

MEAN PERFORMANCE OF BEETROOT GENOTYPES FOR DIFFERENT QUALITATIVE AND QUANTITATIVE TRAITS

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ABSTRACT

Twenty five diverse genotypes of beet root procured from IPGCPR, Gatersleben Germany and India including two check cultivars (Detroit Dark Red and Crimson Globe) were evaluated for nine horticultural traits. The observations recorded showed that the highest number of leaves were found in genotype BETA-2221(13.41) whereas genotype TNBR-1 recorded with highest root length (10.46cm), root diameter (76.13mm), average root weight (336.49g), net root weight (236.52g) and yield per hectare (48.67 q/ha). Genotype BETA-2221 showed lowest root top ratio on length basis (0.29) while genotype TNBR-8 showed lowest root top ratio on weight basis (3.07) and non reducing sugar (14.17 %) was highest in genotype BETA-340. Maximum root yield of 448.67q/ha was recorded in genotype TNBR-1. This cultivar also performed well for majority of other characters viz., root diameter, root length, net root weight, flesh thickness and average root weight.

INTRODUCTION

Beet root (*Beta vulgaris* L.) is a member of the family Chenopodiaceae, commonly known as Goosefoot family. It is highly productive and believed to be native of Europe, West Asia and Africa (Vavilov, 1951). Beet root is rich in protein, carbohydrate, iron, calcium, phosphorus, vitamin C and betanine. Beet root also contains a relatively high level of folic acid. The relative sugar beet is grown for the high sucrose contents of the roots. It is basic need to develop high yielding varieties with better quality to increase the production and productivity of beet root in India. The available germplasm serves as most valuable natural reservoir for providing donor parent to improve the particular traits by genetic reconstruction of plants. Beet root is emerging exotic vegetable crop in India but most of the cultivars under cultivation are from foreign countries so there is an urgent need to strengthen the breeding programme. According to Ravishanker *et al.* (2013) collection, conservation and evaluation of germplasm are essential for present as well as future crop improvement programmes. The evaluation of the quantitative and qualitative variation under a wide range of environment and climatic condition provide useful information regarding the viability and genetic diversity within different genotypes as similar reported by Srivastava *et al.*(2000). Thus, keeping in view the above need for variability study in beet root some new genotypes procured from indigenous and exotic sources have been evaluated to formulate further breeding programme. Hence, the study was carried out to identify genotypes which may provide better qualitative and quantitative characters under mid-hill conditions of Himachal Pradesh.

MATERIALS AND METHODS

The field experiment was conducted at Experimental Farm of the Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during the Rabi season of 2011-12 and 2012-13. Twenty five diverse genotypes of beet root collected from different exotic and indigenous sources including two recommended varieties Crimson Globe and Detroit Dark Red as checks (Table-1) were used for the present investigations. All the genotypes were planted in a Randomized Block Design (RBD) in three replications. Seeds were directly sown in the field in the month of August, during 2011-12 and 2012-13 respectively at a spacing of 30 cm × 10 cm in a raised bed of 3.0 m × 1.8 m size, accommodated 180 plants per plot. The observations were recorded from ten randomly selected plants from each plot in each replication on different characters, viz., number of leaves per plant, root diameter, root length, root top ratio both on length and weight basis, average and net root weight, non reducing sugars and yield per hectare. Root length was measured from crown to distal end in centimetre. It was calculated by using following formula:

$$\text{Root/top ratio} = \frac{\text{Root length}}{\text{Length of the leaves}}$$

Root/top ratio (weight basis) was calculated by using following formula:

$$\text{Root/to p ratio} = \frac{\text{Root weight}}{\text{Weight of the leaves}}$$

For average root weight ten randomly selected roots from the pooled produce were taken and their weights were recorded in grams and then average root weight was calculated and for net root weight (g) ten randomly selected roots were taken from the pooled produce and their weights were recorded in

grams excluding the leaves and then net root weight was calculated. Yield per hectare was recorded in quintals by converting root yield per plot into root yield per hectare. The root diameter of ten randomly selected roots was calculated in millimeters with the help of digital vernier calliper. Non reducing sugar was calculated as per the method suggested by Ranganna (1986). The statistical analysis was carried out for each observed character under the study using MS-Excel and OPSTAT.

