

Effect of organic manure and inorganic fertilizer on growth and root yield of beetroot (*Beta vulgaris* L.)

ABSTRACT

Beetroot cultivation is benefited from the use of both organic and inorganic fertilizers. Organic fertilizers such as compost or manure improve soil fertility, enhance nutrient availability, and promote microbial activity. Inorganic fertilizers provide precise nutrient ratios and are readily available for immediate plant uptake. Combining organic and inorganic fertilizers ensures a balanced nutrient supply, promoting healthy growth, improved yield, and nutrient-rich beetroot production. The present investigation was carried out at Horticultural Research Farm (HRF), Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh during the *Rabi-2022* with a view to identify the best treatment combination that performed in the Prayagraj region. The treatments comprised of T₁ (Recommended dose of fertilizers (RDF)), T₂ (75% (RDF) +25% (FYM)), T₃ (75% (RDF) +25% (Vermicompost)), T₄ (75% (RDF) +25% (Poultry Manure)), T₅ (50% (RDF) + 50% (FYM)), T₆ (50%(RDF) +50% (Vermicompost)), T₇ (50%(RDF) +50% (Poultry Manure)), T₈ (25% (RDF) + 75% (FYM)), T₉ (25% (RDF) +75% (Vermicompost)), T₁₀ (25% (RDF) +75% (Poultry Manure)), T₁₁ (75% (RDF) + 12.5% (Poultry Manure) + 12.5% (Vermicompost)), T₁₂ (50% (RDF) +25% (FYM) +25 % (Poultry Manure)) and T₁₃ (25% (RDF)+ 50% (FYM)+ 25% (Vermicompost)). From the above experimental finding it is concluded that the treatment T₁₁ (75% (RDF) + 12.5% (Poultry Manure) + 12.5% (Vermicompost)) was found to be best in the terms of growth and yield among different treatment combinations of Beet root.

Keywords: *Farmyard Manure, Poultry manure, Vermicompost, Beet root.*

INTRODUCTION

Beetroot botanically known as *Beta vulgaris* (L.) is one of the well-known plants belonging to the Amaranthaceae family. It includes approximately 1400 species divided into 105 genera. Also known as sugar beet, members of this family are dicotyledonous. It is an erect annual herb with tuberous root stocks. There are basically four varieties of Beetroot, namely known as Detroit dark red, Crimson Globe, Crosby Egyptian and early Wonder. It ranks among the ten most potent vegetables with respect to antioxidant property. It is a

diploid cross-pollinated dicot plant species with chromosome number $2n=2x=18$. The beetroot is the taproot (bulb) portion of the beet plant. It is grown in temperate countries and biennial plant. The beetroot and its juice are freely consumed for its great taste, nutritional benefit, and flavor content. At present its productivity is 20-25 t/ha fruit per year in India (Anonymous, 2013)¹. Beetroot grows plentiful throughout the country, but most widely in Germany and France, and in lesser amounts in other European countries. In 2016-2017, the total world production of red beets was found to be 61.51 ton per hectare (FAOSTAT, 2020)³. In India beetroot is grown in Uttar Pradesh, Haryana, Maharashtra, West Bengal, and Himachal Pradesh on large scale. The varieties of beetroot that are cultivated in India are Detroit dark red, crimson globe, early wonder, ooty-1.

The technology of collecting and using animal, human and plant waste to improve crop productivity is as old as agriculture. Manures are organic materials derived from animal, human, and plant residues that contain phytonutrients in complex organic form. Natural or synthetic chemicals that contain nutrients for plants are called fertilizers. Though, Manures contains low nutrient per unit amount not only improve soil properties, but also have a longer residual effect than fertilizers with a high nutrient content. Farmyard manure is primarily made from cow dung, cow urine, straw, and other milk waste. It is very useful and some of its features are: FYM is rich in nutrients. On an average well decomposed farmyard manure contains 0.5 per cent Nitrogen (N), 0.2 per cent Phosphate (P_2O_5) and .0.5 per cent Potassium (K_2O) (Reddy *et al.*, 2018). Vermicompost is the product of a decomposition process that uses various types of earthworms (usually red worms, white worms, and other earthworms) to create a decomposition mixture of vegetable or food waste, bedding materials, and vermicast. Vermicompost is rich in NKP (nitrogen 2-3%, potassium 1.85-2.25% and phosphorus 1.55-2.25%), micronutrients, beneficial soil microbes and contain 'plant growth hormones & enzymes (Reddy *et al.*, 2018). The excreta of birds ferment very quickly. If left exposed, 50 percent of its nitrogen is lost within 30 days. Poultry manure contains higher nitrogen and phosphorus compared to other bulky organic manures. The average nutrient content is 3.03 per cent N; 2.63 per cent P_2O_5 and 1.4 per cent K_2O (Reddy *et al.*, 2018). Organics such as FYM, Poultry manure and Vermicompost not only promote increased yields and improved crop quality, but also maximize the genetic potential of plants and the presence of nutrients enhances root development, fruit set, affects the vitality and health of plants. Fertilizers may be distinct from liming materials or other non-nutrient soil amendments. Many sources of fertilizer exist, both natural and industrially produced. For most modern agricultural

