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Evaluation of potato (*Solanum tuberosum* L.) germplasm for some important morphological traits using multivariate analysis

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Abstract
The experiment entitled "Evaluation of potato (*Solanum tuberosum* L.) Germplasm for some important morphological traits using multivariate analysis" was organized under All India Coordinated Research Project on Potato at Research and Instructional Farm, Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, in Rabi 2020-21. All values obtained by analysis of variance for potato yield and yield attributing attributes revealed that there is sufficient amount of variability for all the characters. Presence of higher phenotypic coefficient of variance (PCV) than genotypic coefficient of variance (GCV) for all the characters indicating that expression of characters is less influenced by environment. The high heritability coupled with high genetic advance were exhibited by number of compound leaves plant^{-1}, fresh weight of shoots plant^{-1}, plant height and number of leaves plant^{-1} and hence, it can be concluded that the selection of these traits may accumulate more additive genes leading to improvement of these characters. Tuber yield showed positive and significant correlation with number of compound leaves plant^{-1}, number of tuber plant^{-1}, dry weight of shoots plant^{-1}, and fresh weight of shoots plant^{-1} at both genotypic and phenotypic level Therefore, selection based on these characters can give notable results for tuber yield improvement. Tuber yield showed positive direct effect with number of leaves plant^{-1}, number of tuber plant^{-1}, plant emergence, number of shoots plant^{-1}, number of compound leaves plant^{-1} and dry weight of shoots plant^{-1}. These traits can be considered as key trait for advancement of total tuber yield. Clusters analysis distributed 20 genotypes into five clusters and it designates the presence of sufficient amount of genetic divergence in population. The maximum inter-cluster distance was found between cluster V and cluster IV indicates that the genotypes present in these cluster may be used as parent for hybridization.

Keywords: Evaluation of potato, Morphological traits, Multivariate analysis

1. Introduction
Potato (*Solanum tuberosum* L.) belongs to family Solanaceae with chromosome number 2n=48. Potato is one of the most important staple food crops among the vegetables; which is utilized throughout the year in India. Due to its great utility, the potato is acknowledge as the "King of Vegetables" among crops, which includes over two thousand plants, only seven of which are cultivated. Due to its high yield potential in a short time, it is one of the most remunerative and profitable crop. Though it was once a labour oriented crop, mechanization has permitted it to be grown in a large area with low labour. Besides, it is very suitable for use in multiple cropping systems, since cultivars capability of early bulking with higher yields have been identified for various regions of the country through the "All India Co-ordinated Potato Improvement Project." Tuber yield is a complex character related with many interrelated components. Study of connection between various quantitative characters gives a thought of affiliation that could be adequately used in choosing a superior plant type in potato. The main breeding center focus has been to create varieties with brief length, high return, great keeping quality, protection from biotic pressure exceptionally late scourge and viral maladies and appropriate for table and handling purposes (Luthra *et al*., 2001) [14]. Genetic divergence analysis estimates the extent of diversity existed among selected genotypes. In addition, genetic diversity is studied to identify specific parents for wider genetic variation and heterosis when they are crossed. Character association and genetic parameters of variation provide information on expected character response and help in the development of a suitable breeding procedure for improvement. The nature and magnitude of variability in existing plant material, or the role of various characters, are prerequisites for better yield and plant type selection, and path coefficient analysis provides for permits further.

The partitioning of a correlation coefficient into direct and indirect effect components makes it easier to identify important traits. These parameters, on the other side, depend upon the type of material used and the environment in which the genotypes are subjected. Such studies in potato have been conducted in India, either in sub-tropical plains or temperate hill conditions with various genotypes (Gopal, 1999) [10], but there have been very less in this Chhattisgarh.

