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Effect of biofertilizer and organic manure on yield and yield contributing characters of beetroot (*Beta vulgaris* L.)

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Abstract
The present investigation entitled "Studies on organic production of beetroot (*Beta vulgaris* L.) was carried out during *rabi* season of year 2016-2017 at Horticulture Farm, Department of Horticulture, Dr. PDKV, Akola. The experiment was laid out in Randomised Block Design (RBD) with three replications and ten treatments comprises 100 % RDF, FYM, vermicompost, neem cake alone and in combination with *azatobacter*, PSB, VAM as soil treatment.

The results of present investigation indicated that, yield and yield contributing characters was increased due to different organic sources of nutrient and *azatobacter*, PSB, VAM. All organic sources of the nutrients influenced the growth, yield parameter of beetroot.

The treatment combination of organic nutrient sources T_6 i.e. vermicompost @ 9.2 tha^{-1} + *azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (40 kg ha^{-1}) as soil treatment was found to be significantly superior for growth and yield attributes i.e. root circumference (20.83 cm), root length (8.03 cm), root diameter (6.27 cm), average root weight (158.33 g), root yield per plot (4.75 kg) and root yield per hectare (234.33 q) of beetroot, which was at par with treatment T_7 i.e. neem cake @ 2.5 tha^{-1} + *azatobacter* (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (40 kg ha^{-1}) as soil treatment.

Considering the cost economics, the treatment T_6 i.e. vermicompost @ 9.2 t ha^{-1} + azatobacter (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (40 kg ha^{-1})) were found to be most remunerative and profitable as per its benefit cost ratio (3.51:1) as compared to remaining treatment and absolute control (T10).

Keywords: Beetroot, Biofertilizers, Organic mannure, and Yield.

Introduction

In human nutrition Vegetable play an important role as they provide carbohydrates, protein, fat, vitamin and mineral. It is also called as protective food. For daily consumption 300 g of vegetables in which 125 g green leafy vegetables, 100 g root and tubers and 75 g other vegetable is recommended. India ranks second in the world for area and production of vegetables. The total area under vegetable in India is 8.98 million ha. and with 156.32 million tonnes of annual production and average productivity level is 17.4 tonnes/ha. An area under vegetable crops in Maharashtra is 6.11 lakh ha with 75.04 lakh tonnes of annual production and average productivity 12.3 tha^{-1}. (Annon, 2012) [1]. The major growing states of vegetables are West Bengal, Bihar, Uttar Pradesh, Karnataka, Punjab, Maharashtra and Assam.

The addition of organic fertilizer to agricultural soil has beneficial effect on crop development and yield by improving soil physical and biological properties. Organic and biofertilizer in comparison to the chemical fertilizer have lower nutrient content and slow release but they are as effective as chemical fertilizer over long period of usage. Also, several researchers revealed that organic manuring increased the vegetative growth and biomass production effectively. In recent year's use of organic manures like FYM, vermicompost, neemcake for improving the productivity of crops and maintaining soil fertility and productivity of soil is gaining prominence. The organic manuring has positive influence on soil texture and water holding capacity (Kale *et al.*, 1991) [2]. Several attempts have been made to increase yield potential of root crops, but they are concerned with use of inorganic fertilizers which results in loss of soil fertility and soil health. In this context, the use of organics and biofertilizers like FYM, vermicompost, neemcake, Fermented cow dung slurry, *azatobacter* VAM and PSB is gaining more importance for getting higher yield.

