Original Research Article

Assessment of Morphological and Biochemical characters by using Principal Component analysis on beetroot (*beta vulgaris* l.) cv. crimson globe under alkaline conditions

ABSTRACT

Beet root is one of the most important root crops with health promoting substances like vitamins, minerals and betalains, grown in northern and southern parts of India. The present study was carried to assess the morphological and biochemical characters by using principal component analysis over eight treatments and twenty-one parameters. Principal component analysis accounted 81.57% variation among eight treatments of beet root grown under alkaline conditions. Root yield was observed positive significant with height of the plant, number of leaves/plant, leaf area chlorophyll content index, length of the root, root diameter, root yield/plant, root yield per hectare, root to shoot ratio, harvest index, TSS, ascorbic acid content, betanine content nitrogen, phosphorus and potassium content (in the soil following crop harvest) and organic carbon (in the soil following crop harvest) whereas negative significant correlation with number of days required for 80 % germination, pH in the soil following crop harvest and EC in the soil after the harvest of the crop.

Key words: Beet root, Correlation analysis and Principal Component analysis, Root yield

Introduction

Beet root belongs to the family Chenopodiaceae (12). It is one of the important root crops

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originated in Mediterranean region cultivated throughout Europe. It is mainly used as food coloring agent (5). Beet root is having betacyanin which is composed of betanin's and isobetanins (9) which impart reddish to purple pigment having the properties to obviate cancer and cardiovascular diseases by increasing the low-density lipoproteins to oxidation by reducing the oxidative effect of lipids (23, 26, 8). Sucrose is the primary sugar in beetroot, with minor amounts of glucose and fructose. (3) Juice of beetroot has capacity to reduce blood pressure and protect from liver diseases (6, 16) and it is also best-known anti-inflammatory properties (27). In India major beet root crop growing states are Haryana, Uttar Pradesh, Himachal Pradesh, West Bengal and Maharashtra. Beetroot is grown on an area of 0.079 lakh hectares in India, with an annual production of 1.51 lakh million tonnes, and Telangana has 0.04 lakh hectares with an annual production of 0.11 lakh million tonnes. (11).

The most significant characteristic, yield, is controlled by a variety of traits and its interaction. The link between the variables is understood through correlation analysis. Studies of correlation are helpful for choosing traits that are closely related and for determining features that have an indirect influence on other traits (4). Without mentioning cause and effect, the correlation coefficient provides information about the relationship among the independent and dependent variables (1). The variability among the treatments is ascertained using principal component analysis (13).

MATERIALS AND METHODS

The current study was carried out at the College of Horticulture, Mojerla, SKLTSH University, Mulugu, Telangana State, India, between the last week of October 2019 and the second week of January 2020. The farm has a semi-arid climate and is located at an elevation of 401 meters above mean sea level on 770.96' East longitude and 160.36' North latitude. The experiment was carried out in randomized complete block design with eight treatments and three replications. All agronomic practices are done and plant protection measures were followed to raise a healthy crop. During the experiment, observations for with number of days required for 80 % germination, height of the plant, number of leaves/plants, leaf area chlorophyll index, root length, root diameter, root yield/plant, root yield ha^{-1}, root to shoot ratio, harvest index (HI), TSS, ascorbic acid content, betanine content, nitrogen, phosphorus, potassium content, pH, EC and organic carbon in the soil following the crop harvest and five plants were randomly selected and data is recorded. The degree of association of character root yield and among themselves are calculated by Correlation coefficients. Used Statistical Package for the Social Science (SPSS) software to find out correlation coefficient analysis. The statistical tools used WINDOSTAT 9.1, created by INDOSTAT Services

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RESULTS AND DISCUSSION

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Table 1 and figure 1 presents the principal component analysis (PCA) findings. The results of the principal component analysis on the correlation matrix for the eight treatments and 21 parameters used to study morphological and biochemical characters include the eigenvalues, percent of variability, cumulative percent of variability, and factor loading values for the various traits for the respective principal components shown in table 1 and fig 1. According to principal component analysis, significant principal components had eigen values greater than one, whereas important principal components had eigen values less than one. During analysis two principal components (PCs) exhibited more than 1.00 Eigen value, and showed about 81.57% variability among the trait studied. These results are according with the (19).