2. Materials and Methods

A set of twenty new potato genotypes obtained from CPRI – Modipuram (U.P.) under AICRP on potato were conserved and maintained at Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) grown in a the randomized block design with three replication. The plot size 3 x 2.4 m and 60 x 20 cm spacing during Rabi season 2020-21, with the necessary experimental facilities available. The trial field soil was found to be sandy loam. Soil samples within a depth of 20 cm were randomly obtained from five spots before the experiment was planned. The soil measurements obtained were fully mixed and a mix sample was created to determine the soil's physio-compound structure.

3. Details of experiments

The research material consisted of twenty potato genotypes. The seed tuber of the genotypes was collected from the "All India Coordinated Research Project on Potato, Vegetable Science Division, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.). Field preparation was completed by furrowing with mould board plough followed by two cross-nerve racking and levelling with the aid of "Pata." Farm Yard Manure (FYM) was mixed @ of 20 t per ha^{-1} before the preparation of ridge. The height of ridge was 15 cm were made up by tractor drawn ridger. Spacing between two ridges was 60 cm. The area of experiment was divided into 60 plots as per layout. Analysis of variance is a major tool to check importance of genotypic variations. The estimated value of 'F' was contrasted to the tabular value of 'F' at 5% and 1% likelihood point against error degree of freedom to check the importance of treatment. Statistically the data collected from the individual plants were evaluated according to the Cocharan and Cox (1957) [5] protocol. The Genotypic and phenotypic coefficient of variation are calculated by using the following formula proposed by Burton (1952) [4]. Coefficient of correlation was determined using the following method suggested by Miller *et al.,* (1958) [15] for all conceivable variations of all the characters at genotypic, phenotypic and environmental stages. The aim of the path coefficient study was to demonstrate the cause-and-effect relationship between yield and its components and also their partitioning into direct and indirect results. Wright (1921) [25] established this equation, which was later adopted by Dewey and Lu (1959) [7], and then used Singh and Choudhary's method to measure residual effects (1985). This research was performed using SPAR-1 software to taking all the traits into account, the total number of possible pairs from twenty genotypes was estimated. The genotypes were clustered into several clusters using the method of Tocher, as defined by Rao (1952) [19].

Table 1: Layout details of the experimental field

Sl. No	Particulars	
1	Crop	: Potato (*Solanum tuberosum* L.)
2	Number of genotypes	: 20
3	Design of experiment	: Randomized Block Design (RBD)
4	Number of replications	: 03
5	Number of treatments	: 20
6	Plot area	: 3m x2.4m
7	Spacing	: 20 cm x 60 cm

4. Results and Discussion

4.1 Genetic variability

Analysis of variance revealed that there were presence sufficient variation among the genotypes used in present investigation for all characters. The characters number of compound leaves plant^{-1}, number of tuber plant^{-1}, dry weight of shoot plant^{-1}, fresh weight of shoots plant^{-1} demonstrated higher magnitude of GCV, similarly higher magnitude of PCV was exerted by the characters number of compound plant^{-1}, number of tuber plant^{-1}, dry weight of shoots plant^{-1} and fresh weight of shoots plant^{-1}. Maximum mean performance was observed for the character fresh weight of shoots plant^{-1} and minimum unmarketable tuber weight (t/h). High heritability in broad sense was exerted by the characters total tuber yield (t/h) followed by marketable tuber yield (t/h) and moderate by number of shoots plant^{-1}. On the other hand, plant emergence (%) showed lowest heritability. High heritability combined with high genetic advance as percent of mean was exhibited by fresh weight of shoots plant^{-1}and high heritability combined with low genetic advance as percent of mean was exhibited by number of compound leaves plant^{-1}. Similar result was also reported earlier by Pradhan *et al.,* (2014) [17], Darabad. (2014) [6], Tripura *et al.,* (2016) [23], Rangare and Rangare (2017) [18], Hajama *et al.,* (2018) [11]

