Indian J. Agric. Res., 50 (4) 2016 : 345-349
Print ISSN:0367-8245 / Online ISSN:0976-058X

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com/www.ijarjournal.com

Assessment of genetic diversity and association among agro-morphological characters in potato (*Solanum tuberosum* L.)

Anamika Verma* and Dhirendra Singh

Department of Vegetable Science, College of Agriculture,
G. B. Pant University of Agriculture and Technology, Pantnagar -263145, India.

Received: 24-08-2015 Accepted: 19-05-2016 DOI:10.18805/ijare.v50i4.11254

ABSTRACT

In the present investigation the level of diversity in 44 potato germplasm was assessed using principal component analysis (PCA) and cluster analysis and interrelationships among ten different quantitative characters was also worked out. A variation of 94.52 per cent was recorded due to first seven principal components on various genotypes. The first PC had high positive weight for plant height, average tuber weight and tuber yield per plant and second was more related to number of shoot per plant, number of tuber per plant and tuber yield per plot. The forty-four potato germplasm were grouped into eleven well distinct clusters. Genotypes belonging to cluster IV, II, IX and VIII were found diverse and best in all respect. Positive and significant correlation of tuber yield observed for plant height followed by number of shoots per plant, average weight of tuber, tuber yield per plant and marketable yield per plot. Path analysis revealed that marketable yield per plot, tuber yield per plant, number of tuber per plant and plant height had highest positive direct effect on tuber yield.

Key words: Cluster analysis, Correlation, Genetic diversity, Path analysis, Potato, PCA.

INTRODUCATION

In order of economic importance, potato is the fourth most important food crop in the world. Potato produces more calories and protein per unit of land with minimum time than any other field crop (Upadhya, 1995). For improvement in potato crop genetic diversity is required. However due to narrow genetic base in cultivated potato, in India lot of potential yet to be explore. Principal component analysis was done to estimate the variability in germplasm under study which was suggested by Hotelling (1933) after its original concept given by Pearson (1901) and non-hierarchical Euclidean cluster analysis by Beale (1969) was used for grouping all genotypes into clusters. Correlation coefficient analysis (Searle,1961) and path coefficient analysis (Wright, 1921) was performed to measure the mutual relationship among various plant characters and to show the extent of direct and indirect effects of the causal components on the response component.

MATERIALS AND METHODS

The present study on genetic diversity was conducted at Vegetable Research Center of GB Pant University of Agriculture and Technology, Pantnagar in the year 2013-14. The climate of this place is humid and subtropical and frost can be expected from last week of December to end of the January. The potato tubers were planted during third week of October. The experiment was laid out in an augmented block design with 4 blocks. Each block contains eleven genotypes along with four checks (Kufri Badshah, Kufri Chipsona-2, Kufri Khyati and Kufri Ashoka) each having 4 rows which were 2 m long. Data were measured and recorded with five randomly selected plants. A total of 10 agro-morphological traits were analyzed by Principal Component Analysis through software SPAR I. Non-hierarchical Euclidean analysis was done for grouping the genotypes in various clusters. Correlation and path component analysis was also carried out to know the interrelationship between yield and yield attributing traits.

RESULTS AND DISCUSSION

Principal component analysis and Non-hierarchical Euclidean cluster analysis: The PCA of 44 genotypes based on correlation matrix of the morphological traits yielded 10 Eigen roots and Eigen vectors presented in Table 1. The eigen root of first PC (principal component) accounted for 33.72 percent of variation followed by second 16.16 per cent and third 10.70 per cent of total variation. Approximately 94.52 percent of variation was recorded due to first seven PC on various genotypes. Rao (1964) reported that covering 90 per cent of total variation is useful and should be adopted to explain the variation in the breeding material. The first vector had high positive weight to average tuber weight followed by plant height and tuber yield per plant. The second vector had high positive weight to number of shoot per plant followed by tuber yield per plot and emergence percent. From this result it may be concluded that important variables in potato genotypes with respect to agronomic traits were plant height, number of shoots per plant, average tuber weight

*Corresponding author's e-mail: verma.anamika02@gmail.com.

Table 1: Eigen vector, Eigen root and associated variation for principal component in potato based on economic traits.