Nutrient management is most important in beet root to obtain good growth and higher yield of root crops. The crop benefiting microbial inoculatants generally called biofertilizers, help in

augmenting the crop productivity through effective mobilization of major plant nutrient like N, P and K and other minor nutrients needed by the crop. These beneficial microorganisms are also known to secrete plant growth promoting substances like IAA, GA, Cytokinins, vitamins for the improvement of crop growth, yield and for quality produce. (Kumar *et al.,* 2013) [3]

Materials and Method

The present investigation entitled, "Studies on organic production of beetroot (*Beta vulgaris* L.) Was carried out during *rabi* season of 2016-2017 at Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

The experiment was laid out in Randomized Block Design with three replication. There were 10 treatment tested to study the effect of different organic nutrient sources on growth, yield and quality parameters in beetroot vr. Detroit Dark Red. In the treatments, T_1 includes recommended dose of fertilizers (125:50:70 kg of NPKha^{-1}). T_2, T_3 and T_4 (T_2 - Farm yard manure, T_3 - vermicompost and T_4 - neemcake) the only organic sources of nutrients are used. In the treatment T_5, T_6 and T_7 T_5 – FYM @ 12.5 tha^{-1} + azatobacter (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (40 kg ha^{-1}), T_6 – vermicompost @ 9.2 t ha^{-1} + azatobacter (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM(40 kg ha^{-1}) and T_7 – neemcake @ 2.5 t ha^{-1} + azatobacter (10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM(40 kg ha^{-1}). In treatment T_8, T_9 and T_{10} (T_8 – Fermented cow dung slurry @ 6 lit/m^2 in 2 splits, T_9 - Fermented cow dung slurry @ 6 lit/m^2 in 2 splits + azatobacter (100g/200lit) + PSB (100g/200lit) + VAM (200/200lit) and T_{10} (Absolute control).

Results and Discussion

1. Root circumference (cm)

The significantly maximum root circumference (20.83 cm) was recorded in treatment T_6 i.e. vermicompost @9.2 t ha^{-1} + azatobacter 10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (10 kg ha^{-1}), which was at par with T_7 (20.73 cm), T1 (20.50) and T_5 (20.00 cm), showed significant superiority over all other remaining treatments. The lowest root circumference was recorded in T_{10} (10.60) i.e. absolute control.

This might be due to increased and readially available nutrients and their uptake, which might have contributed to increased root circumference there by increased root yield.

2. Root diameter (cm)

That effect of different organic nutrient sources on root diameter was found to be significant.

The highest root diameter was recorded in treatment T_6 i.e. vermicompost @9.2 t ha^{-1} + *azatobacter* 10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (10 kg ha^{-1}), which found at par with T_7 (6.06 cm) and T_1 (6.13 cm), indicating significantly superior over all other treatment at harvest. The lowest root diameter was recorded in T_{10} (4.93 cm) i.e. control.

Decrease in bulk density and increase in porosity and water holding capacity of the soil due to organic nutrient sources might have contributed in increasing root diameter of the plants.

3. Root length (cm)

The effect of different organic nutrient sources on root length was found to be statistically significant.

The highest root length (8.03 cm) was recorded in treatment T_6 i.e. vermicompost @9.2 t ha^{-1} + azatobacter 10 kg ha^{-1}) + PSB(10 kg ha^{-1}) + VAM(10 kg ha^{-1}) followed by T_7 (7.80 cm), T_5 (7.63 cm) and T_1 (7.92 cm) which was at par with each other, while the lowest root length was recorded in T_{10} (6.20 cm) i.e. control.

4. Root weight (g)

The effect of different organic nutrient sources on root weight was found to be significant.

The significantly maximum root weight (158.33 g) was recorded in treatment T_6 i.e. vermicompost @9.2 t ha^{-1} + azatobacter 10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (10 kg ha^{-1}), which found at par with T_7 (135.33 g) and T_1 (141.0 g), and statistically significant over all other remaining treatments. The minimum root weight was recorded in T_{10} (95.33 g) with absolute control.

5. Root yield plot^{-1} (kg)

The effect of different organic nutrient sources on root yield plot^{-1} (kg) was found to be significant.

The significantly maximum root yield per plot (4.75 kg) was recorded by treatment T_6 i.e. vermicompost @ 9.2 t ha^{-1} + azatobacter 10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (10 kg ha^{-1}) followed by treatment T_1 i.e. RDF (4.23 kg) (125:50:70 kg of NPK ha^{-1}) T_7 (4.06 kg) i.e. neemcake@9.2 t ha^{-1}+ azatobacter10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (10 kg ha^{-1}),which was statistically significant superior over all other remaining treatments and the lowest was recorded in T_{10} (3.09) i.e. control.