As per the analysis, the first components accounted for most of the variation. The first component F1 explained 81.57% of total variation and more divergent with leaf area, chlorophyll, root length, root diameter, root yield (kg/plot), Root yield (t/ha), Nitrogen and Total soluble solids. Similar results were obtained by (7) reported results may help in technical improvement of the genotype characteristics which might be used for further selection in breeding program. From the results it is stated that traits which are showing significant contribution to the observed variation is used for future breeding program. The treatments which are showing variation among the traits should be given most importance. to increase the quality of future segregant selection regarding parent selection during hybridization programmes. Results are congruity with (3) in tomato (25) in mango. It is necessary to know the best treatment and traits whose contribution is the most for the variation so as to improve that character in the further breeding programs.

Correlation Analysis

In order to understand how numerous characteristics interacted and were connected to the root yield, correlation analysis is used. Table 2 shows that all correlations are significant at the 1% level. In present experiment a significant positive correlation between root yield (kg plot^{-1}) with plant height (0.9090 cm) congruity with (22), number of leaves per plant (0.6619), leaf area (0.9448 cm^2) similar results are obtained by (10), chlorophyll content index at (0.9679), root length (0.9265 cm), root diameter (0.9640 cm) reported by (21) , root yield/plant (0.9528 g), root yield/hectare (0.9973 t) similar compulsions were congruity with (24, 18), root to shoot ratio (0.9198), harvest index (0.8594), ascorbic acid content (0.9186 mg 100 g^{-1}) similar results are reported by (2), betanine

content (0.5753 mg 100 g^{-1}) TSS (0.9934 ^{0}Brix), nitrogen, phosphorus and potassium content in the soil following the crop harvest (0.9858 kg ha^{-1}, 0.4708 kg ha^{-1}, 0.8469 kg ha^{-1}, respectively) and organic carbon in the soil following the crop harvest (0.9493 %). Root yield was negatively correlation with number of days required for 80 % germination (-0.7287 days), pH in the soil after the harvest of the crop (-0.9660) and Electric conductivity in the soil after the harvest of the crop (-0. 9429 decisiemens per metre (dS mol^{-1}) these results are in congruity with (17)

Inference of investigation revealed that, the capacity of the plant to produce more photosynthates, which are mobilized to the organ of economic value, could be improved by the timely application of Nitrogen fertilizer this would increase root weight and root diameter, which would ultimately result in a higher yield per unit area, as reported by (10). The characters like root yield were observed positively significant with height of the plant, number of leaves/plants, leaf area, chlorophyll content index, root length, root diameter, root yield/plant, root yield/hectare, root to shoot ratio, harvest index (HI), TSS, ascorbic acid content, betanine content nitrogen, phosphorus and potassium content and organic carbon in the soil following the crop harvest. Selection above traits is desirable in selection among beet root genotypes in further breeding programmes. Similar observations are recorded by (15,14).and (21) reported in beet root genotypes, positive correlation was observed between root yield with shoot length, shoot weight, root girth, root volume.

Conclusion

Experimental result shows that root yield was observed in positive association with height of the plant, number of leaves/plants, chlorophyll content index, leaf area, length of root, root diameter of root, root yield/plant, root yield/hectare, root to shoot ratio, harvest index (HI), TSS, ascorbic acid content, betanine content nitrogen, phosphorus and potassium content in the soil following the crop harvest and organic carbon in the soil following the crop harvest

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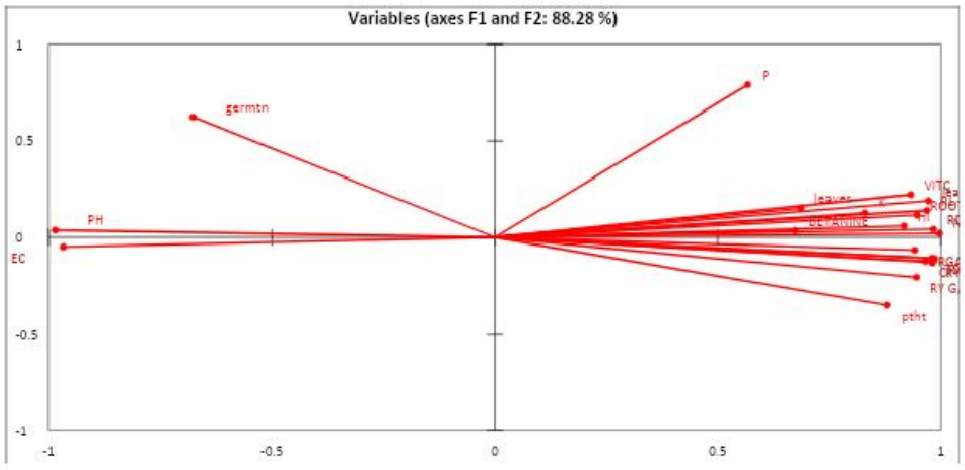