RESULTS AND DISCUSSION

The observations recorded on number of leaves per plant, root diameter, root length, root top ratio both on length and weight basis, average and net root weight, non reducing sugars and yield per hectare after analysis are presented in Table 2, 3, 4, 5 and 6 respectively. It is evident from data that significant differences among genotypes were recorded for all the characters under study. The analysis of variance indicated significant differences among genotypes for number of leaves. Maximum numbers of leaves were recorded in genotype BETA-2221 (13.41). Minimum number of leaves were recorded in BETA-344 (7.95) followed by BETA-154 (8.51), Crimson Globe (8.62) and Detroit Dark Red (8.53).

Significant differences were observed among the genotypes for root length and it was ranged from 5.50-10.46 cm. The mean performance presented in Table 3 showed that root length was maximum in genotype TNBR-1 (10.46 cm) and minimum root length of 5.50 cm was observed in BETA-340. The mean values of genotypes for root diameter ranged from 39.87-76.13 mm (Table 3). Significantly maximum root diameter of 76.13 mm was observed by genotype TNBR-1 and minimum root diameter of 39.87 mm was recorded in

genotype BETA-344. The observations recorded on root top ratio (length basis) revealed significant difference. The root top ratio (length basis) ranged from (0.29-0.52) (Table 4). Highest root top ratio of 0.52 was observed in check cultivar Detroit Dark Red which was statistically at par with BETA-273 (0.50cm). Significant differences were observed among the genotypes for root top ratio (weight basis). It ranged from 3.07-4.96. The mean performance presented in Table 4 showed that root top ratio (weight basis) was maximum in genotype TNBR-4 (4.96) and found statistically at par with BETA-99 (4.55), BETA-22291 (4.76) and TNBR-5 (4.95). Likewise, minimum root top ratio was observed in TNBR-8 (3.07). Highly significant variations were recorded for root weight. The differences between the genotypes for this character were ranged from 142.52-336.49g. Significantly maximum average root weight was recorded in genotype TNBR-1 (336.40g). Significant differences were observed among the genotypes for net root weight and it ranged from 97.69-236.52g. The mean performance of different genotypes presented in Table 5 revealed that significantly maximum net root weight was recorded in genotype TNBR-1 (236.52 g). Likewise, minimum root length was observed in TNBR-8 (97.69g) followed by BETA-344 (101.23g). Highly significant variations were recorded for yield/ha (Table 6). The difference between the mean values of different genotypes for the characters ranged from 190.00-448.67 q/ha. The data presented in table 6 clearly revealed that maximum yield of 448.67q/hectare was recorded in genotype TNBR-1. The minimum yield of 190.00 q was observed in BETA-344 and found statistically at par with TNBR-8 (193.19 q) and BETA-154 (196.45 q). Analysis of variance showed significant differences among genotypes for non-reducing sugars and the mean values of genotypes for this character ranged from 11.99-14.17 per cent (Table 6).

Table 1: List of beet root genotypes studied with their sources

Sr. No.	Genotype	Source
1.	TNBR-1	TNAU, Coimbatore, Tamilnadu
2.	TNBR-2	TNAU, Coimbatore, Tamilnadu
3.	TNBR-3	TNAU, Coimbatore, Tamilnadu
4.	TNBR-4	TNAU, Coimbatore, Tamilnadu
5.	TNBR-5	TNAU, Coimbatore, Tamilnadu
6.	TNBR-6	TNAU, Coimbatore, Tamilnadu
7.	TNBR-8	TNAU, Coimbatore, Tamilnadu
8.	TNBR-9	TNAU, Coimbatore, Tamilnadu
9.	TNBR-10	TNAU, Coimbatore, Tamilnadu
10.	BETA-33	IPGCPR, Gatersleben Germany
11.	BETA-34	IPGCPR, Gatersleben Germany
12.	BETA-49	IPGCPR, Gatersleben Germany
13.	BETA-99	IPGCPR, Gatersleben Germany
14.	BETA-112	IPGCPR, Gatersleben Germany
15.	BETA-133	IPGCPR, Gatersleben Germany
16.	BETA-135	IPGCPR, Gatersleben Germany
17.	BETA-154	IPGCPR, Gatersleben Germany
18.	BETA-273	IPGCPR, Gatersleben Germany
19.	BETA-340	IPGCPR, Gatersleben Germany
20.	BETA-344	IPGCPR, Gatersleben Germany
21.	BETA-1529	IPGCPR, Gatersleben Germany
22.	BETA-2221	IPGCPR, Gatersleben Germany
23.	BETA-22291	IPGCPR, Gatersleben Germany
24.	Crimson Globe*	IARI, Regional Research Station, Katrian, Kullu
25.	Detroit Dark Red*	IARI, Regional Research Station, Katrian, Kullu

