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Varietal evaluation of beet root (*Beta vulgaris* L.) under Prayagraj agro-climatic conditions

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Abstract
The present investigation entitled "Varietal evaluation of Beet root (*Beta vulgaris* L.) under Prayagraj Agro-Climatic condition" was conducted at the Department of Horticulture, SHUATS, Prayagraj during Rabi season (2023-2024). The experimental material consisted of 9 beet root varieties. The experiment was laid out in Randomized Block Design consisting of nine treatments and are replicated thrice. Analysis of variance revealed significant differences among the nine varieties for all the characters studied. Among the varieties, V_7 Crystal improved recorded the highest Days to germinations (6.44), Germinations (%) (92.21), plant height (36.87 cm), number of leaves per plant (14.72), Leaf area (cm^2) (168.56), days to harvest (81.51), root length (cm) (14.39), root girth (cm) (24.93), root weight (g) (137.67), Root yield per plot (kg) (18.30), Root yield (t ha^{-1}) (45.75), TSS (0Brix) (8.73) and Ascorbic acid (3.07). The maximum Gross return (365971.67Rs. ha^{-1}), Net return (275065.27Rs. ha^{-1}) and Benefit cost ratio (3.03) was recorded in treatment V_7 (Crystal improved).

Keywords: Varietal, beet root, growth, yield and quality

Introduction
Beetroot (*Beta vulgaris* L.) is one of the important root vegetable crops belongs to the family Chenopodiaceae along with Spinach, Palak, Swiss Chard, Parsley and Celery. It has a diploid chromosome number of (2n=18) and is native to Western Europe Mounika *et al*., (2020) [10]. It is grown for vegetables, salad, Juice, and other food uses (pickles). Beetroot was first described in 1557 when it was referred to as Roman beet in Germany. The crop was introduced in the USA in 1800 and is known as garden beet. In India Beetroot is mainly cultivated in Haryana, Uttar Pradesh, Himachal Pradesh, West Bengal, Maharashtra, and Tamil Nadu. It is highly productive and usually free from pests and diseases" Kumar *et al.*, (2023) [9]. Beet root is a highly productive, popular root vegetable grown mainly for its fleshy, enlarged roots. Shapes are variable and may be globular, cylindrical, top like and flattened. Upper portion of root develop from hypocotyl and lower from tap root. The tap root may penetrate the soil to a depth of 3 m (Weaver and Bruner, 1927). It is a rich source of carbohydrate (9.56 g 100 g^{-1}), protein (1.61g 100g^{-1}), dietary fibre (2.8 g 100g^{-1}), vitamin A (33 I.U. 100g^{-1}), vitamin C (4.9 mg 100g^{-1}), folate (109 µg 100g^{-1}) and minerals *viz*., potassium (325 mg 100g^{-1}), sodium (78 mg 100g^{-1}), phosphate (40 mg 100g^{-1}), calcium (16 mg 100g^{-1}), zinc (0.35 mg 100g^{-1}) and iron (0.80 mg 100g^{-1}) (Chawla *et al.*, 2016) [12]. The main nitrogen pigment present in beet root known as betalains comprising of red coloured β-cyanin and yellow coloured β- xanthin have antioxidant property (Kanner *et al*., 2001) [13], anti-inflammatory effect (Clifford *et al*., 2015; Neha *et al*., 2018) [15, 14], hepatoprotective and anti-cancer properties (Georgiev *et al.*, 2010; Chhikara *et al*., 2018) [16, 18]. The ratio of these two pigments varies with cultivation and changes during the growth and environmental conditions. Beet root is eaten boiled or as salad, cooked with other vegetables and also used in pickles, chutneys and in canned food products. Green leaves are rich in iron, vitamin A, thiamine and ascorbic acid (Bhat, 2007) [17].

Materials and Methods
The present investigation entitled "Varietal evaluation of Beet root (*Beta vulgaris* L.) under Prayagraj Agro-Climatic condition" was carried out at the Horticulture Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology

and Sciences, Prayagraj during the winter (*Rabi*) season of 2023-2024. The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 32 °C – 34 °C and seldom falls as low as 4 °C – 5 °C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1013.4 mm annually. The experiment was laid in Randomized Block Design with 9 varieties, each replicated three times, thus making a total of 27 plots. The unit plot size was 2 x 2 m^2. The plants were spaced at 30cm between the rows and 10 cm between the plants. The observations of Growth parameters, yield and quality parameters were recorded on five randomly selected and tagged plants from each treatment in all replications. The data recorded during the course of investigation on growth, yield and quality components were subjected to two-way classification analysis of variance (ANOVA) as outlined.