4.2 Correlation coefficient

The analysis of correlation coefficient reported that character tuber yield had positive significant correlation with number of tuber plant^{-1}, fresh weight of shoots plant^{-1} and harvest index at genotypic level and at phenotypic level. Also add plant emergence and number of shoots plant^{-1}. Whereas, negative significant correlation at genotypic level was observed for dry weight of shoots plant^{-1}, number of leaves plant^{-1} and plant height at phenotypic level. Plant emergence showed positive significant correlation at genotypic level with harvest index, plant height, number of shoots plant^{-1} and unmarketable tuber yield. Whereas, plant height exhibited a strong positive significant association with number of compound leaves plant^{-1}, dry weight of shoots plant^{-1} and fresh weight of shoots plant^{-1} at both genotypic and phenotypic level, Similarly, number of leaves plant^{-1}exhibited a positive significant association at genotypic level with fresh weight of shoots plant^{-1}, unmarketable tuber weight and dry weight of shoots plant^{-1}. Number of compound leaves plant $^{-1}$ exhibited a positive significant association at genotypic level with fresh weight of shoots plant^{-1}, number of tuber plant^{-1} and dry

weight of shoots plant^{-1}. Fresh weight of shoot plant $^{-1}$ exhibited a positive significant association at genotypic level with number of tuber plant^{-1}, unmarketable tuber yield (t/h), marketable tuber yield (t/h), dry weight of shoots plant^{-1}. Dry weight of shoot plant^{-1} exhibited a positive significant association at genotypic level with harvest index. Number of tuber plant^{-1} exhibited a positive significant association at genotypic level with marketable tuber yield (t/h), unmarketable tuber yield (t/h). Harvest index exhibited a positive significant association at genotypic and phenotypic level with marketable tuber yield. Similar result observed in the present study was also found in research of Fekadu *et al*., (2020) [9], Ummyiah *et al*., (2013) [24], Ara *et al*., (2009) [2], Zelalem *et al.*, (2009) [26].

4.3 Path coefficient analysis

The investigation of path coefficient revealed that the direct effect on tuber yield was exerted by number of tuber plant^{-1}, number of leaves plant^{-1}, plant emergence, number of shoots plant^{-1}, number of compound leaves plant^{-1}, dry weight of shoots plant^{-1}and marketable tuber yield. Whereas, negative direct effects on total tuber yield was also revealed by harvest index, fresh weight of shoots plant^{-1}, plant height, unmarketable tuber yield were main component of yield should be given high priority in the selection programme. These traits can be considered as key trait for improving total tuber yield." On the basis of above findings, it can be suggested that improvement in total tuber yield can be achieved through selection for the characters namely; fresh weight of tuber plant^{-1}, number of tubers plant^{-1}. This result are in agreement with Fekadu *et al*.,(2013) [8], Ummyiah *et al.*, (2013) [24], Khayatnezhad *et al.*, (2011) [12], Ara *et al.*, (2009) [2].

4.4 Genetic Divergence

The analysis of genetic divergence between the 20 genotypes of potato were investigated by using Mahalanobis D^2 statistics. According to result all the genotypes were divided into five different clusters, where maximum number of genotypes appeared in cluster III and cluster IV with seven genotypes each. The moderate number of genotypes was observed in clusters II and cluster I each of contain three and two genotypes, respectively. Among those, cluster V recorded lowest number *i.e.* one genotypes. Results of cluster analysis also revealed inter and intra cluster distance between five clusters. The maximum inter-cluster distance was found between cluster IV and followed by cluster III, cluster I and cluster II. The maximum intra-cluster distance showed by cluster IV followed by cluster III and cluster I. Selection should be done from the clusters with maximum inter-cluster distance for hybridization as they possess greatest genetic divergence which could be exploited in future programmes. The genotypes present in cluster-IV showed highest mean value for plant emergence and harvest index(%). The genotypes present in cluster II exhibited highest mean value for plant height, number of shoots plant^{-1}, number of leaves plant^{-1} and number of compound leaves plant^{-1}. The genotypes present in cluster V reported maximum mean value for fresh weight of shoots plant^{-1}, dry weight of shoots plant^{-1}, number of tuber plant$^{-1,}$ marketable tuber yield, unmarketable tuber yield and total tuber yield.Similar finding are reported in research of Bhadauriya *et al.*, (2018) [3], Rymuza. (2015) [20], Singh. (2015) [21], Panigrahi *et al*., (2014) [16], Lohani *et al*., (2012) [13], Ahmadizadeh *et al*., (2011) [1].

