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EFFECT OF ORGANIC NUTRIENTS AND BIOSTIMULANTS ON YIELD CHARACTERS OF BEETROOT (*BETA VULGARIS* L.)

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Abstract

Investigation was carried out on the effect of organic nutrients on yield of beetroot (*Beta vulgaris* L.) var. Jhelum at the Department of Horticulture, Faculty of Agriculture, Annamalai University, Tamil Nadu (India) during 2014-2015. The experiment was laid out in RBD (Randomized Block Design) with 15 treatments in three replications. The organic manures used in the study were FYM, vermicompost, consortium of biofertilizers (CBF) and biostimulants like panchakavya, effective microorganism and humic acid. The organic manures *viz*., FYM @ 25 t ha^{-1}, vermicompost @ 5 t ha^{-1} and consortium of biofertilizers (CBF) @ 2 kg ha^{-1}, were applied in the soil as basal application. The biostimulants like panchakavya (PK) (3%), effective microorganism (EM) (1:1000 dilution ha^{-1}) and humic acid (HA) (2%) were given as foliar spray once in 10 days intervals. The results of the experiment revealed that the yield parameters *viz*., root length, root girth, root weight, shoot : root ratio $plant^{-1}$, yield $plot^{-1}$ and yield $hectare^{-1}$ were recorded maximum in the treatment which received the soil application of vermicompost @ 5 t ha^{-1} and CBF @ 2 kg ha^{-1}, combined with foliar application of EM @ 1:1000 dilution ha^{-1}, PK @ 3% and HA @ 2%.

Key words : Beetroot, farmyard manure, vermicompost, consortium of biofertilizers, effective microorganisms, humic acid, panchakavya, yield.

Introduction

Beetroot (*Beta vulgaris* L.) is the offspring of wild sea beet (*Beta vulgaris* subsp. *Maritime*), a plant with origin throughout the coasts of Europe and Africa. It belongs to family Amaranthaceae (Kadereit *et al*., 2006). In India, it grows in the hills of Southern regions and hilly areas of North. The area under beetroot cultivation in India is about 5000 hectares with an annual production of 90,000 tonnes (Anonymous, 2001). The area under beetroot cultivation in Tamil Nadu during the year 2012-2013 is 1,308 hectares with a production of 39,383 t ha^{-1}.

The crop is widely cultivated for the production of commercial sugar, forage plants, natural dye and food for human consumption. The extracts used as a natural colorant for food products have been shown to possess effective antioxidant properties (Rey *et al*., 2005). Roots are excellent source of folic acid and a very good source of fibre, manganese and potassium. They are consumed as salad or cooked and used in pickling and canning. The beet tops are rich in proteins, carbohydrates, calcium, phosphorus, iron and vitamin C (Bavec *et al*., 2010). The roots are rich in fiber as well as sugar, but have a moderate caloric value. Beetroot have long been used for medicinal purposes. It helps to stimulate the liver's detoxification processes. The plant pigment that gives beetroot its rich, purple-crimson colour is betacyanin; a powerful agent, helps to suppress the development of cancer. The rich fiber content in beetroot exerts faourable effects on bowel function thereby preventing constipation and helps to lower cholesterol levels too (Vali *et al*., 2007).

To achieve the large goal of sustainable production and to effect the recycling of nutrients in an eco-friendly manner, the use of organic manures like farmyard manure, vermicompost, consortium of biofertilizers and biostimulants like panchakavya, effective microorganisms, humic acid were found to enhance and improve soil health, growth and yield of many crops. Since, domestic consumption of beetroot in our daily diet increases day by day, it becomes utmost important to avoid polluted consumption of chemically grown beets. With this idea, the present investigation was framed to study the effect of organic nutrients and biostimulants on yield of beetroot cultivar "Jhelum".

