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Classificatory analysis of potato (*Solanum tuberosum* L.) Genotypes for yield and yield attributing traits

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Abstract
An experiment with forty four genotypes of potato was conducted under AICRP-Potato in the Horticultural Research Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *Rabi* season of 2006-07. Potato genotypes were grown in Randomized Complete Block Deign with three replications planted on November 2006. The analysis of genetic variance revealed that the sufficient variability was present in genotypes. The Phenotypic coefficient of variation (PCV) was slightly higher than genotypic coefficient of variation (GCV) for all the parameters. The high heritability (broad sense) was recorded in fresh weight of shoots plant^{-1}, harvest index (%), tuber dry matter plant^{-1}, plant emergence, total number of leaves plant^{-1}, fresh weight of tubers plant^{-1}, total yield plot^{-1} and plant height. The high heritability estimates coupled with high genetic advance was recorded for total tuber yield (kg plot^{-1}). The tuber yield showed positive and highly significant association with marketable tuber yield plant^{-1}. Whereas total tuber yield plant^{-1} was positively correlated with plant emergence (%), number of tubers plant^{-1} and fresh weight of tubers plant^{-1}. Path coefficient analysis revealed that marketable yield plot^{-1}, plant height and number of tubers plant^{-1} had high positive and direct influence on total tuber yield.
On the basis of D^2 analysis all the genotypes were grouped into five clusters and the D^2 value noted for different parameters indicated the presence of appreciable genetic diversity. Genetic diversity study suggested that genotypes namely J/93-86, MS/95-1309, J/95-227, MS/92-3146, K. Chipsona-3, and MP/97- 637 possessed high *per se* performance. Thus, these genotypes may be included as parents in hybridization programme for getting superior hybrids and segregants suitable for Chhattisgarh.

Keywords: classificatory analysis, *Solanum tuberosum*, yield, attributing traits

1. Introduction
Potato (*Solanum tuberosum* L.) is one of the most important staple food crops among the vegetables; which is utilized throughout the year in India. The history of potato is the testimony of the fact that whenever, there has been scarcity of food grains, potato has become the food security of people, because of its great utility potato occupies a pre-eminent place amongst the crops and acknowledges as the "king of vegetables". Potato is an essential crop and has received great attention in the recent past, as it fits well in the multiple and inter cropping systems, considering the importance of the crop there is need to improve its yield. In the past the cultivation area for the potato has increased but there is lack of suitable cultivars for this State, therefore it is an urgent need to evolve the potato genotypes suitable for Chhattisgarh Plains. For the evaluation of suitable potato genotypes, genetic parameters and characters association provides information about expected response of various characters to helps in developing suitable breeding procedure for their improvement on nature and magnitude of variability in the existing plant material. The association among the various characters are pre-requisite for yield and correlation among different characters utilized in selection of better plant types and path coefficient analysis permits further portioning of correlation coefficient into components of direct and indirect effects facilitating important traits to be identified. These parameters however, vary with the type of material used and the environmental conditions to which the genotypes are subjected. In India, such studies in potato have been made either under sub-tropical plains or temperate hill conditions with different sets of genotypes (Gopal, 1999) [8].

2. Material and Methods
A set of forty four old and new potato genotypes obtained from CPRI and AICRP, Shimla (H.P.) were conserved & maintained at Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (C.G.) grown in a the randomized complete block design with three replication, of plot size 1.2 m x

3.0 m and 60 cm x 20 cm spacing during *Rabi* 2006-07. All the recommended package of practices were adopted for the raising a good crop. The crop was harvested at maturity and observations were recorded on five randomly selected competitive plants in each genotypes in each replication and the means were calculated. Data were subjected to analysis of variance (ANOVA) as per (Panse and Sukhatme 1968) [13]. The genetic parameters like GCV and PCV were estimated according to (Burton, 1952) [5], heritability as suggested by (Johanson *et al.*, 1956) [9] and genetic advances as percentage of mean as given by (Johnson, *et al*., 1955) [10]. Coefficient of correlation was calculated for all possible combinations of all the characters at genotypic, phenotypic and environmental levels (Al Jibouri *et al.*, 1958) [1]. Path coefficient analysis was laid out to show the cause and effect relationship between yield and its attributing traits and their partition into direct and indirect effects. This relationship was evolved by (Wright 1921) [16] which was later used by (Dewey and Lu 1959) [7]. The genetic divergence was estimated by Mahalanobis' D^2 statistics as described by (Rao 1952) [14].