Characters	1	2	3	4	5	6	7	8	9	10
Emergence %	0.083	0.208	0.241	0.126	0.271	0.436	0.440	0.441	0.171	0.442
Plant height (cm)	0.535	0.120	0.453	0.510	-0.164	-0.066	-0.082	-0.058	-0.433	-0.078
No. of shoot	0.057	0.880	0.097	-0.194	0.174	-0.150	-0.165	-0.155	0.222	-0.149
No. of tuber/plant	-0.490	0.205	0.196	0.506	-0.518	-0.022	-0.014	-0.023	0.429	0.001
Average tuber weight (g)	0.547	-0.198	-0.273	0.294	0.183	-0.090	-0.020	-0.107	0.662	-0.097
Tuber yield/plant (g)	0.391	-0.015	0.147	-0.536	-0.682	0.056	0.075	0.110	0.203	0.106
Tuber length (mm)	0.011	0.003	0.001	-0.005	-0.004	-0.014	0.093	-0.738	-0.025	0.667
Marketable yield/ plot(kg)	-0.016	0.017	-0.010	0.011	0.013	-0.851	0.433	0.233	-0.033	0.178
Unmarketable yield/plot (kg)	0.022	-0.013	-0.051	0.037	0.026	-0.166	-0.744	0.378	0.026	0.520
Tuber yield/plot (kg)	0.103	0.342	-0.768	0.235	-0.319	0.138	0.131	0.110	-0.262	0.093
Eigen root	**2.87**	**2.62**	**1.87**	**1.82**	**0.90**	**0.81**	**0.68**	**0.44**	**0.21**	**0.10**
Percent variation	**33.72**	**16.16**	**10.70**	**10.20**	**8.93**	**8.05**	**6.76**	**2.40**	**2.06**	**1.03**

and tuber yield per plant which contributed maximum towards diversity. Similar results were obtained by Lohani *et al*. (2012) and Nickmanesh and Hassanpanah (2014).

Non-hierarchical Euclidean Cluster Analysis was done to diversify 44 genotypes into different cluster as given in Table 2. A total eleven clusters were obtained which was determined using F-test, that cluster combination ten and eleven was significant and most appropriate. The average inter- and intra-cluster distances have been presented in Tables 3. The maximum intra and inter cluster distance was noticed in cluster IX (1.931) and between cluster IV and IX (6.514) respectively. Genotypes presented in cluster IV recorded maximum tuber yield per plot (26.43 kg), number of shoot per plant (5.13) and tuber yield per plant (440g). The genotypes in cluster IX recorded maximum number of tubers per plant (11.20). Cluster VIII had highest mean value for plant height (55.08 cm) and average tuber weight (119.62g). Although, cluster IX had highest mean value for

Table 2: Distributing pattern of 44 genotypes of potato into eleven clusters.

Cluster number	Number of genotypes	Genotypes included
I	3	Pant Sel-08-11, Pant Sel-09-03 and Pant Sel-09-04
II	5	Pant Sel-09-20, Pant Sel-09-53, Pant Sel-08-02, Pant Sel-01 and J-97-242
III	4	Pant Sel-09-07, Pant Sel-09-46, Kufri Arun and Kufri Giriraj
IV	5	Pant Sel-09-38, Pant Sel-09-08, Pant Sel-09-01, Kufri Jawahar and Kufri Chipsona-2
V	5	Pant Sel-09-11, Pant Sel-09-43, Kufri Ashoka, Kufri Frysona and Kufri Khyati
VI	3	Pant Sel-09-33, Pant Sel-09-55 and Kufri sutlej
VII	7	Pant Sel-09, Pant Sel-08-07-01(CT), Pant Sel-09-19, J-95-225, J-96-288, Kufri Jyoti and Kufri Chipsona-1
VIII	1	Pant Sel-15/5
IX	3	Pant Sel-09-58, Pant Sel-09-18 and Kufri Pushkar
X	6	Pant Sel-09-21, Pant Sel-09-50, J-93-159, J-96-54, Kufri Gaurav and Kufri Badshah
XI	2	Pant Sel-01-15 and Pant Sel-09-57