Materials and Methods

The present investigation on "Effect of organic nutrients on yield of beetroot (*Beta vulgaris* L.) var. Jhelum" was carried out in the Department of Horticulture, Faculty of Agriculture, Annamalai University during October 2014-January 2015. The experiment was carried out in RBD with 3 replications. There were 15 treatments *viz*., $\mathbf{T_1}$ - FYM 25t ha^{-1} + RDF @ 60 : 100 : 60 kg NPK ha^{-1} (control), $\mathbf{T_2}$ - FYM 25t ha^{-1} + CBF 2 kg ha^{-1}, $\mathbf{T_3}$ – VC 5t ha^{-1} + CBF 2 kg ha^{-1}, $\mathbf{T_4}$- FYM 25 t ha^{-1} + CBF 2 kg ha^{-1} + EM (1:1000 dilution ha^{-1}), $\mathbf{T_5}$ - FYM 25 t ha^{-1} + CBF 2 kg ha^{-1} + PK (3%), $\mathbf{T_6}$- FYM 25 t ha^{-1} + CBF 2 kg ha^{-1}+HA (2%), $\mathbf{T_7}$ - VC 5 t ha^{-1} + CBF 2 kg ha^{-1} + EM (1:1000 dilution ha^{-1}), $\mathbf{T_8}$ - VC 5 t ha^{-1} + CBF 2 kg ha^{-1} + PK (3%), $\mathbf{T_9}$ - VC 5 t ha^{-1} + CBF 2 kg ha^{-1} + HA (2%), $\mathbf{T_{10}}$ - FYM 25 t ha^{-1} + CBF 2 kg ha^{-1} + EM (1: 1000 dilution ha^{-1}) + HA (2%), $\mathbf{T_{11}}$ - FYM 25 t ha^{-1} + CBF 2 kg ha^{-1} + EM (1:1000 dilution ha^{-1}) + PK (3%), $\mathbf{T_{12}}$ - FYM 25 t ha^{-1} + CBF 2 kg ha^{-1} + EM (1:1000 dilution ha^{-1}) + HA (2%) + PK (3%), $\mathbf{T_{13}}$ - VC 5 t ha^{-1} + CBF 2 kg ha^{-1} + EM (1:1000 dilution ha^{-1}) + HA (2%), $\mathbf{T_{14}}$ - VC 5 t ha^{-1} + CBF 2 kg ha^{-1} + EM (1:1000 dilution ha^{-1}) + PK (3%), $\mathbf{T_{15}}$ - VC 5 t ha^{-1} + CBF 2 kg ha^{-1} + EM (1:1000 dilution ha^{-1}) + HA (2%) + PK (3%). Inorganic nitrogen was applied before sowing whereas phosphorus and potash were applied basally. Total quantity of farmyard manure, vermicompost and biofertilizers were applied during field preparation. Weeeding, irrigation, drainage and other intercultural operations were done on regular interval. Data on yield parameters such as root length, root girth, root weight, shoot: root ratio plant^{-1}, yield plot^{-1} and yield hectare^{-1} were recorded and statistically analysed (Panse and Sukhatme, 1978).

Results and Discussion

Yield components like root length, root girth, root weight, crop dry matter production and shoot : root ratio are the important characters, which decide the yield of a crop and the ultimate goal of any crop management practice is to achieve higher yield. Root weight and root yield are the most important traits of beetroot in determining the yield. These were greatly influenced by the application of organic manures in this experiment. The root girth and length were significantly influenced by the application of organic nutrients. The maximum value of root girth (20.16 cm) and length (6.74cm) were recorded in $\mathbf{T_{15}}$ where the application of VC @ 5 t ha^{-1} + CBF@ 2 kg ha^{-1} along with the foliar spray of EM (1:1000 dilution ha^{-1}) + HA (2%) + PK (3%) was done. The least was recorded in $\mathbf{T_2}$ (14.41 cm and 5.04 cm, respectively), which received FYM @ 25 t ha^{-1} and CBF @ 2 kg ha^{-1}. Application of vermicompost significantly increased the root girth and root length in the present study. The reason might be due to the adequate supply of macro and micro nutrients to the metabolic activities of plants. These findings are in agreement with Thanunathan *et al*. (1997) and Kalembasa and Deska (1998) in onion; Senthil and Sekar (1998) in okra. Application of biofertilizers showed significant influences with respect to increase in root characters in the present study. The results are in confirmation with the findings of Joi and Shende (1976) in onion. The maximum root weight (134.28 g plant^{-1}), shoot root ratio (0.41), root yield plot^{-1} (10.94 kg) and root yield hectare^{-1} (36.20 t) were recorded in $\mathbf{T_{15}}$, which include the treatment combinations of VC @ 5 t ha^{-1} + CBF @ 2 kg ha^{-1} + EM (1:1000 dilution ha^{-1}) + HA (2%) + PK (3%). The increased nutrient availability from the organic manures might have increased the various endogenous hormonal levels in the plant tissues, which might be responsible for enhanced root growth, which ultimately increased the yield levels. This finding is in line with Subramani *et al*. (2011) in radish.

