 5g of air-dried soil sample and shaken for five minutes mechanically and immediately filtered through a dry grade-1 filter paper. 25 ml of distilled water added to 5ml of the filtrate. The diluted extract was atomized to a flame photometer to note the potassium quantity in soil samples (mg/L) (Jackson, 1958).

Manganese, Sulphur, Iron, Zinc, Copper and Boron

For analysis of Cu, Fe, Zn and Mn, processing was carried out according to the procedure given by Lindsay and Norvell (1978). The soil samples were air-dried. The extractant consists of DTPA solution i.e. 0.005M DTPA (Diethylene triamine penta acetic acid), 0.1M triethylamine and 0.01M $CaCl_2$ with pH 7.3. The soil test consists of shaking 10g of air-dried soil with 20 ml of extractant for 2 hours. The leachate of all the four metals was filtered and measured in the filtrate by atomic absorption spectroscopy. The standards of the heavy metals were prepared by dissolving respective salts to get 1000 mg metal/L of the solution. For Zn, 4.398g of $ZnSO_4.7H_2O$ was added to one litre of double-distilled water. Similarly, for Cu, 3.929g of $CuSO_4.5H_2O$, for Fe, 4.977g of $FeSO_4.7H_2O$ and for Mn, 3.598g of $MnSO_4.H_2O$ were used. The various heavy metals' absorption was done using Atomic Absorption Spectrophotometer (AAS) at 213.9 nm for Zn, 324.8 nm for Cu, 248.3 nm for Fe and 279.5 nm for Mn.

RESULTS

Pre-analysis gave an idea about the initial makeup and fertility status of soil and the post-analysis of soil showed significant changes after cultivation. The pre-analysis of soil results showed a moderate acidic nature of soil pH (5.4) with 0.63 of total nitrogen of 36 kg/h of phosphorus and 261kg/h of potassium content, respectively optimum for most crops. Organic fertilizer helped keep soil pH, a measure of acidity or alkalinity, in a healthy range for crops. Inorganic fertilizer made the soil more acidic and more soil organic carbon for all the estimated soil depths to inorganic fertilizer and control treatments. Abundant carbon means a better soil structure. Organic amendments significantly increased total nitrogen compared to fertilizer treatments. The integrated effects of fertilizers on the brinjal plant tabularized along with statistical data. A significant difference in all the combinations of treatments has been observed when compared to control. The various physical and chemical properties of the soil used are shown in Table:3. The textural class of the soil is sandy clay loam. The detected physicochemical parameters of soil before starting the experiment were pH (5.4), electrical conductivity (0.1 mhos/cm), total organic carbon (1.38%), total organic matter (3.22), total nitrogen (0.63), phosphorus (36 Kg/ha), potassium (261 Kg/ha), manganese (16.2s), Sulphur (12s), iron (34.5s), zinc (4.96s), copper (1.82s), boron (0.81s).

Post experimental results showed that the soil pH, soil potassium, total organic matter, total organic carbon and total nitrogen were significantly affected by applying organic and inorganic fertilizers. The magnitude of variation of N, P, K and Fe, Cu, Mn and Zn contents concerning fertilizer treatments were apparent. Soil pH showed with the range varying from 4.3 (NPK 16:16:16) to 5.6. Bonemeal (5.6) showed the least reduction from the pre-analyzed soil pH (5.9). Total organic carbon was highest in vermicompost (1.55%) treated soil. An increase of 12.31% of the pre-soil organic carbon was obtained. The percentage of organic carbon decreased in inorganic fertilizer treatments. The same result showed in the case of total organic matter.

Groundnut cake treatment gave the highest organic matter (4.75) increase from 3.22. 47.5% increase had seen. Total nitrogen is highest in bonemeal (0.95) and potassium was highest in vermicompost (330kg/ha). Table:3 showed that adding organic materials to soil leads to a significant increase in nutrient availability of soil. Phosphorous (48.33kg/ha) and sulphur (43.1mg kg^{-1}) were recorded highest in bonemeal.

The highest values of trace elements (25 mg $kg^{-1}$for Fe in groundnut cake; 0.96mg kg^{-1}Cu, 14mg kg^{-1} Mn, 5.1mg kg^{-1} Zn and 0.98 mg kg^{-1} B in vermicompost observed. Therefore, macro and micronutrient availability increased in organic fertilizer treated soil. Among the treatments, vermicompost increased soil properties significantly. 38% of the increase in iron, 17.0% of copper, 14.75% increase in manganese, 2.82% increase in zinc and 20.99% increase seen in boron.

DISCUSSION

Several investigators reported the positive effect of applying organic fertilizer on the soil. They ascribed to the mineralization of nitrogen from compost during its composition and might be the biological fixation of atmospheric nitrogen and its reflection on soil fertility. Increasing phosphorous soil content due to the application of organic fertilizers might result from its decomposition and producing organic acids, which increases the nutrients available in the soil. It might also be due to these nutrients' additions after the decay of the organic fertilizers (Mahmoud, 2000) and preventing the fixation of phosphorous and probably other nutrients (Ahmed and Osman, 2003). Rasoli and Forghani (2006) also reported that different organic fertilizers influenced the soil's zinc and manganese content. The higher available nutrients status by the use of organics manure, which is more readily hydrolyzed by the organic materials, made the solubilization of phosphorous, potassium and micronutrients from mineral fertilizers easier and resulted in an increased nutrients availability. It will explain by regulating nutrient release from sources phosphorus and potassium combined with organic matter, which plays an essential role in ensuring efficient utilization of phosphorus and potassium-phosphorus interaction or the phosphorus's integrated management and Potassium (Lewis *et al*., 1981).

Salam *et al*. (2015) pointed out the chicken manure caused an increase in the soil available Fe, Mn and Zn compared with other treatments. The magnitude of N, P, K and Fe, Cu, Mn, and Zn contents concerning organic treatments were apparent, supporting the current study.

Many chemical fertilizers do not contain micro-nutrients; however, specific trace element fertilizers are available in regions where their application is economically necessary. They do not add organic content to the soil. It is clearly understood from the present investigation. Both organic and inorganic fertilizers supply plants with the nutrients will grow healthy and strong. However, each contains different ingredients and supplies these nutrients in different ways. Organic fertilizers work overtime to create a healthy growing environment, while inorganic fertilizers provide rapid nutrition. Ozlu *et al*. (2019) concluded that manure's long-term annual application improved most soil quality properties than inorganic fertilizer. Results showed the nitrogenous fertilizer might result in the deficiency of other nutrients and a decline in soil chemical, biological, physical properties (Kaur *et al*., 2005).

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