Results and Discussion

The days to germinations and germinations (%) of beetroot plant were significantly influenced by different varieties as presented in Table 1. The minimum Days to germinations recorded was (6.44) in treatment V_7 (Crystal improved). Whereas the maximum Days to germinations reported was (9.69) in treatment V_6 (Bradely 105). However, V_4 Crimson Globe are found statistically at par to V_7 (Crystal improved). The maximum Germinations (%) recorded was (92.21) in treatment V_7 (Crystal improved). Whereas the minimum Germinations (%) reported was (59.84) in treatment V_6 (Bradely 105). However, V_4 Crimson Globe are found statistically at par to V_7 (Crystal improved). The vegetative growth parameters of beetroot plant were significantly influenced by different varieties of beetroot as presented in Table 1. The maximum plant height (cm) has been recorded with the treatment V_7 (Crystal improved) was 36.87. Whereas the minimum recorded plant height (cm) was (26.89) with the treatment V_6 (Bradely 105). However, V_4 Crimson Globe and V_3 Detroit Dark Red are found statistically at par to V_7 (Crystal improved). At harvest, the maximum number of leaves per plant have been recorded with the treatment V_7 (Crystal improved) was 14.72. Whereas the minimum recorded number of leaves per plant was (8.83) with the treatment V_6 (Bradely 105). However, V_3 Detroit Dark Red and V_4 Crimson Globe are found statistically at par to V_7 (Crystal improved). At harvest, the maximum Leaf area (cm^2) have been recorded with the treatment V_7 (Crystal improved) was 168.56. Whereas the minimum recorded Leaf area (cm^2) was (130.14) with the treatment V_6 (Bradely 105). However, V_4 Crimson Globe and V_3 Detroit Dark Red are found statistically at par to V_7 (Crystal improved). Similar varietal variation in plant height and leaves per plant was also reported by Coutinho *et al.* (2018) [4] in beet root, Khogali *et al*. (2012) [5] in fodder beet, Basavaraj (2016) [2] in carrot, Pervez *et al.* (2003) [3] and Dongarwar *et al.* (2018) [1] in radish, which might be attributed to the inherent genetic makeup of the plant and its expression to the growing soil and environmental conditions. The root yield parameters of beetroot plant were significantly influenced by different varieties of beetroot as presented in Table 1. The minimum days to harvest recorded was (81.51) in treatment V_8 (Lali). Whereas the maximum days to harvest reported was (94.07) in treatment V_6 (Bradely 105). However, V_4 Crimson Globe are found statistically at par to V_8 (Lali). The maximum root length (cm) recorded was (14.39) in treatment V_7 (Crystal improved). Whereas the minimum root length (cm) reported was (8.61) in treatment V_4 (Bradely 105). However, V_3 Detroit Dark Red, V_4 Crimson Globe, V_2 Merlin, V_5 Castello and V_8 Lali are found statistically at par to V_7 (Crystal improved). The maximum root girth (cm) recorded was (24.93) in treatment V_7 (Crystal improved). Whereas the minimum root girth (cm) reported was (17.51) in treatment V_4 (Bradely 105). However, V_4 Crimson Globe, V_3 Detroit Dark Red, V_2 Merlin and V_1 Kestrel are found statistically at par to V_7 (Crystal improved). The maximum root weight (g) recorded was (137.67) in treatment V_7 (Crystal improved). Whereas the minimum root weight (g) reported was (83.78) in treatment V_4 (Bradely 105). However, V_4 Crimson Globe and V_3 Detroit Dark Red are found statistically at par to V_7 (Crystal improved). The cultivar differences in root length, root diameter and root weight are in line with the results obtained by Ijoyah *et al.* (2008) [8]; Patel *et al*. (2015) [6] and Sharma (2013) [7] in beet root, Basavaraj (2016) [2] in carrot, Pervez *et al*. (2003) [3] and Dongarwar *et al*. (2018) [1] in radish. This could be due to the difference in genetic makeup of the different varieties and ecological conditions. This conforms with the findings of Coutinho *et al.* (2018) [4] that cultivars with increased number of leaves and lower heights can result in self-shadowing, consequently showing a reduction in productivity. In the case of hybrids, higher root weight per plant was due to a greater number of leaves for photosynthesis and efficient utilization of these photosynthates, might have enhanced the better root length, root width and root yield per plant. This is in agreement with the findings of Patel *et al.* (2015) [6] in beet root in radish. The maximum Root yield per plot (kg) recorded was (18.30) in treatment V_7 (Crystal improved). Whereas the minimum Root yield per plot (kg) reported was (11.05) in treatment V_4 (Bradely 105). However, V_4 Crimson Globe, V_3 Detroit Dark Red and V_2 Merlin are found statistically at par to V_7 (Crystal improved). The maximum Root yield (t ha^{-1}) recorded was (45.75) in treatment V_7 (Crystal improved). Whereas the minimum Root yield (t ha^{-1}) reported was (27.63) in treatment V_4 (Bradely 105). However, V_4 Crimson Globe are found statistically at par to V_7 (Crystal improved). Similar varietal variation in root yield per plot was observed by Dongarwar *et al.* (2018) [1] in radish and Basavaraj (2016) [2] in carrot. Significant variation in yield $plot^{-1}$ might be due to difference in root length, root diameter and root weight, which are the important components of yield. These findings are in line with those of earlier workers - Sharma (2013) [7] in beet root and Basavaraj (2016) [2] in carrot. The quality parameters of beetroot plant were significantly influenced by different varieties of beetroot as presented in Table 1. The maximum TSS (0Brix) recorded was (8.73) in treatment V_7 (Crystal improved). Whereas the minimum TSS (0Brix) reported was (7.19) in treatment V_4 (Bradely 105). However, V_3 Detroit Dark Red, V_2 Merlin and V_8 Lali are found statistically at par to V_7 (Crystal improved). These results are in agreement with Sharma (2013) [7], Patel *et al*. (2015) [6] and Baliram (2015) [11] in beet root. The maximum Ascorbic acid recorded was (3.07) in treatment V_7 (Crystal improved). Whereas the minimum Ascorbic acid reported was (2.08) in treatment V_4 (Bradely 105). However, V_4 Crimson Globe