3. Result & Discussion

3.1 Performance of genotypes

Based on overall findings of mean performance for various yield and its components for potato the genotypes *viz.* J/95-71 and K. Badshah possessed the highest plant height; J/95-227 and MP/97-644 possessed maximum shoots plant^{-1}; K. Anand had higher number of total leaves plant^{-1}; Atlantic and MP/97-699 possessed high number of branches plant^{-1}; KMS/95-117 possessed the highest number of compound leaves plant^{-1}; K. Jawahar, MS/92-3128 and Atlantic for high fresh weight of shoots plant^{-1}; J/95-221, K. Ashoka and MS/92-3128 for high dry weight of shoots plant^{-1}; J/95-227, J/93-86 and K. Pukhraj for higher fresh weight of tubers plant^{-1}; MP/90-83 and J/95-229 for high harvest index; K. Chipsona-1, MP/97-644 for high number of tubers plant^{-1}; J/93-139 and J/93-86 for high dry weight of tubers plant^{-1}; K. Pukhraj, MP/97-644, K. Anand and K. Ashoka for high per cent of plant emergence; MS/95-1309, J/95-227 and K. Pukhraj for high marketable tuber yield and the genotypes J/93-86, J/95-1309 and K. Pukhraj were overall recorded to possessed high total tuber yield under study. Hence, the genotypes *viz.* J/95-227, J/93-86, K. Pukhraj, MP/90-83, J/95-229 for and MS/95-1309, J/95-227 and K. Pukhraj for marketable yield could be considered as promising genotypes of potato. Similar findings were also reported by (Sharma 1999) [15] and Barik *et al.*, (2009) [2].

3.2 Genetic Variability

The analysis of variance indicated the existence of sufficient amount of variability among genotypes for all the characters studied which is indicating that the genotypes were widely variable. In the present study, the phenotypic variance was in general higher than the genotypic variance for all the characters. Among different yield attributing characters studied, unmarketable tuber yield plot^{-1} had the highest magnitude of PCV (46.92 per cent) and GCV (45.58 per cent). The estimates of heritability revealed that, characters namely for fresh weight of shoots plant^{-1}, harvest index, unmarketable tuber yield, dry weight tubers plant^{-1}, per cent plant emergence, total number of leaves plant^{-1}, fresh weight of tubers plant^{-1}, total tuber yield, plant height and dry weight of shoots plant^{-1} were recorded with high heritability. The highest genetic advance as percentage of mean was recorded for unmarketable yield plot^{-1}, dry weight of tubers plant^{-1} and total yield plant^{-1}. High heritability coupled with high genetic advance was recorded for the traits *viz.* unmarketable tuber yield plot^{-1}, dry weight of tubers (g plant^{-1}) and total tuber yield plot^{-1}. Hence, these characters were predominantly governed by additive gene action and can be improved through simple selection. This results are also supported by the findings of (Luthra *et al* 2005) [12] and (Barik, 2007) [2] for genetic variability, heritability and genetic advance.