Figure 1: Biplot graphic with two principal components (PC1 and PC2: 88.28 %) for 21 parameters in beet root grown under alkaline conditions.

Table 1: Principal component loadings of 21 parameters in beet root grown under alkaline conditions.

	F1	F2	F3	F4	F5	F6	F7
Eigenvalue	17.1304	1.4081	0.9546	0.6918	0.4032	0.2673	0.1445
Variability (%)	81.5734	6.7052	4.5459	3.2942	1.9200	1.2730	0.6883
Cumulative %	81.5734	88.2786	92.8245	96.1187	98.0387	99.3117	100.0000
Germination	-0.1635	0.5254	0.1315	-0.2421	-0.3242	0.4202	0.2190
Plant height	0.2128	-0.2971	-0.0300	0.0025	-0.0340	-0.2521	0.7512
Leaves	0.1660	0.1277	-0.4755	0.5933	-0.0629	0.3870	0.1676
leaf area	0.2349	0.1599	0.0016	-0.1225	-0.0706	-0.1160	0.1405
Chlorophyll	0.2331	-0.1038	0.1208	-0.1974	-0.1518	0.0975	0.0833
Rootlength	0.2341	0.1178	0.1471	0.0716	0.1711	0.0742	0.1718
Root diameter	0.2375	0.0355	0.0314	-0.0805	-0.0350	-0.2322	-0.2803
Root yield g/plant	0.2283	-0.1738	0.1635	-0.1617	-0.0479	0.2225	-0.2186
Root yield (KG/Plot)	0.2382	-0.0920	-0.0879	-0.1033	0.0369	0.0381	0.0246

Root Yield(t/HA)	0.2367	-0.1080	-0.0808	-0.1217	-0.0073	0.1554	0.0669
ROOT/SHOOT	0.2286	0.0975	0.0653	-0.1633	-0.4069	-0.0821	0.0559
Harvest Index	0.2215	0.0493	0.3847	0.0566	-0.1648	0.0614	-0.0502
VITC	0.2252	0.1871	-0.2323	-0.1247	-0.1541	-0.1575	-0.1605
BETANINE	0.1629	0.0298	0.6156	0.5047	0.0567	0.1373	-0.0118
TSS	0.2367	-0.0900	-0.1163	-0.0889	-0.1161	0.1397	-0.0047
Nitrogen	0.2408	0.0169	-0.0035	-0.0436	0.1012	0.0004	0.0651
Phosphorus	0.1372	0.6666	-0.0320	0.0652	0.1780	-0.3594	0.0722
Potassium	0.2006	0.1070	-0.0631	-0.3222	0.6683	0.3825	0.0077
PH	-0.2383	0.0310	-0.0724	-0.0743	-0.1669	0.1147	0.1302
EC	-0.2339	-0.0412	0.1189	-0.1947	-0.0477	0.2326	0.1948
ORGANIC CARBON	0.2273	-0.0545	-0.2332	0.1034	-0.2751	0.1902	-0.2758