Table 2: Mean performance of genotypes for different yield attributing characters in Potato

S. No.	Character	PE	PH	NOSP	NOLP	NOCP	FWSP	DWSP	NOTP	HI	MTY	UTY	TTY
1	P-43	90.68	45.50	3.48	73.25	34.66	171.71	42.58	6.18	67.56	17.50	0.19	17.69
2	P-71	89.11	52.83	4.61	74.79	43.17	189.12	33.11	8.81	72.17	35.94	0.36	36.30
3	C-14	93.30	46.67	5.29	82.49	51.41	240.86	35.69	9.72	69.93	28.81	0.55	29.36
4	C-6	97.01	47.53	4.72	64.32	53.09	237.54	40.30	9.72	69.64	42.99	0.45	43.44
5	P-73	90.95	53.26	5.48	76.25	59.79	222.09	36.52	10.08	73.39	21.65	0.28	21.93
6	P-51	89.59	49.56	4.66	73.41	29.33	134.41	33.51	6.86	75.56	29.41	0.39	29.79
7	P-1	95.54	35.79	5.16	71.41	17.84	140.74	25.19	8.96	77.86	26.59	0.42	27.02
8	P-9	88.49	43.61	3.67	74.92	29.33	259.59	42.52	11.81	68.55	59.77	0.51	60.28
9	C-17	97.88	47.83	4.32	55.96	44.01	144.03	39.33	8.88	76.24	44.03	0.36	44.39
10	P-62	89.01	48.83	3.79	75.44	60.55	159.64	33.15	8.42	72.40	29.92	0.37	30.28
11	P-55	91.15	43.80	5.12	73.01	36.05	161.41	22.45	7.05	68.97	29.10	0.46	29.56
12	P-54	94.66	52.67	4.50	81.15	47.73	241.28	20.60	14.25	72.04	60.52	0.54	61.07
13	P-69	88.43	35.93	4.98	74.26	37.55	230.18	22.03	11.07	70.58	50.47	0.56	51.02
14	P-68	88.43	43.76	5.50	83.33	41.72	243.41	34.11	10.87	70.57	45.90	0.48	46.19
15	P-45	91.11	45.06	5.62	73.59	40.96	219.15	38.71	12.25	74.50	49.04	0.51	49.51
16	P-46	92.46	52.40	4.31	68.65	35.50	135.69	31.14	9.10	78.76	40.88	0.39	40.95
17	P-53	97.08	51.34	4.03	49.50	45.33	218.02	33.35	12.00	72.68	41.15	0.40	41.34
18	P-75	89.26	48.96	3.68	81.29	40.97	238.95	43.03	5.93	60.78	18.21	0.30	18.52
19	P-57	87.95	43.17	3.28	61.64	50.97	224.71	29.54	12.48	73.47	44.07	0.35	44.42
20	P-58	89.83	40.59	3.62	66.22	51.56	148.10	19.82	9.60	**79.29**	38.02	0.23	38.25
	CD at 5%	3.75	3.16	0.68	5.10	3.81	25.71	3.74	1.07	3.12	3.33	0.06	3.31

PE- Plant emergence (%), PH- Plant height (cm), NOSP- Number of shoots plant^{-1}, NOLP- Number of leaves plant^{-1}, NOCP- Number of compound leaves plant^{-1}, FWSP- Fresh weight of shoots plant^{-1} (g), DWSP- Dry weight of shoots plant^{-1} (g), NOTP- Number of tubers plant^{-1}, HI- Harvest index (%), MTY- Marketable tuber yield (t/h), UTY- Unmarketable tuber yield (t/h), TTY- Total tuber yield (t/h)