*Check cultivars, TNAU : Tamil Nadu Agriculture University, IPGCPR : Institute of Plant Genetic and Crop Plant Research, Gatersleben, Germany

Table 2: Mean performance of different genotypes of beet root for number of leaves per plant

Sr .No.	Years	Genotypes		
		2011-12	2012-13	mean
1.	TNBR- 1	13.54	12.41	12.98
2.	TNBR- 2	13.68	12.33	13.01
3.	TNBR- 3	10.64	10.08	10.36
4.	TNBR- 4	12.44	10.19	11.32
5.	TNBR- 5	10.91	10.01	10.46
6.	TNBR- 6	10.82	9.61	10.22
7.	TNBR- 8	10.69	9.98	10.34
8.	TNBR -9	12.62	11.28	11.95
9.	TNBR -10	11.71	10.75	11.23
10.	BETA-33	17.58	17.06	17.32
11.	BETA-34	12.21	12.17	12.19
12.	BETA-49	10.77	10.07	10.42
13.	BETA-99	10.51	10.12	10.32
14.	BETA-112	12.18	11.63	11.90
15.	BETA-133	10.28	10.65	10.46
16.	BETA-135	10.57	9.90	10.23
17.	BETA-154	8.80	8.22	8.51
18.	BETA-273	11.54	10.39	10.97
19.	BETA-340	9.69	9.22	9.46
20.	BETA-344	8.11	7.79	7.95
21.	BETA-1529	12.33	12.01	12.17
22.	BETA-2221	13.67	13.15	13.41
23.	BETA-22291	12.19	11.47	11.83
24.	Crimson Globe	8.71	8.53	8.62
25.	Detroit Dark Red	8.67	8.39	8.53

Table 3: Mean performance of different genotypes of beet root for root diameter and root length

Sr. No.	Genotypes/Years	Root diameter (mm)			Root length (cm)			
		2011-12	2012-13	mean	2011-12	2012-13	mean	
1.	TNBR- 1	76.78	75.48	76.13	10.66	10.25	10.46	
2.	TNBR- 2	63.12	62.49	62.81	8.91	8.09	8.50	
3.	TNBR- 3	57.23	56.26	56.74	9.16	8.75	8.96	
4.	TNBR- 4	59.54	58.35	58.94	9.77	9.34	9.56	
5.	TNBR- 5	64.39	63.51	63.95	9.42	9.33	9.38	
6.	TNBR- 6	50.31	50.37	50.34	8.26	7.91	8.09	
7.	TNBR- 8	40.35	40.17	40.26	6.21	5.83	6.02	
8.	TNBR -9	49.27	48.53	48.90	6.91	6.21	6.56	
9.	TNBR -10	53.53	52.62	53.07	7.60	7.26	7.08	
10.	BETA-33	53.38	52.10	52.74	7.56	7.25	7.41	
11.	BETA-34	48.32	47.30	47.81	7.33	6.80	7.07	
12.	BETA-49	48.87	47.52	48.20	6.80	6.84	6.82	
13.	BETA-99	49.95	48.97	49.46	7.51	7.23	7.37	
14.	BETA-112	45.87	45.08	45.47	6.57	6.96	6.77	
15.	BETA-133	48.08	47.97	48.02	6.26	6.57	6.42	
16.	BETA-135	42.25	41.29	41.77	6.27	6.81	6.54	
17.	BETA-154	40.14	39.74	39.94	5.86	5.65	5.75	
18.	BETA-273	42.32	41.66	41.99	6.23	5.89	6.06	
19.	BETA-340	42.02	39.80	40.91	5.98	5.01	5.50	
20.	BETA-344	40.03	39.71	39.87	5.77	5.39	5.58	
21.	BETA-1529	48.73	46.20	47.46	6.85	6.15	6.50	
22.	BETA-2221	50.90	49.27	50.09	7.00	6.74	6.87	
23.	BETA-22291	50.01	48.43	49.22	7.46	6.53	6.99	
24.	Crimson Globe	62	58.52	60.26	7.80	7.86	7.83	
25.	Detroit Dark Red	63.64	62.74	63.19	9.12	8.33	8.72	
	Mean	51.64	50.56		7.48	7.17		
	CD _{0.05}					260.22		
	Genotypes	: 4.25		Genotypes	: 0.84		Genotypes	: 12.60
	Years	: NS		Years	: 0.24		Years	: 3.57
	Genotypes x Years	: NS		Genotypes x Years	: NS		Genotypes x Years	: NS