Further, higher yield due to application of vermicompost may be attributed due to the high level of nutrients along with growth stimulating substances excreted by earthworm into their cast (Tomati *et al*., 1998). It could also be attributed to the fact that after decomposition and mineralization, the manures supply available nutrients directly to plants and also render solubilising effect on fixed form of nutrients (Singh *et al*., 1982). This results corroborate with the findings of Sreenivas *et al*. (2000) in ridge gourd, Bhodaria *et al*. (2002) in okra and Sharma *et al*. (2009) in okra and onion. The increased availability of plant nutrients from the rapid decomposition of organic amendment by the EM cultures might also have contributed to the higher yield in the EM treated plots. This is in line with the findings of Higa and Wididana (1991). The proportion and activity of beneficial microbes have been at the higher rate in panchakavya, humic acid and effective microorganism, which would have helped to increased yield. This falls in line with the findings of Sarma and Anandraj (2003). The crop dry matter production also showed significant influence in this study. It was recorded the highest in $\mathbf{T_{15}}$ (16.31 g plant^{-1}) and the least in $\mathbf{T_2}$ (11.11 g plant^{-1}). The application of vermicompost, biofertilizer and biostimulants would have lead to an increase of accelerated mobility of photosynthates from source to sink as influenced by organic amendments and its accumulation in roots. The higher translocation was possible due to better sink capacity as indicated by the higher weight of root and resulted in increase of dry matter production. The results

Table 1 : Effect of organic nutrients on yield and yield characters in beetroot.

T. no.	Root length (cm)	Root girth (cm)	Root weight (g/plot)	Root: shoot ratio	Root yield (kg/plot)	Root yield (t/ha)	Crop dry matter production
T_1	6.57	19.54	130.96	0.40	10.52	35.41	15.79
T_2	5.04	14.41	101.08	0.26	6.65	21.58	11.11
T_3	5.21	15.03	104.40	0.28	7.07	23.02	11.63
T_4	5.96	18.23	123.85	0.37	9.00	31.61	14.32
T_5	5.77	16.92	117.68	0.35	8.66	28.75	13.45
T_6	5.55	16.27	111.04	0.31	7.91	25.90	12.67
T_7	5.98	17.53	120.81	0.36	9.10	30.21	14.01
T_8	5.89	17.06	116.97	0.35	8.75	28.82	13.71
T_9	5.38	15.65	107.72	0.29	7.49	24.46	12.15
T_{10}	5.72	16.44	114.36	0.32	8.33	27.38	13.19
T_{11}	6.06	17.68	121.00	0.36	9.17	30.35	14.23
T_{12}	6.40	18.81	127.64	0.39	10.10	33.37	15.00
T_{13}	6.23	18.30	124.32	0.37	9.59	31.77	14.75
T_{14}	6.34	18.92	128.27	0.38	10.07	33.34	15.27
T_{15}	6.74	20.16	134.28	0.41	10.94	36.20	16.31
S.Ed	0.08	0.04	1.62	0.005	0.21	0.67	0.10
C.D (p=0.05)	0.17	0.08	3.32	0.011	0.43	1.37	0.22

are in conformity with the findings of Malawadi *et al*. (2003) in chillies and Patil *et al*. (2004) in tomato. Based on the findings of the present study, it can be concluded that the combination of VC @ 5 t ha^{-1} + CBF 2 kg ha^{-1} + EM (1:1000 dilution ha^{-1}) + HA (2%) + PK (3%) recorded maximum values for yield and yield characters in beetroot variety Jhelum when compared to the other treatments.

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