Table 3: Analysis of variance for tuber yield and its components in potato

S. No.	Characters	Mean Sum of Squares		
		Replication	Treatment	Error
	D.F	2	19	38
1.	Plant emergence (%)	16.62	31.19**	5.16

2.	Plant height (cm)	2.27	79.62**	3.66
3.	Number of shoots plant^{-1}	0.52	1.64**	0.17
4.	Number of leaves plant^{-1}	0.87	227.43**	9.50
5.	Number of compound leaves plant^{-1}	6.34	338.62**	5.32
6.	Fresh weight of shoots plant^{-1} (g)	77.61	5711.29**	241.95
7.	Dry weight of shoots plant^{-1} (g)	5.49	168.23**	5.12
8.	Number of tubers plant^{-1}	0.63	14.78**	0.42
9.	Harvest index (%)	4.54	55.94**	3.56
10.	Marketable tuber yield (t/h)	2.43	466.01**	4.06
11.	Unmarketable tuber yield (t/h)	0.00	0.03**	0.00
12.	Total tuber yield (t/h)	2.86	469.90**	4.02

, * Significant at 5% and 1% probability levels

Table 4: Estimates of genetic parameters of variation for tuber yield and its components in potato

Sl. No	Characters	Mean	Range		Coefficient of Variation		H^2BS (%)	Genetic Advance (GA)	Genetic Advance as percentage of mean
			Max.	Min.	Phenotypic	Genotypic			
1	Plant emergence (%)	91.60	97.88	87.95	4.06	3.22	62.70	4.80	5.25
2	Plant height (cm)	46.45	53.26	35.79	11.59	10.83	87.39	9.69	20.86
3	Number of shoots plant^{-1}	4.49	5.62	3.28	18.10	15.61	74.40	1.25	27.74
4	Number of leaves plant^{-1}	71.74	83.33	49.50	12.63	11.88	88.43	16.51	23.01
5	Number of compound leaves plant^{-1}	42.58	60.55	17.84	25.34	24.76	95.43	21.21	49.82
6	Fresh weight of shoots plant^{-1} (g)	198.03	259.59	134.41	22.95	21.56	88.28	82.65	41.73
7	Dry weight of shoots plant^{-1} (g)	32.83	43.03	19.82	23.49	22.46	91.40	14.52	44.23
8	Number of tubers plant^{-1}	9.70	14.25	5.93	23.51	22.55	92.01	4.32	44.56
9	Harvest index (%)	72.25	79.29	60.78	6.35	5.78	83.06	7.84	10.86
10	Marketable tuber yield (t/h)	37.70	60.52	17.50	33.35	32.92	97.43	25.23	66.93
11	Unmarketable tuber yield (t/h)	0.40	0.56	0.19	27.07	25.53	88.95	0.20	49.60
12	Total tuber yield (t/h)	38.07	61.07	17.69	33.16	32.74	97.48	25.35	66.58

Table 5: Phenotypic correlation coefficient between tuber yield and its contributing traits in potato