3.3 Correlation Coefficient

The tuber yield showed significant positive correlation with marketable tuber yield both at the genotypic and phenotypic levels, whereas, the tuber yield was recorded having positive and significant correlation both at phenotypic and genotypic levels with per cent plant emergence, number of tubers plant^{-1} and fresh weight of tubers plant^{-1}. Association of component characters revealed positive and highly significant correlation of marketable tuber yield with per cent plant emergence, fresh weight of tubers plant^{-1} and number of compound leaves plant^{-1} at phenotypic and genotypic levels. Dry matter content of tubers plant^{-1} exhibited positive and highly significant correlations both at phenotypic and genotypic levels with fresh weight of tubers plant^{-1} and harvest index. Similarly number of tubers plant^{-1} exhibited significant and positive correlation with the number of shoots plant^{-1} at genotypic levels. Fresh weight of tubers plant^{-1} showed positive and highly significant correlation for number of compound leaves plant^{-1} and number of shoots plant^{-1} (0.592) at genotypic levels. Similar trends for correlation coefficient for potato was also recorded by (Luthra *et al* 2005) [12] (Joseph *et al.* 2005) [11] (Barik, 2007) [2] and (Barik *et al*., 2010) [3]

3.4 Path Coefficient

Path coefficient analysis revealed positive and direct effect of marketable yield plot^{-1}, unmarketable yield plot^{-1}, plant height, number of shoots plant^{-1}, fresh weight of shoots plant^{-1}, number of compound leaves plant^{-1} and number of tubers plant^{-1}. However, high negative direct effects on tuber yield was showed by characters *viz.* number of branches plant^{-1}, per cent plant emergence, dry weight of shoots plant^{-1}, fresh weight of tubers plant^{-1} and tuber dry matter plant^{-1}. These results are also supported by the (Desai and Jaimini 1997) [6] (Barik, 2007) [2] and (Barik *et al*., 2010) [3].

Table 1: Mean performance of forty four potato genotypes for tuber yield and its contributing traits.