practices, fertilization focuses on three main macro nutrients: nitrogen (N), phosphorus (P), and potassium (K) with occasional addition of supplements like rock flour for micronutrients. This experiment was conducted to help in understanding the Effect of different organics and inorganics on plant growth and yield attributes of Beetroot crop. Therefore, present study of analysis in Beetroot crop was carried out to identify the best treatment combination with high yield, early maturing suited to Prayagraj agro-climatic conditions of U.P.

MATERIAL AND METHODS

The present investigation was done to understand the effect of organic manures and inorganic fertilizer at different doses combination on growth, yield and quality of beetroot variety Golden Lalima. The experiment was carried out at Horticultural Research Farm (HRF), Department of Horticulture, Naini Agricultural Institute SHUATS, Prayagraj, U.P., during the *Rabi* season of 2022. The different combination doses of organic manures and inorganic fertilizers mentioned in table 1 and replicated thrice. Observations were recorded at different stages of growth periods. The data were statistically analysed (by the method suggested by Fisher and Yates, 1963)⁴.

Table 1 details of different doses of organic manure and inorganic fertilizers.

Treatment Notation	Treatment Details
T ₁	Recommended dose of fertilizers (RDF)
T ₂	75% (RDF) +25% (FYM)
T ₃	75% (RDF) +25% (Vermicompost)
T ₄	75% (RDF) +25% (Poultry Manure)
T ₅	50% (RDF) + 50% (FYM)
T ₆	50% (RDF) +50% (Vermicompost)
T ₇	50% (RDF) +50% (Poultry Manure)
T ₈	25% (RDF) + 75% (FYM)
T ₉	25% (RDF) +75% (Vermicompost)
T ₁₀	25% (RDF) +75% (Poultry Manure)
T ₁₁	75% (RDF) + 12.5% (Poultry Manure) + 12.5% (Vermicompost)
T ₁₂	50% (RDF) +25% (FYM) +25 % (Poultry Manure)
T ₁₃	25% (RDF)+ 50% (FYM)+ 25% (Vermicompost)

Table 2 Performance of different treatment combinations of organic manure and inorganic fertilizer on growth and yield parameters studied for beetroot.