Characters	Plant emergence (%)	Plant height (cm)	Number of shoots plant^{-1}	Number of leaves plant^{-1}	Number of compound leaves plant^{-1}	Fresh weight of shoots plant^{-1} (g)	Dry weight of shoots plant^{-1} (g)	Number of tubers plant^{-1}	Harvest index (%)	Marketable tuber yield (t/h)	Unmarketable tuber yield (t/h)
Plant height (cm)	0.125										
Number of shoots plant^{-1}	0.206	-0.040									
Number of leaves plant^{-1}	-0.459**	-0.032	0.280*								
Number of compound leaves plant^{-1}	0.001	0.396**	-0.070	-0.041							
Fresh weight of shoots plant^{-1} (g)	-0.082	0.027	0.114	0.293*	0.276*						
Dry weight of shoots plant^{-1} (g)	0.058	0.306*	-0.087	-0.004	0.046	0.259*					
Number of tubers plant^{-1}	0.100	-0.048	-0.113	-0.112	0.215	0.523**	-0.256*				
Harvest index (%)	0.157	-0.067	-0.096	-0.392**	-0.066	-0.628**	0.428**	-0.251			
Marketable tuber yield (t/h)	0.063	-0.108	0.017	-0.136	-0.007	0.371**	-0.209	0.800**	0.198		
Unmarketable tuber yield (t/h)	0.063	-0.163	0.465**	0.235	-0.162	0.412**	-0.191	0.496**	-0.061	0.604**	
Total tuber yield	0.062	-0.110	0.020	-0.132	-0.008	0.374**	-0.210	0.800**	0.195	0.871**	0.610**

* & ** indicate significant at 1% and 5% levels respective

Table 6: Genotypic correlation coefficient between tuber yield and its contributing traits in potato

Characters	Plant emergence (%)	Plant height (cm)	Number of shoots plant^{-1}	Number of leaves plant^{-1}	Number of compound leaves plant^{-1}	Fresh weight of shoots plant^{-1} (g)	Dry weight of shoots plant^{-1} (g)	Number of tubers plant^{-1}	Harvest index (%)	Marketable tuber yield (t/h)	Unmarketable tuber yield (t/h)
Plant height (cm)	0.240										
Number of shoots plant^{-1}	0.146	-0.077									
Number of leaves plant^{-1}	-0.555**	-0.006	0.405**								
Number of compound leaves plant^{-1}	0.008	0.439**	-0.087	-0.067							
Fresh weight of shoots plant^{-1} (g)	-0.176	0.046	0.119	0.307*	0.292*						
Dry weight of shoots plant^{-1} (g)	0.029	0.362**	-0.151	0.011	0.034	0.271*					
Number of tubers plant^{-1}	0.137	-0.022	0.143	-0.139	0.248	0.563**	-0.276*				
Harvest index (%)	0.311*	-0.079	0.161	-0.424**	-0.040	-0.602**	0.461**	-0.239			
Marketable tuber yield (t/h)	0.081	-0.094	0.023	-0.149	-0.008	0.399**	-0.225	0.825**	0.203		
Unmarketable tuber	0.170	-0.211	0.569**	0.281*	-0.173	0.485**	-0.199	0.567**	-0.091	0.653**	

yield (t/h)											
Total tuber yield	0.081	-0.098	0.027	-0.145	-0.009	0.402**	-0.225	0.825**	0.199	0.882**	0.658**

* & ** indicate significant at 1% and 5% levels respectively.

Table 7: Path coefficient showing the direct and indirect effect of Yield contributing traits on tuber yield of potato