Entries	Plant height	No. of shoots	Total No. of leaves	No. of branches	Fresh weight of shoots (g plant $^{-1}$)	Dry weight of shoots (g plant $^{-1}$)	Fresh weight of tubers (g plant $^{-1}$)	Harvest index (%)	No. of tubers plant $^{-1}$	Dry weight of tubers (g plant $^{-1}$)	Per cent Emergence (%)	Un-marketable Yield (kg plot $^{-1}$)	Marketable Yield (kg plot $^{-1}$)	Total Yield (kg plot $^{-1}$)
Atlantic	48.58	3.67	70.77	10.07	181.79	22.54	0.42	278.30	7.53	83.24	91.03	0.720	20.0	157.78
K. Anand	44.27	5.33	65.81	15.33	138.00	23.33	0.43	337.10	10.20	74.77	97.97	1.250	34.72	224.16
K. Ashoka	44.13	7.51	52.70	10.93	148.44	27.01	0.50	267.40	7.00	63.86	97.40	0.800	22.22	267.22
K. Badshah	50.84	4.33	76.64	18.82	160.75	23.85	0.49	321.90	7.89	103.60	93.67	1.040	28.88	176.66
K. Chandramukhi	39.42	3.67	55.47	15.13	149.78	18.26	0.44	312.70	9.20	72.26	92.67	0.570	15.83	228.60
KCH-1	42.82	4.07	71.19	16.80	136.00	17.67	0.31	275.00	7.33	63.17	67.77	1.050	29.16	144.16
KCH-3	36.87	4.40	78.89	17.80	115.11	14.85	0.43	371.90	14.6	63.30	77.96	0.660	18.33	170.55
K. Jawahar	31.29	4.07	67.50	10.73	189.42	22.51	0.47	264.20	9.33	87.07	88.83	0.790	21.94	225.25
K. Pukhraj	35.00	5.07	59.60	9.95	175.61	23.29	0.52	265.70	10.00	86.95	100.00	0.980	27.22	294.44
K. Sutlej	40.07	4.60	79.22	18.20	151.95	19.41	0.47	292.60	9.40	71.53	88.93	0.600	16.66	255.80
MP/90-83	32.40	4.47	54.91	16.80	95.73	12.12	0.40	487.40	7.20	121.8	51.43	0.680	18.89	130.00
MP/97-625	38.02	5.40	67.54	17.27	94.67	16.39	0.40	349.00	8.73	87.95	31.83	0.140	3.88	68.33
MP/97-637	56.40	3.27	87.71	23.87	94.11	16.42	0.40	343.90	7.13	101.8	41.84	0.480	13.33	103.05
MP/97-644	39.53	6.80	79.33	22.27	143.11	18.31	0.44	269.32	13.73	66.40	66.63	1.880	52.22	160.00
MP/97-921	52.40	4.84	63.33	18.73	163.33	18.82	0.37	269.33	7.40	70.44	76.63	0.570	15.83	171.11
MP/97-699	51.20	4.40	69.75	20.07	135.33	21.11	0.39	203.10	9.87	39.15	56.65	0.710	19.72	157.22
J/92-148	46.93	3.40	83.13	20.80	153.67	23.84	0.36	236.06	9.60	56.57	91.10	0.910	25.28	246.11
J/93-4	43.53	5.13	63.80	11.23	179.53	24.51	0.43	221.60	10.53	79.47	93.30	0.780	21.67	240.00
J/93-77	40.67	5.20	75.40	15.13	140.99	19.22	0.50	357.76	10.93	84.78	96.43	1.240	34.44	197.77
J/93-139	37.80	5.00	63.81	14.07	117.10	14.33	0.47	366.06	7.40	130.15	55.74	0.570	15.83	153.88
J/94-90	48.27	5.27	71.33	17.22	115.95	16.54	0.48	303.10	9.13	85.36	81.11	1.260	31.00	261.11
J/92-164	45.00	4.67	51.59	9.47	140.67	25.56	0.36	214.36	11.91	46.14	98.22	1.130	31..39	235.00
J/93-81	40.49	4.00	64.29	8.69	175.59	26.47	0.41	245.92	9.27	103.99	92.21	1.240	34.44	242.77
J/93-58	37.93	4.93	66.67	13.80	111.00	18.06	0.40	306.85	6.27	68.78	84.40	1.960	54.41	196.38
J/93-86	47.37	4.53	84.50	14.47	113.27	15.11	0.56	443.22	12.12	128.33	94.11	2.150	59.72	328.88
J/95-71	52.27	4.80	67.70	14.27	163.78	25.81	0.36	345.53	10.27	70.00	86.63	1.240	34.44	290.71
Continued.....														
JX-90	38.04	3.73	67.37	15.47	146.43	16.61	0.50	330.81	9.07	82.52	77.67	0.700	19.44	200.55
JX-374	36.53	4.67	76.47	14.53	151.33	20.42	0.46	311.21	5.99	64.70	72.87	0.570	15.83	171.11
J/92-159	31.07	4.07	70.66	13.93	166.40	24.59	0.48	378.42	8.13	82.01	92.99	2.160	60.00	214.40
J/95-221	39.20	4.87	52.65	12.31	174.78	28.08	0.47	337.15	7.59	82.05	90.97	1.080	30.00	197.22
J/95-227	40.00	7.72	86.75	12.87	146.00	21.88	0.57	341.10	6.07	90.81	92.54	0.710	19.72	264.72