6. Root yield hectare^{-1} (q)

The effect of different organic nutrient sources on root yield hectare^{-1}was found to be statistically significant.

The highest root yield ha^{-1} was recorded in T_6 (234.33 q) with the application of treatment T_6 i.e. vermicompost @9.2 t ha^{-1} + *azatobacter* 10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (10 kg ha^{-1}) which was significantly superior over all other treatments.

Table 1: Root circumference (cm), Root diameter (cm) and Root length (cm) as influence by various treatments of organic nutrient sources

Treatments	Root circumference (cm)	Root diameter (cm)	Root length (cm)
T_1 RDF (125:50:70 kg NPK ha^{-1})	20.50	6.13	7.92
T_2 Farm yard manure @ 12.5 t ha^{-1}	17.93	5.33	6.70
T_3 vermicompost @ 9.2 t ha^{-1}	18.77	5.54	7.00
T_4 *Neem* cake @ 2.5 t/ha	18.27	5.60	6.83
T_5 FYM @ 12.5 t ha^{-1} + *azatobacter* (10 kg/ha) + PSB (10 kg/ha) + VAM (40kg/ha)	20.00	5.73	7.63
T_6 Vermicompost @ 9.2 t ha^{-1} + *azatobacter* 10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (10 kg ha^{-1})	20.83	6.27	8.03
T_7 *Neem* cake @ 2.5t/ha + *azatobacter* (10 kg/ha) + PSB (10 kg/ha) + VAM (40kg/ha)	20.73	6.06	7.80
T_8 Fermented cow dung slurry @ 6 lit/m2 in 2 splits	10.73	5.20	6.37

T_9 Fermented cow dung slurry @ 6 lit/m^2 in 2 split + *azatobacter* (10 kg/ha) + PSB(100g/200lit) + VAM (200g/200lit)	16.00	5.23	6.53
T_{10} Absolute control.	10.60	4.93	6.20
'F' test	Sig.	SIG	Sig.
SE(m)±	0.620	0.271	0.271
CD at 5%	1.843	0.804	0.804

Table 2: Root yield plot-1 (kg), root weight (g) and Root yield hectare^{-1}(q) as influence by various treatments of organic nutrient sources

Treatments	Root yield plot^{-1} (kg)	Root weight (g)	Root yield hectare^{-1}(q)
T_1 RDF (125:50:70 kg NPK ha^{-1})	4.23	141.00	208.67
T_2 Farm yard manure @ 12.5 t ha^{-1}	3.14	104.67	155.00
T_3 vermicompost @ 9.2 t ha^{-1}	3.70	123.33	182.67
T_4 *Neem* cake @ 2.5 t/ha	3.50	115.33	170.67
T_5 FYM @ 12.5 t ha^{-1} + *azatobacter* (10 kg/ha) + PSB (10 kg/ha) + VAM (40kg/ha)	4.01	133.67	198.00
T_6 Vermicompost @ 9.2 t ha^{-1} + *azatobacter* 10 kg ha^{-1}) + PSB (10 kg ha^{-1}) + VAM (10 kg ha^{-1})	4.75	158.33	234.33
T_7 *Neem* cake @ 2.5t/ha + *azatobacte*r (10 kg/ha) + PSB (10 kg/ha) + VAM (40kg/ha)	4.06	135.33	200.33
T_8 Fermented cow dung slurry @ 6 lit/m2 in 2 splits	2.89	96.33	143.00
T_9 Fermented cow dung slurry @ 6 lit/m^2 in 2 split + *azatobacter* (10 kg/ha) + PSB(100g/200lit) + VAM (200g/200lit)	2.95	98.33	145.67
T_{10} Absolute control.	3.09	95.33	141.33
'F' test	Sig	Sig	Sig.
SE(m)±	0.180	5.452	8.058
CD at 5%	0.535	16.199	23.941

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