Character	PE	PH	NOSP	NOLP	NOCP	FWSP	DWSP	NOTP	HI	MTY	UTY	TTY (t/h)
PE	0.00743	-0.00213	0.00075	-0.00479	0.00004	0.00234	0.00008	0.00125	-0.00435	0.08106	-0.00090	0.081
PH	0.00178	-0.00888	-0.00040	-0.00005	0.00197	-0.00062	0.00098	-0.00020	0.00111	-0.09455	0.00112	-0.098
NOSP	0.00108	0.00069	0.00512	0.00350	-0.00039	-0.00159	-0.00041	0.00130	-0.00225	0.02273	-0.00303	0.027
NOLP	-0.00413	0.00005	0.00208	0.00863	-0.00030	-0.00409	0.00003	-0.00127	0.00592	-0.15010	-0.00150	-0.145
NOCP	0.00006	-0.00390	-0.00044	-0.00058	0.00449	-0.00389	0.00009	0.00226	0.00056	-0.00809	0.00092	-0.009
FWSP	-0.00131	-0.00041	0.00061	0.00265	0.00131	-0.01332	0.00074	0.00514	0.00841	0.40075	-0.00258	0.402**
DWSP	0.00022	-0.00321	-0.00078	0.00010	0.00015	-0.00361	0.00271	-0.00252	0.00644	-0.22604	0.00106	-0.225
NOTP	0.00102	0.00020	0.00073	-0.00120	0.00111	-0.00750	-0.00075	0.00912	-0.00334	0.82848	-0.00302	0.825**
HI	0.00231	0.00070	0.00083	-0.00366	-0.00018	0.00802	-0.00125	0.00218	-0.01397	0.20363	0.00048	0.199
MTY	0.00060	0.00084	0.00012	-0.00129	-0.00004	-0.00532	-0.00061	0.00752	-0.00283	1.00446	-0.00347	1.000**
UTY	0.00126	0.00187	0.00291	0.00243	-0.00078	-0.00647	-0.00054	0.00517	0.00127	0.65619	-0.00532	0.658**

PE- Plant emergence (%), PH- Plant height (cm), NOSP- Number of shoots plant^{-1}, NOLP- Number of leaves plant^{-1}, NOCP- Number of compound leaves plant^{-1}, FWSP- Fresh weight of shoots plant^{-1} (g), DWSP- Dry weight of shoots plant^{-1} (g), NOTP- Number of tubers plant^{-1}, HI- Harvest index (%), MTY- Marketable tuber yield (t/h), UTY- Unmarketable tuber yield (t/h), TTY- Total tuber yield (t/h)

Table 8: Distribution of potato genotypes in various clusters on the basis of their similar features

Cluster Number	Number of genotypes included	Name of genotypes
I	2	P-43, P-71
II	3	C-14, P-73, P-75
III	7	C-6, P-54, P-69, P-68, P-45, P-53, P-57
IV	7	P-51, P-1, C-17, P-62, P-55, P-46, P-58
V	1	P-9

Table 9: Average inter and intra-cluster distance (D^2 values)

Cluster Number	I	II	III	IV	V
I	17.604 (4.195)	55.485 (7.448)	59.604 (7.720)	37.705 (6.140)	92.931 (9.640)
II		15.072 (3.882)	38.429 (6.199)	91.331 (9.556)	62.787 (7.923)
III			19.685 (4.436)	86.929 (9.323)	39.652 (6.296)
IV				21.581 (4.645)	120.679 (10.985)
V					0.0 (0)

* Figure given in diagonals bold is intra-cluster D^2 values and Figure in parenthesis is $\sqrt{D^2}$ values

Table 10: Mean performance of different genotypes parent clusters in potato

Cluster No.	No. of Genotype Included	Plant emergence (%)	Plant height (cm)	No. of shoots plant^{-1}	No. of leaves plant^{-1}	No. of compound Leaves plant^{-1}	Fresh weight of shoot plant^{-1} (g)	Dry weight of shoot plant^{-1} (g)	No. of tuber plant^{-1}	Harvest Index (%)	Marketable Yield (t/h)	Unmarketable yield weight(t/h)	Total tuber yield (t/h)
I	2	89.90	49.16	4.05	74.02	38.91	180.42	37.85	7.50	69.87	26.72	0.27	26.99
II	3	91.17	49.63	4.82	80.01	50.72	233.97	38.41	8.58	68.03	22.89	0.38	23.27
III	7	92.09	45.64	4.66	69.68	45.34	230.61	31.23	11.80	71.93	47.73	0.47	48.14
IV	7	92.21	45.54	4.43	69.16	39.26	146.29	29.23	8.41	75.58	33.99	0.37	34.32
V	1	88.49	43.61	3.67	74.92	29.33	259.59	42.52	11.81	68.55	59.77	0.51	60.28

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