J/95-229	56.09	4.00	57.60	12.73	172.89	25.51	0.38	399.60	5.13	76.33	89.97	0.590	16.39	179.16
J/95-242	48.13	4.47	58.60	13.27	158.33	21.82	0.48	385.40	8.93	70.68	87.75	0.820	22.78	250.22
MS/91-1326	35.49	2.93	63.61	12.40	157.33	21.48	0.38	330.42	4.50	45.21	79.97	1.580	43.89	102.77
MS/92-132	40.47	6.53	68.97	15.07	159.67	18.91	0.45	397.81	10.90	95.41	92.22	0.730	20.28	188.33
J/98-159	50.68	4.33	49.27	14.87	157.33	22.78	0.47	287.53	9.66	92.00	93.42	1.210	33.61	195.00
MS/92-3128	34.40	4.27	67.07	14.27	187.11	26.66	0.46	193.60	7.73	83.45	76.67	1.730	48.06	169.16
MS/92-209	41.80	7.00	73.33	16.27	162.33	21.70	0.52	328.81	12.36	92.16	77.83	1.410	39.17	230.55
MS/92-3146	45.00	5.53	80.73	14.33	181.78	18.80	0.49	333.00	8.47	105.78	95.33	1.620	45.00	207.50
MS/95-1309	38.60	5.40	83.87	13.87	128.75	17.09	0.51	375.73	11.00	79.88	96.67	1.930	53.61	328.05
KMS/95-117	34.09	3.53	68.27	12.80	128.00	15.89	0.42	327.01	8.13	63.79	87.76	0.850	23.61	174.16
DTP-1	47.32	4.67	74.24	18.96	158.00	21.01	0.37	227.09	11.20	57.82	76.64	1.410	39.17	133.05
92-PT-27	43.20	4.00	43.00	14.93	171.53	22.77	0.35	347.60	6.80	51.60	79.60	0.890	24.72	213.3
B-420 (2)	39.13	5.33	51.00	11.93	115.99	15.45	0.37	368.99	10.47	88.11	83.27	1.110	30.83	166.67
CD at 5%	8.41	2.42	9.88	5.45	10.84	5.42	0.063	33.62	4.4	12.69	11.91	0.267	10.02	21.15

Residual Effect= 0.0288

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

Bold figures are direct effect and rest are indirect effect.

Table 2: Analysis of variance of potato genotypes for tuber yield and its contributing traits.

S. No.	Characters	Mean of Sum of Square		
		Replication d. f. = 2	**Genotypes** d. f. = 43	**Errors** d. f. = 86
1	Plant height plant^{-1} in cm	63.0*	125.3**	13.5
2	No. of shoots plant^{-1}	3.9*	3.4*	1.1
3	Total No. of leaves plant^{-1}	13.4	351.2**	18.5
4	No. of branches plant^{-1} at	39.0**	34.1**	5.5
5	Fresh weight of shoots plant^{-1} (g)	12.5	1964.5**	22.3
6	Dry weight of shoots plant^{-1} (g)	8.0	47.1**	5.6
7	Fresh weight of tubers plant^{-1} (g)	0.007	0.011**	0.008
8	Harvest index (%)	118.0	11915.9**	214.0
9	No. of tubers plant^{-1}	1.0	14.13*	3.7
10	Dry weight of tubers plant^{-1} (g)	42.9	1241.2**	30.5
11	Per cent Emergence (%)	222.2**	719.9**	26.9
12	Marketable Yield plot (kg)	11.9**	10.1**	1.4
13	Total Yield plot^{-1} (kg)	10.8**	11.9**	1.2

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

Table 3: Phenotypic correlation coefficient between tuber yield and its contributing traits in potato.

Characters	No. of Shoots plant^{-1}	No. of leaves plant^{-1}	No.of branches plant^{-1}	No. of compound Leaves plant^{-1}	Fresh weight of shoot g plant^{-1}	Dry weight of shoot g plant^{-1}	Fresh weight of tuber g plant^{-1}	Harvest Index (%)	No. of tuber plant^{-1}	Dry weight of Tuber g plant^{-1}	Per Cent emergence (%)	Un-marketable yield Kg plot^{-1}	Marketable yield Kg plot^{-1}	Total tuber yield plot-1
Plant height (cm)	-0.002	0.087	0.250	0.015	0.035	0.160	-0.190	-0.105	-0.025	-0.080	0.015	-0.144	-0.043	-0.010
No. of Shoots plant-^{1}		0.075	-0.042	-0.065	-0.031	0.000	0.308*	0.058	0.201	0.135	0.092	0.068	0.277	0.270
No. of leaves plant^{-1}			0.439**	0.173	-0.176	-0.264	0.279	0.031	0.163	0.158	-0.109	0.185	0.009	0.056
No.of branches plant^{-1}				-0.100	-0.346**	-0.289	-0.146	0.018	0.104	-0.045	-0.483**	-0.037	-0.266	-0.276
No. of comp. Leaves plant^{-1}					0.253	0.092	0.320*	0.079	-0.090	0.190	0.375**	-0.018	0.346**	0.253
Fresh weight of shoot g plant^{-1}						0.671**	0.070	-0.409**	-0.086	-0.173	0.533**	0.082	0.234	0.212
Dry weight of shoot g plant^{-1}							-0.012	-0.443**	-0.144	-0.261	0.430**	0.071	0.238	0.231
Fresh weight of tubers Plant $^{-1}$								0.192	0.155	0.461**	0.311*	0.206	0.525**	0.512**
Harvest Index (%)									-0.041	0.479**	-0.098	0.035	-0.047	-0.013
No. of tuber plant^{-1}										0.012	0.124	0.183	0.126	0.930**
Dry weight of Tuber g plant^{-1}											-0.089	0.021	0.094	0.109
Per Cent emergence (%)												0.325*	0.609**	0.663**
Un-marketable yield kg plot^{-1}													0.157	0.290
Marketable yield kg plot^{-1}														0.926**