and V_3 Detroit Dark Red are found statistically at par to V_7 (Crystal improved).

Table 1: Effect of different varieties of Beetroot (*Beta vulgaris* L.) on growth, yield and quality

Notation	Varieties	Days to germinations	Germinations (%)	Plant height (cm)	Number of leaves per plant	Leaf area (cm^2)	Days to harvest	Root length (cm)	Root girth (cm)	Root weight (g)	Root yield per plot (kg)	Root yield (t ha-1)	TSS (0Brix)	Ascorbic acid
V_1	Kestrel	7.44	87.67	31.37	13.31	160.37	87.41	12.63	23.43	126.94	16.86	42.14	7.44	2.33
V_2	Merlin	7.33	86.17	32.08	13.25	148.00	86.98	13.47	23.77	129.60	17.22	43.05	8.31	2.48
V_3	Detroit Dark Red	7.10	89.84	35.26	14.57	164.38	85.09	14.12	23.11	131.04	17.46	43.64	8.51	2.75
V_4	Crimson Globe	6.76	91.08	36.78	14.65	165.81	83.84	14.23	23.92	133.15	17.75	44.38	8.60	2.83
V_5	Castello	7.63	81.41	29.24	13.12	151.14	85.10	13.16	22.01	121.92	16.16	40.39	7.73	2.48
V_6	Bradely 105	9.69	59.84	26.89	8.83	130.14	94.07	8.61	17.51	83.78	11.05	27.63	7.19	2.08
V_7	Crystal improved	6.44	92.21	36.87	14.72	168.56	82.01	14.39	24.93	137.67	18.30	45.75	8.73	3.07
V_8	Lali	8.18	84.34	31.94	13.26	153.01	81.51	13.37	20.52	101.81	13.36	33.40	8.07	2.34
V_9	Mahylal II	8.37	84.14	30.41	13.12	159.09	83.71	11.95	21.24	120.14	15.94	39.84	7.36	2.34
	F-Test	S	S	S	S	S	S	S	S	S	S	S	S	S
	S.Ed.	0.056	0.040	0.152	0.091	0.067	0.067	0.050	0.029	0.074	0.165	0.119	0.075	0.036
	C.D. at 0.5%	0.118	0.084	0.323	0.193	0.142	0.142	0.106	0.061	0.156	0.350	0.253	0.160	0.076
	CV	0.888	0.058	0.578	0.846	0.053	0.096	0.478	0.159	0.075	1.266	0.366	1.157	1.743

Conclusion

From the present investigation it is conclude that, varieties V_7 Crystal improved of beetroot was found to be the best varieties among the other varieties in Root weight (137.67g), Root yield per plot (18.30kg), Root yield per ha (45.75t/ha) attributing parameters and quality parameters as maximum TSS ($8.73Brix^0$) and ascorbic acid (3.07) compared to all other varieties as well as maximum Gross return (Rs. 365971.67), Net return (Rs. 275065.27) and cost benefit ratio was found to be best (1: 3.03).

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