Table 3: Average distance of inter and intra-cluster centroids.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
I	**1.467**										
II	4.941	**1.735**									
III	3.454	4.132	**1.175**								
IV	4.314	2.004	3.903	**1.166**							
V	3.408	5.079	3.599	4.836	**1.738**						
VI	2.701	5.144	3.632	5.212	2.846	**1.323**					
VII	2.911	5.571	2.560	5.158	2.268	3.246	**1.544**				
VIII	4.703	4.478	4.378	3.739	4.208	4.594	5.120	**1.450**			
IX	3.657	6.481	4.149	6.514	2.985	3.158	2.757	6.061	**1.931**		
X	3.435	2.772	4.024	2.888	3.730	3.638	4.617	3.988	4.683	**1.359**	
XI	3.966	4.613	2.812	4.771	3.032	3.719	2.651	4.593	4.299	4.740	**1.020**

(The intra cluster distances are shown in bold)

number of tuber per plant the total yield was recorded low which clearly indicate that if crosses among the genotypes of cluster IX with cluster IV, II and VIII are made are likely to give better hybrids with more number of tubers having more weight and high tuber yield. Similar results were obtained by Mondal *et al*. (2007) and Panigrahi *et al*. (2014).

Correlation analysis and Path coefficient analysis: The correlation matrix (Table 4) showed stronger positive highly significant correlation of tuber yield with plant height followed by number of shoots per plant, average weight of tuber, tuber yield per plant and marketable yield per plot. However non significant association was found with emergence percent, number of tuber per plant and unmarketable yield per plot. Number of shoots per plant was found significantly associated with number of tuber per plant, tuber yield per plant and marketable yield per plot. Significant and positive correlation of plant height with number of shoots per plant, tuber yield per plant and marketable yield per plot was found. Positive correlation of tuber yield has been also reported with plant height and number of shoot per plant by Zakaria *et al*. (2007), average tuber weight, tuber yield per plant and marketable yield per plot by Lomboro *et al*. (2014).

In order to get a clear picture of the interrelationships between different traits, the direct and indirect effects of different characters were worked out using path coefficient analysis given in Table 5. Path analysis revealed that the marketable yield per plot had highest positive direct effect on total tuber yield followed by tuber yield per plant, unmarketable yield per plot, average tuber weight, number of tuber per plant and plant height. However, number of shoot per plant, tuber length and emergence per cent exerted negative direct effect on total tuber yield. Similar results were also reported by Khayatnezhad *et al*. (2011) and Fekadu *et al*. (2013). In the investigation the contribution of residual factor was found to be low, which indicated that the component traits chosen in the study are adequate to explain the yield.

CONCLUSION

It was concluded that an improvement programme involving patterns of different clusters may yield transgressive and heterotic segregants. Moreover, the genotypes of same series (*viz*., Pant Selection-series, J-series and Kufri-series) fell into different clusters indicating thereby that geographical diversity is not related to genetic diversity. Plant height, number of tuber per plant, average tuber weight and tuber yield per plant have been identified as most important traits since they exhibited positive, highly significant and direct effect on yield. Therefore, these characters should be preferred while making selection.

Table 4: Simple correlation coefficient between different characters.

Characters	Plant height (cm)	No. of shoot/plant	No. of tuber/plant	Avg. tuber weight (g)	Tuber yield /plant (g)	Tuber Length (mm)	Marketable yield/plot (kg)	Unmarketable yield/plot (kg)	Tuber yield/ plot(kg)
Emergence %	0.152	0.300 *	0.25	0.086	0.123	0.109	0.115	-0.180	0.105
Plant height (cm)		0.335 *	0.125	0.271	0.350 *	0.354	0.353 *	0.159	0.354 *
No. of shoot/plant			0.375 *	0.167	0.431**	0.164	0.472**	-0.070	0.464**
No. of tuber/plant				0.021	0.236	-0.198	0.201	-0.017	0.204
Avg. tuber wt. (g)					0.527**	0.209	0.508**	0.192	0.509**
Tuber yield/plant (g)						0.214	0.974**	0.265	0.974**
Tuber Length (mm)							0.298	0.300	0.297
Marketable yield/plot (kg)								0.272	0.898**
Unmarketable yield/plot (kg)									0.297

** Significant at 1 % level of probability
* Significant at 5 % level of probability

Table 5: Path coefficient analysis showing direct (diagonal) and indirect (off diagonal) effects of different traits on tuber yield in potato.