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

Table 4: Genotypic correlation coefficient between tuber yield and its contributing traits in potato.

Characters	No. of Shoots plant^{-1}	No. of leaves plant^{-1}	No.of branches plant^{-1}	No. of compound Leaves plant^{-1}	Fresh weight of shoot g plant^{-1}	Dry weight of shoot g plant^{-1}	Fresh weight of tuber g plant^{-1}	Harvest Index (%)	No. of tuber plant^{-1}	Dry weight of Tuber g plant^{-1}	Per Cent emergence (%)	Un-marketable yield Kg plot^{-1}	Marketable yield Kg plot^{-1}	Total tuber yield plot-1
Plant height (cm)	-0.085	0.079	0.375**	0.087	0.029	0.218	-0.221	-0.121	-0.02	-0.06	0.011	-0.157	-0.043	0.008
No. of Shoots plant-^{1}		0.139	-0.055	-0.218	-0.064	0.058	0.592**	0.057	0.330*	0.18	0.13	0.146	0.281	0.303*
No. of leaves plant^{-1}			0.506**	0.27	0.197	-0.299	0.338*	0.026	0.263	0.171	-0.097	0.215	0.033	0.089
No.of branches plant^{-1}				-0.564**	-0.448**	-0.481*	-0.225	0.02	0.249	-0.09	-0.609**	-0.059	-0.465**	-0.44
No. of comp. Leaves plant^{-1}					0.671**	0.247	0.628**	0.256	-0.169	0.368**	0.828**	-0.081	0.891**	0.784**
Fresh weight of shoot g plant^{-1}						0.806**	0.106	-0.430**	-0.122	-0.179	0.576**	0.08	0.294	0.257
Dry weight of shoot g plant^{-1}							-0.015	-0.518**	-0.163	-0.351**	0.543**	0.093	0.322*	0.256
Fresh weight of tubers Plant $^{-1}$								0.251	0.148	0.524**	0.375**	0.229	0.640**	0.607**
Harvest Index (%)									-0.113	0.509**	-0.105	0.029	-0.045	-0.005
No. of tuber plant^{-1}										-0.007	0.163	0.28	0.248	0.365**
Dry weight of Tuber g plant^{-1}											-0.096	0.018	0.057	0.089
Per Cent emergence (%)												0.358**	0.757**	0.757**
Un-marketable yield kg plot^{-1}													0.166	0.313*
Marketable yield kg plot^{-1}														0.979**

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

Table 5: Path coefficient showing the direct and indirect effect of Yield contributing traits on tuber yield of potato.