Maximum value of 14.17 per cent was observed for the genotype BETA-340 and found at par with BETA-1529 (13.84 %), BETA-154 (13.91 %), Crimson Globe (13.91 %) and TNBR-

8 (14.06 %) and minimum (11.99 %) in genotype TNBR-1. Wide range of variation for different quantitative and qualitative characters in different genotypes of wild type of beets had also

Table 4: Mean performances of different genotypes of beet root for root top ratio, length basis and weight basis.

Sr. No.	Years/ Genotypes	Length basis			Weight basis		
		2011-12	2012-13	mean	2011-12	2012-13	mean
1.	TNBR- 1	0.42	0.41	0.41	3.36	3.37	3.37
2.	TNBR- 2	0.35	0.34	0.35	4.33	4.43	4.38
3.	TNBR- 3	0.38	0.37	0.37	4.03	4.35	4.19
4.	TNBR- 4	0.40	0.41	0.40	5.42	4.48	4.96
5.	TNBR- 5	0.37	0.39	0.38	4.82	5.08	4.95
6.	TNBR- 6	0.45	0.48	0.47	3.34	3.52	3.43
7.	TNBR- 8	0.38	0.40	0.39	3.11	3.03	3.07
8.	TNBR -9	0.38	0.36	0.37	3.18	3.55	3.37
9.	TNBR -10	0.36	0.39	0.37	3.70	3.40	3.55
10.	BETA-33	0.40	0.41	0.40	3.60	3.49	3.54
11.	BETA-34	0.38	0.35	0.37	3.60	3.66	3.63
12.	BETA-49	0.37	0.39	0.38	3.54	3.43	3.49
13.	BETA-99	0.38	0.37	0.38	5.02	4.04	4.55
14.	BETA-112	0.38	0.43	0.41	3.12	3.38	3.25
15.	BETA-133	0.29	0.41	0.35	3.35	3.73	3.48
16.	BETA-135	0.37	0.43	0.40	3.68	4.23	3.75
17.	BETA-154	0.41	0.40	0.41	3.99	3.66	3.78
18.	BETA-273	0.49	0.51	0.50	4.39	4.49	4.45
19.	BETA-340	0.36	0.34	0.35	3.82	4.22	3.81
20.	BETA-344	0.41	0.39	0.40	3.41	3.50	3.44
21.	BETA-1529	0.33	0.32	0.32	4.08	3.73	3.79
22.	BETA-2221	0.28	0.30	0.29	3.91	4.19	3.88
23.	BETA-22291	0.31	0.30	0.31	5.12	5.23	4.76
24.	Crimson Globe	0.33	0.40	0.39	3.91	3.77	3.91
25.	Detroit Dark Red	0.39	0.50	0.52	3.68	4.18	3.67
	Mean	0.36	0.38		2.91	3.82	
	CD _{0.05}		CD _{0.05}			260.22	
	Genotypes	: 0.04	Genotypes	: 0.46	Genotypes	: 12.60	
	Years	: NS	Years	: 0.13	Years	: 3.57	
	Genotypes x Years	: NS	Genotypes x Years	: 0.65	Genotypes x Years	: NS	