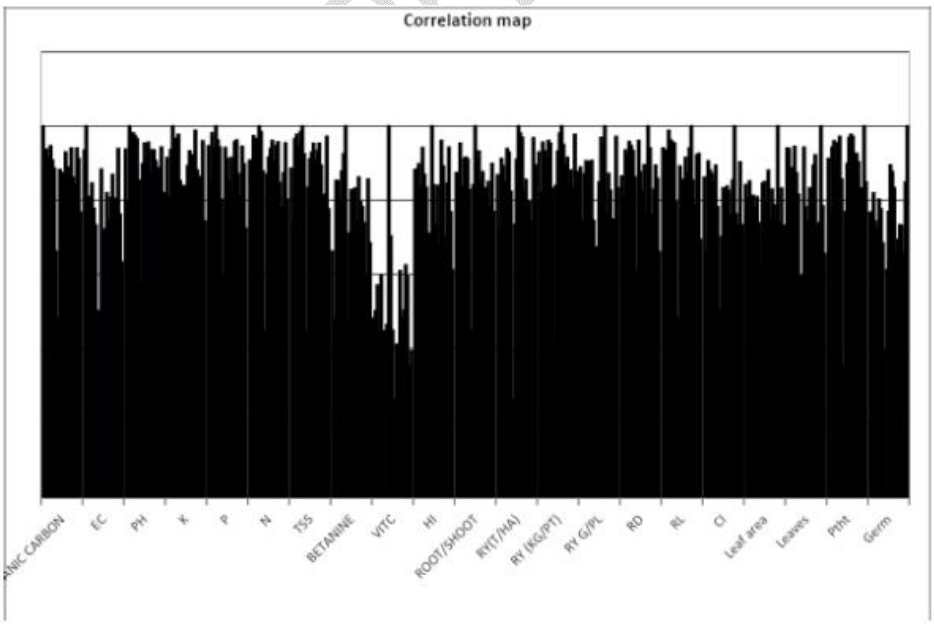

Figure 2: No. of days taken for germination, Ph and electrical conductivity is negatively

correlated with all other parameter indicated by blue color.

Table 2: Correlation coefficient analysis showing relationship of different Characters on root yield of beet root Cv. Crimson Globe.

Variables	germination	Plant height	leaves	leaf area	Chlorophyll	Root length	Root diameter	Root Yield(g/ plant)	Root yield (KG/PT)	Root yield (t/hA)	ROOT/SHOOT	Harvest Index
Germination	**1**	-0.8200	-0.4724	-0.5181	-0.6480	-0.5705	-0.6518	-0.6959	-0.7287	-0.7120	-0.4867	-0.5182
Plant height	-0.8200	**1**	0.5593	0.8132	0.8941	0.8113	0.8357	0.8619	0.9090	0.9072	0.8076	0.7688
Leaves	-0.4724	0.5593	**1**	0.6388	0.5243	0.6569	0.6046	0.4962	0.6619	0.6583	0.5740	0.4967
leaf area	-0.5181	0.8132	0.6388	**1**	0.9346	0.9589	0.9732	0.8834	0.9448	0.9352	0.9709	0.9001
Chlorophyll	-0.6480	0.8941	0.5243	0.9346	**1**	0.9184	0.9508	0.9842	0.9679	0.9738	0.9519	0.9253
Rootlength	-0.5705	0.8113	0.6569	0.9589	0.9184	**1**	0.9449	0.8973	0.9265	0.9183	0.9056	0.9420
Root diameter	-0.6518	0.8357	0.6046	0.9732	0.9508	0.9449	**1**	0.9299	0.9640	0.9500	0.9546	0.9128
Rootyield g/plant	-0.6959	0.8619	0.4962	0.8834	0.9842	0.8973	0.9299	**1**	0.9528	0.9605	0.8997	0.9164
Rootyield(KG/Plot)	-0.7287	0.9090	0.6619	0.9448	0.9679	0.9265	0.9640	0.9528	**1**	0.9973	0.9198	0.8594
Root Yield(t/HA)	-0.7120	0.9072	0.6583	0.9352	0.9738	0.9183	0.9500	0.9605	0.9973	**1**	0.9192	0.8590
ROOT/SHOOT	-0.4867	0.8076	0.5740	0.9709	0.9519	0.9056	0.9546	0.8997	0.9198	0.9192	**1**	0.9171
Harvest Index	-0.5182	0.7688	0.4967	0.9001	0.9253	0.9420	0.9128	0.9164	0.8594	0.8590	0.9171	**1**
VITC	-0.5031	0.7443	0.7119	0.9644	0.8655	0.8774	0.9440	0.8112	0.9186	0.9054	0.9344	0.7861
BETANINE	-0.4336	0.5532	0.4087	0.6141	0.6481	0.7759	0.6457	0.6767	0.5753	0.5714	0.6108	0.8646
TSS	-0.6983	0.8953	0.6904	0.9383	0.9678	0.9081	0.9532	0.9501	0.9934	0.9960	0.9331	0.8558
Nitrogen	-0.6661	0.8766	0.6706	0.9750	0.9595	0.9745	0.9790	0.9380	0.9858	0.9783	0.9340	0.9049
Phosphorus	0.0326	0.2519	0.5113	0.7041	0.4185	0.6664	0.6039	0.3340	0.4708	0.4372	0.5986	0.5395
Potassium	-0.4806	0.6536	0.5087	0.8276	0.7913	0.8511	0.8040	0.7940	0.8469	0.8431	0.7145	0.6946
PH	0.7323	-0.8710	-0.6503	-0.9418	-0.9396	-0.9702	-0.9761	-0.9365	-0.9660	-0.9527	-0.8990	-0.9196
EC	0.7105	-0.8330	-0.7763	-0.9356	-0.8764	-0.9315	-0.9610	-0.8556	-0.9429	-0.9233	-0.8877	-0.8488
ORGANIC CARBON	-0.6749	0.8194	0.8049	0.8897	0.8933	0.8529	0.9128	0.8798	0.9439	0.9455	0.8952	0.8007