Traits	Emergence %	Plant height (cm)	No. of shoot/plant	No. of tuber/ plant	Avg. tuber weight (g)	Tuber yield / plant (g)	Tuber length (mm)	Marketable yield/plot (kg)	Unmarketable yield/plot (kg)
Emergence %	**-0.0051**	0.0000	-0.0013	0.0218	-0.0001	0.0014	-0.0302	0.0445	-0.0061
Plant height (cm)	-0.0007	**0.0024**	-0.0014	0.0128	-0.0012	0.0042	0.0082	0.0435	0.0054
No. of shoot/plant	0.0115	0.0011	**-0.0043**	0.0126	-0.0011	0.0052	0.0287	-0.0931	-0.0023
No. of tuber/plant	-0.0013	0.0010	0.0016	**0.0070**	0.0031	0.0028	-0.0549	0.0525	-0.0005
Avg. tuber weight (g)	-0.0004	0.0101	-0.0007	0.0301	**0.0211**	0.0063	-0.0412	0.0383	0.0065
Tuber yield/plant (g)	-0.0116	0.0221	0.0118	0.0216	0.0122	**0.0720**	-0.0703	0.0997	0.0090
Tuber length (mm)	-0.0015	0.0071	-0.0020	0.0013	-0.0011	0.0117	**-0.0075**	-0.0097	0.0102
Marketable yield/plot (kg)	-0.0115	0.0010	-0.0020	0.0314	0.0101	0.0117	-0.0775	**0.0921**	0.0092
Unmarketable yield/plot (kg)	0.0009	0.0000	0.0003	-0.0011	-0.0010	0.0032	-0.0632	0.0418	**0.0340**

Residual factor = 0.0140

REFERENCES

Beale, E.M.L. (1969). Euclidean cluster analysis. In: Bulletin of International Statistical Institute: Proceedings of the 37th Session (UK).

Fekadu, A., Petros, Y. and Zelleke, H. (2013). Genetic variability and association between agronomic characters in some potato (*Solanum tuberosum* L.) genotypes in SNNPRS, Ethiopia. *Indian J. Biodiversity and Cons.* **5:** 523-528.

Hotelling, H. (1933). Analysis of complex of statistical variables into principal components. *J. Educational Psych.* **24 :** 417-441.

Khayatnezhad, M., Shahriari, R. and Gholamin, R. (2011). Correlation and path analysis between yield and yield components in potato (*Solanum tubersum* L.).*Middle-East J. Scientific Res.***7:** 17-21.

Lohani, M., Singh, D. and Singh, J.P. (2012). Genetic diversity assessment through principal component analysis in potato (*Solanum tuberosum* L.). *Veg. Sci*. **39 :** 207-209.

Lomboro, A., Petros, Y. and Andargie, M. (2014). Correlation and path coefficient analysis between yield and yield components in potato (*Solanum tuberosum* L.). *Plant Sci. Today*, **1:** 196-200.

Mondal, M.A.A., Hossain, M.M., Rasul, M.G. and Uddin, S.M. (2007). Genetic diversity in potato (*Solanum tuberosum* L.). *Bangladesh J. Bot.* **36:** 121-125.

Nickmanesh, L. and Hassanpanah, D. (2014). Evaluation of genetic diversity for agronomic traits in 127 potato hybrids using multivariate statistical methods. *Indian J. Fundamental Appl. Life Sci.* **4:** 502-507.

Panigrahi, K.K., Sarkar, K.K., Baisakh, B. and Mohanty, A. (2014). Assessment of genetic divergence in potato (*Solanum tuberosum* L.) genotypes for yield and yield attributing traits. *Int. J. Agric. Env. Biotech.* **7:** 247-254.

Pearson, K. (1901). On lines and planes of closest fit to systems of point in space. *Philos. Mag.* **2:** 559-572.

Rao, T.S. (1964). Advance Statistical Methods in Biometrical Research. John Willey and Sons. New York.

Searle, S.R. (1961). Phenotypic, genotypic, environmental correlations. *Biometrics*, **17:** 474-480.

Upadhya, M.D. (1995). The potential of true potato seed technology for increased potato production in Bangladesh. *Proceeding of the national workshop on national program for true potato seed (TPS) Bangladesh*, Bangladesh Agricultural Research Council, Dhaka.

Wright, S. (1921). Correlation and causation. *J. Agric. Res.* **20:** 557-587.

Zakaria, R.A., Fathi, M. and Panah, D. H. (2007). Sequential path analysis of yield components in potato. *Potato Res.* **49:** 273-279.