Treatment Notation	Treatment details	Days to germination	Days to 50% germination	Plant height (cm) (60 DAS)	Plant height with root (cm)	No of leaves/plant 60 DAS	Root length (cm)	Root diameter (cm)	Fresh plant weight (g)	Dry plant weight (g)	Biological yield (g)	Root yield per plot (Kg/plot)
T ₁	RDF	2.47	5.13	49.51	61.34	21	11.17	2.71	136.34	102.97	138.55	3.54
T ₂	75% (RDF) +25% (FYM)	2.8	5.07	50.15	60.47	21.07	11.32	3.69	148.72	113.97	151.05	3.74
T ₃	75% (RDF) +25% (VC)	2.93	7.27	48.11	58.3	21.67	11.19	4.38	161.62	124.45	162.95	4.4
T ₄	75% (RDF) +25% (PM)	3.8	6.13	47.43	57.4	22.2	10.97	3.17	143.72	108.69	145.05	4.17
T ₅	50% (RDF) + 50% (FYM)	3.87	5.27	46.82	57.26	21.73	11.45	3.12	163.52	126.12	164.85	4.32
T ₆	50%(RDF) +50% (VC)	2.53	5.53	46.72	57.14	22	11.08	3.11	167.22	129.37	168.55	4.31
T ₇	50%(RDF) +50% (PM)	2.87	5.87	45.78	55.39	21.87	10.28	4.01	138.22	103.85	139.55	3.61
T ₈	25% (RDF) + 75% (FYM)	2.87	5.2	43.45	54.13	22.2	11.35	3.21	131.72	98.13	133.05	3.61
T ₉	25% (RDF) +75% (VC)	3.47	5.47	50.66	61.09	22.2	11.02	4.14	126.62	93.65	127.95	3.63
T ₁₀	25% (RDF) +75% (PM)	3	7.2	49.39	60.6	21.53	11.57	4.2	168.72	130.69	170.05	4.29
T ₁₁	75%(RDF)+12.5%+(PM)+12.5%(VC)	3.07	5.47	42.53	53.87	22.53	12	4.5	181.42	141.87	182.75	4.74
T ₁₂	50%(RDF)+25%(FYM)+25%(PM)	2.47	5.2	43.14	53.54	21.87	11.24	4.33	157.12	120.49	158.45	4.29
T ₁₃	25%(RDF)+50%(FYM)+25%(VC)	2.73	5.2	44.21	54.22	22.93	11.01	4.09	148.72	130.72	150.05	3.83
‘F’ test		S	S	S	S	S	S	S	S	S	S	S
S.E. (m) ±		0.13	0.06	0.01	0.61	0.26	0.01	0.01	0.35	0.02	0.03	0.21
C.D. at 5%		0.38	0.18	0.04	1.78	0.76	0.02	0.04	1.04	0.07	0.01	0.6
C.V.		7.61	1.98	0.05	1.83	2.07	0.08	0.07	0.4	0.03	0.04	8.82

Abbreviations used: **RDF**: Recommended doses of Fertilizers, **FYM**: Farmyard Manure, **VC**: Vermicompost, **PM**: Poultry Manure.

RESULTS AND DISCUSSION

Growth Parameters

Days to germination and Days to 50% germination

From table 2 it was found that the maximum days to germination (3.87 days) was observed with T₅. Minimum days to germination (2.47 days) was observed T₁ and T₁₂. The maximum days to 50% germination (7.27 days) was observed with T₃ followed T₁₀ with 7.20 days. Minimum days to 50% germination (5.07 days) was observed T₂. The better germination in beetroot with the use of farmyard manure (FYM) and recommended dose of fertilizer (RDF) can be attributed to the increased availability of nutrients, improved soil structure, and enhanced water retention capacity. FYM provides organic matter and essential nutrients, while RDF ensures a balanced nutrient supply. These factors collectively create favourable conditions for seed germination and plant growth. Similar results have also been reported by Kadalag *et al.*, (2007)⁶, Yeptho *et al.*, (2010)¹⁰, Singh *et al.*, (2014)⁹, Reddy *et al.*, (2018)⁷ and Sapkota *et al.*, (2020)⁸ in okra and Jagdish *et al.*, (2018)⁵ in Beetroot.

Plant height (cm)

The maximum plant height at 60 DAS (50.66 cm) was observed with T₉ followed T₂ with 50.13 cm. Minimum plant height at 60 DAS (42.53 cm) was observed T₁₁. The maximum plant height with roots (61.34 cm) was observed with T₁ followed T₉ with 61.09 cm. Minimum plant height with roots (53.54 cm) was observed T₁₂. Plant development depends on availability of proper nutrient and water to plants. The better plant height in beetroot with the application of vermicompost and recommended dose of fertilizer (RDF) can be attributed to the combined effects of increased nutrient availability, improved soil fertility, and enhanced plant vigour. Vermicompost enriches the soil with organic matter and essential nutrients, while RDF ensures a balanced nutrient supply. These factors promote healthy root development and overall plant growth, resulting in improved plant height in beetroot. Similar findings were reported by Kadalag *et al.*, (2007)⁶, Yeptho *et al.*, (2010)¹⁰, Singh *et al.*, (2014)⁹, Reddy *et al.*, (2018)⁷ and Sapkota *et al.*, (2020)⁸ in okra and Jagdish *et al.*, (2018)⁵ in Beetroot.