Table 5: Mean performances of different genotypes of beet root for average root weight and net root weight

Sr. No.	Years/Genotypes	Average root weight (gm)			Net root weight (gm)		
		2011-12	2012-13	Mean	2011-12	2012-13	Mean
1.	TNBR-1	339.67	333.31	336.49	238.51	234.53	236.52
2.	TNBR-2	237.72	231.92	234.82	182.81	179.53	181.17
3.	TNBR-3	200.23	197.33	198.78	150.49	151.96	151.23
4.	TNBR-4	230.00	226.26	228.13	187.58	175.74	181.66
5.	TNBR-5	275.50	266.70	271.10	218.33	214.22	216.28
6.	TNBR-6	176.78	176.02	176.40	123.91	125.96	124.94
7.	TNBR-8	146.17	143.62	144.90	99.10	96.28	97.69
8.	TNBR-9	177.33	174.88	176.11	121.61	125.62	123.61
9.	TNBR-10	196.53	190.43	193.48	143.40	134.36	138.88
10.	BETA-33	194.77	191.29	193.03	140.63	136.44	138.53
11.	BETA-34	182.14	172.13	177.14	131.49	125.13	128.31
12.	BETA-49	175.98	173.91	174.95	126.27	123.17	124.72
13.	BETA-99	182.50	177.83	180.17	146.12	133.80	139.96
14.	BETA-112	165.03	158.93	161.98	112.16	111.96	112.06
15.	BETA-133	174.60	164.07	169.34	122.42	120.04	121.23
16.	BETA-135	159.41	146.64	153.03	116.14	112.00	114.07
17.	BETA-154	149.40	145.27	147.34	111.96	105.61	108.78
18.	BETA-273	160.40	152.67	156.54	123.83	118.67	121.25
19.	BETA-340	159.51	149.00	154.26	117.74	113.67	115.71
20.	BETA-344	148.24	136.80	142.52	104.75	97.70	101.23
21.	BETA-1529	184.86	183.33	184.10	139.52	134.12	136.82
22.	BETA-2221	192.14	188.42	190.28	143.04	143.47	143.25
23.	BETA-22291	184.86	183.00	183.93	150.91	148.00	149.46
24.	Crimson Globe	244.90	242.29	243.20	189.15	184.30	186.72
25.	Detroit Dark Red	190.81	185.28	188.05	139.02	136.15	137.58
	Mean	193.15	187.65		143.24	139.30	
	CD _{0.05}		CD _{0.05}			260.22	
	Genotypes	: 17.01	Genotypes	: 6.70	Genotypes	: 12.60	
	Years	: 5.00	Years	: 1.88	Years	: 3.57	
	Genotypes x Years	: NS	Genotypes x Years	: 0.65	Genotypes x Years	: NS	

Table 6: Mean performances of different genotypes of beet root for yield per hectare and non reducing sugar