Table 3: **Correlation coefficient analysis showing relationship of different Characters on different nutrients and organic carbon present in beet root**

Variables	VITC	BETANINE	TSS	N	P	K	PH	EC	ORGANIC CARBON
Germination	-0.5031	-0.4336	-0.6983	-0.6661	0.0326	-0.4806	0.7323	0.7105	-0.6749
Plant height	0.7443	0.5532	0.8953	0.8766	0.2519	0.6536	-0.8710	-0.8330	0.8194
Leaves	0.7119	0.4087	0.6904	0.6706	0.5113	0.5087	-0.6503	-0.7763	0.8049
leaf area	0.9644	0.6141	0.9383	0.9750	0.7041	0.8276	-0.9418	-0.9356	0.8897
Chlorophyll	0.8655	0.6481	0.9678	0.9595	0.4185	0.7913	-0.9396	-0.8764	0.8933
Root length	0.8774	0.7759	0.9081	0.9745	0.6664	0.8511	-0.9702	-0.9315	0.8529
Root diameter	0.9440	0.6457	0.9532	0.9790	0.6039	0.8040	-0.9761	-0.9610	0.9128
Root yield g/plant	0.8112	0.6767	0.9501	0.9380	0.3340	0.7940	-0.9365	-0.8556	0.8798
Root yield (KG/Plot)	0.9186	0.5753	0.9934	0.9858	0.4708	0.8469	-0.9660	-0.9429	0.9439
Root Yield(t/HA)	0.9054	0.5714	0.9960	0.9783	0.4372	0.8431	-0.9527	-0.9233	0.9455
ROOT/SHOOT	0.9344	0.6108	0.9331	0.9340	0.5986	0.7145	-0.8990	-0.8877	0.8952
Harvest Index	0.7861	0.8646	0.8558	0.9049	0.5395	0.6946	-0.9196	-0.8488	0.8007
VITC	**1**	0.4470	0.9241	0.9301	0.7086	0.7858	-0.8860	-0.9339	0.9208
BETANINE	0.4470	**1**	0.5597	0.6576	0.4055	0.4438	-0.7318	-0.6453	0.5322
TSS	0.9241	0.5597	**1**	0.9726	0.4495	0.8094	-0.9454	-0.9334	0.9683
Nitrogen	0.9301	0.6576	0.9726	**1**	0.5879	0.8673	-0.9854	-0.9605	0.9204
Phosphorus	0.7086	0.4055	0.4495	0.5879	**1**	0.5705	-0.5537	-0.6245	0.4539
potassium	0.7858	0.4438	0.8094	0.8673	0.5705	**1**	-0.8262	-0.7624	0.7089
PH	-0.8860	-0.7318	-0.9454	-0.9854	-0.5537	-0.8262	**1**	0.9687	-0.9004
EC	-0.9339	-0.6453	-0.9334	-0.9605	-0.6245	-0.7624	0.9687	**1**	-0.9387

Organic carbon	0.9208	0.5322	0.9683	0.9204	0.4539	0.7089	-0.9004	-0.9387	**1**