Number of leaves per plant

The maximum number of leaves per plant at 60 DAS (22.93) was observed with T₁₃ followed T₁₁ with 22.33. Minimum number of leaves per plant at 60 DAS (21.00) was observed T₁.

The application of vermicompost (VC) and recommended dose of fertilizer (RDF) in beetroot cultivation leads to an increased number of leaves due to several factors. FYM enriches the soil with organic matter, improving nutrient availability and enhancing microbial activity. RDF provides a balanced nutrient supply, including essential elements for leaf development. These combined effects result in improved plant vigour, leading to the production of more leaves in beetroot plants. Similar findings were reported by Kadalag *et al.*, (2007)⁶, Yeptho *et al.*, (2010)¹⁰, Singh *et al.*, (2014)⁹, Reddy *et al.*, (2018)⁷ and Sapkota *et al.*, (2020)⁸ in okra and Jagdish *et al.*, (2018)⁵ in Beetroot.

Yield Parameter

Root length (cm) and Root diameter (cm)

The maximum root length 12.00 cm were recorded in treatment T₁₁, and the lowest root length (10.28 cm) were observed in T₇. The maximum root diameter 4.50 cm were recorded in treatment T₁₁, and the lowest root diameter (2.71 cm) were observed in T₁. Uniform root length is essentiality for marketing of root and yield of roots too. The enhancement in root length and root diameter in beetroot plants with the application of poultry manure, vermicompost, and recommended dose of fertilizer (RDF) can be attributed to multiple factors. Poultry manure and vermicompost supply organic matter and beneficial microorganisms, improving soil structure and nutrient availability. RDF ensures a balanced nutrient supply. These factors collectively promote robust root development, resulting in increased root length and diameter in beetroot plants. Results were in accordance with the findings of Kadalag *et al.*, (2007)⁶, Yeptho *et al.*, (2010)¹⁰, Singh *et al.*, (2014)⁹, Reddy *et al.*, (2018)⁷ and Sapkota *et al.*, (2020)⁸ in okra and Jagdish *et al.*, (2018)⁵ in Beetroot.

Fresh plant weight (g) Dry plant weight (g) and biological yield (g)

The maximum fresh plant weight 181.42 g were recorded in treatment T₁₁, and the lowest fresh plant weight (126.62 g) were observed in T₉. The maximum dry plant weight 159.50 g were recorded in treatment T₁₁, and the lowest dry plant weight (111.28 g) were observed in T₉. The maximum biological yield 182.75 g were recorded in T₁₁ and the lowest biological yield (127.95 g) were observed in T₉. Plant weight directly contributes to yield per plants. Weight of root directly depends on higher photosynthates produced that is stored in roots too. The more photosynthates production is directly correlated to higher leaves number per plant and availability of nutrients and sunshine. Nutrition play an important role in improving productivity and quality of root. Increased vigour of plants, assimilating area, size of fruit,

thereby resulting into higher weight of fruit. These results are in close conformity with the findings of Kadalag *et al.*, (2007)⁶, Yeptho *et al.*, (2010)¹⁰, Singh *et al.*, (2014)⁹, Reddy *et al.*, (2018)⁷ and Sapkota *et al.*, (2020)⁸ in okra and Jagdish *et al.*, (2018)⁵ in Beetroot.

Root yield per plot (Kg/plot)

The maximum root yield per plot 4.74 kg/plot were recorded in treatment T₁₁ and the lowest root yield per plot (3.54 kg/plot) were observed in T₁. Yield is a complex character that depends directly on root weight, length, diameter, and numbers per plot. It depends directly or even indirectly on earliness of plant along with plant height and number of leaves per plant too. It was seen in experimentation yield had direct positive correlation with These results are in close conformity with the findings of Kadalag *et al.*, (2007)⁶, Yeptho *et al.*, (2010)¹⁰, Singh *et al.*, (2014)⁹, Reddy *et al.*, (2018)⁷ and Sapkota *et al.*, (2020)⁸ in okra and Jagdish *et al.*, (2018)⁵ in Beetroot.

Conclusion

From the above experimental finding it was concluded that the treatment T₁₁ (75%(RDF)+12.5%(PM)+12.5%(VC)) was found to be best in the terms of growth and yield among different treatment combinations of Beet root.

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