S. No.	Genotypes	Root yield/ha			Non reducing sugars (%)		
		2011-12	2012-13	Mean	2011-12	2012-13	Mean
1.	TNBR- 1	452.89	444.45	448.67	12.85 (3.59)	11.12 (3.33)	11.99 (3.46)
2.	TNBR- 2	316.97	309.26	313.11	13.10 (3.62)	11.97 (3.46)	12.54 (3.54)
3.	TNBR- 3	266.97	263.11	265.04	13.36 (3.66)	12.05 (3.47)	12.70 (3.56)
4.	TNBR- 4	306.67	301.71	304.19	13.35 (3.66)	12.00 (3.46)	12.68 (3.56)
5.	TNBR- 5	367.34	355.63	361.48	13.04 (3.61)	11.89 (3.45)	12.47 (3.53)
6.	TNBR- 6	235.71	234.67	235.19	14.61 (3.82)	12.26 (3.50)	13.44 (3.66)
7.	TNBR- 8	194.89	191.48	193.19	15.02 (3.88)	13.09 (3.62)	14.06 (3.75)
8.	TNBR -9	236.45	233.19	234.82	14.66 (3.83)	12.31 (3.51)	13.48 (3.67)
9.	TNBR -10	262.08	253.93	258.00	13.70 (3.70)	12.22 (3.49)	12.96 (3.60)
10.	BETA-33	259.71	255.04	257.37	14.62 (3.82)	12.21 (3.49)	13.42 (3.66)
11.	BETA-34	242.89	229.48	236.19	14.69 (3.83)	12.38 (3.52)	13.53 (3.68)
12.	BETA-49	234.67	231.85	233.26	14.69 (3.83)	12.34 (3.51)	13.51 (3.67)
13.	BETA-99	243.34	237.11	240.22	14.63 (3.83)	12.26 (3.50)	13.45 (3.66)
14.	BETA-112	220.08	211.93	216.00	14.09 (3.75)	12.43 (3.53)	13.26 (3.64)
15.	BETA-133	232.82	218.74	225.78	13.26 (3.64)	12.42 (3.52)	12.84 (3.58)
16.	BETA-135	212.52	195.56	204.04	13.91 (3.73)	12.21 (3.49)	13.06 (3.61)
17.	BETA-154	199.19	193.71	196.45	14.77 (3.84)	13.04 (3.61)	13.91 (3.73)
18.	BETA-273	213.85	203.56	208.71	14.64 (3.82)	13.19 (3.63)	13.92 (3.73)
19.	BETA-340	212.67	198.67	205.67	14.97 (3.87)	13.37 (3.66)	14.17 (3.77)
20.	BETA-344	197.63	182.37	190.00	14.91 (3.86)	13.19 (3.63)	14.05 (3.75)
21.	BETA-1529	246.52	244.45	245.48	15.06 (3.88)	12.61 (3.55)	13.84 (3.72)
22.	BETA-2221	256.22	251.26	253.74	15.03 (3.88)	12.39 (3.52)	13.71 (3.70)
23.	BETA-22291	250.15	244.00	247.08	14.84 (3.85)	12.39 (3.52)	13.61 (3.69)
24.	Crimson Globe	325.48	323.04	324.25	14.69 (3.83)	13.12 (3.62)	13.91 (3.73)
25.	Detroit Dark Red	254.45	247.04	250.75	13.83 (3.72)	11.89 (3.45)	12.86 (3.59)
Mean		267.99	260.22		14.25(3.77)	12.40 (3.52)	
		CD _{0.05}			CD _{0.05}		
Genotypes		12.60			0.05		
Years		3.57			NS		
Genotypes × Years		NS			NS		

been reported by Manhaley *et al.* (1998) , Baranski *et al.* (2001). and Srivastava *et al.* (2004) in garden beet, Ahmed *et al.*(2012) in sugar beet, Yadav *et al.* (2009) in carrot. Root yield per hectare is one of the most desirable traits attaining highest consideration in any beet root breeding programme. Genotypes under investigation showed great variability for root yield per plot. Maximum root yield of 448.67 q/ha was recorded in genotype TNBR-1 and gave 44.10 and 27.70 per cent more yield over check cultivars, Crimson Globe and Detroit Dark Red, respectively. This cultivar also performed well for majority of other character *viz.*, root length, root diameter, average root weight and net root weight whereas, BETA-340 recorded highest non reducing sugars (13.92%). Genotype TNBR-1 requires further testing for its better utilization in breeding programme.

Genotype and year interaction was significant for the characters root top ratio on weight basis which was entirely due to the difference in prevailed environmental conditions during both the years including biotic and abiotic factors. Therefore for this character the behaviour of genotypes was not consistent and varies with the environmental conditions. Interaction occurs due to different sensitivities of genotypes to environmental changes, and it is an aggravating factor in plant breeding programs by Ramalho *et al.* (1993).

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