Characters	Plant height (c. m.)	No. of Shoots plant^{-1}	No. of leaves plant^{-1}	No.of branches plant^{-1}	No. of compound Leaves plant^{-1}	Fresh weight of shoot g plant^{-1}	Dry weight of shoot g plant^{-1}	Fresh weight of tuber g plant^{-1}	Harvest Index (%)	No. of tuber plant^{-1}	Dry weight of Tuber g plant^{-1}	Per Cent emergence (%)	Un-marketable yield Kg plot^{-1}	Marketable yield Kg plot^{-1}
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	0.235	0.015	0.004	-0.124	0.013	0.005	-0.064	0.051	-0.002	-0.003	0.005	-0.004	-0.046	-0.045
2	-0.020	0.177	0.006	0.018	-0.032	-0.011	-0.017	-0.138	0.001	0.044	-0.014	-0.047	0.043	0.293
3	0.018	0.024	0.047	-0.169	0.039	-0.034	0.088	-0.079	0.000	0.035	-0.013	0.035	0.063	0.034
4	0.087	-0.010	0.024	-0.333	-0.082	-0.078	0.141	0.052	0.000	0.033	0.007	0.221	0.017	-0.485
5	0.020	-0.039	0.013	0.188	0.146	0.117	-0.073	-0.147	0.005	-0.023	-0.029	-0.300	-0.024	0.930
6	0.007	-0.011	-0.009	0.149	0.098	0.174	-0.237	-0.025	-0.008	-0.016	0.014	-0.209	0.023	0.307
7	0.051	0.010	-0.014	0.160	0.036	0.140	-0.294	0.004	-0.009	-0.022	0.025	-0.197	0.027	0.336
8	-0.052	0.105	0.016	0.075	0.092	0.019	0.005	-0.233	0.004	0.020	-0.041	-0.136	0.067	0.668
9	-0.028	0.010	0.001	-0.007	0.037	-0.075	0.152	-0.059	0.018	-0.015	-0.040	0.038	0.009	-0.047
10	-0.005	0.058	0.012	-0.083	-0.025	-0.021	0.048	-0.035	-0.002	0.134	0.001	-0.059	0.082	0.259
11	-0.014	0.032	0.008	0.030	0.054	-0.031	0.103	-0.122	0.009	-0.001	-0.078	0.035	0.005	0.060
12	0.002	0.023	-0.005	0.203	0.121	0.100	-0.160	-0.088	-0.002	0.022	0.007	-0.362	0.105	0.790
13	-0.037	0.026	0.010	0.020	-0.012	0.014	-0.027	-0.054	0.001	0.037	-0.001	-0.130	0.293	0.173
14	-0.010	0.050	0.002	0.155	0.130	0.051	-0.095	-0.149	-0.001	0.033	-0.004	-0.274	0.049	1.043

Table 6: Distribution of potato genotypes in various clusters on the basis of their similar features.

Cluster Number	Number of genotypes included	Genotypes
I	12	K. Anand, K. Badshah, K. Sutlej, J/93 – 77, J/94 – 90, JX – 90, JX – 374, J/92 -159, J/95 – 227, MS/92 – 132, MS/92 – 209, MS/92 – 3146
II	4	MP/90 -83, MP/97 – 625, MP/97 – 637, J/93 – 139
III	16	Atlantic, K. Ashoka, K. Chandramukhi, K. Jawahar, K. Pukhraj, J/92 -148, J/93 -4, J/92 – 164, J/93 – 81, J/95 – 71, J/95 – 221, J/95 – 229, J/95 – 242, J/98 – 159, MS/92 – 3128, 92 – PT - 27
IV	10	K. Chipsona – I, K. Chipsona-III, MP/97 – 644, MP/97 – 921, MP/97 – 699, J/93- 58, MS/91 – 1326, KMS/95 – 117, DTP –1, B – 420 (2)
V	2	J/93 – 86, MS/95 – 1309

Table 7: Average inter and intra-cluster distance (D^2 values)

Cluster Number	I	II	III	IV	V
I	2.588 (1.609)				
II	5.331 (2.309)	2.936 (1.713)			
III	2.503 (1.582)	6.302 (2.510)	2.864 (1.692)		
IV	3.235 (1.799)	4.252 (2.062)	3.475 (1.864)	3.043 (1.744)	
V	4.260 (2.063)	7.850 (2.802)	5.855 (2.42)	6.495 (2.548)	1.676 (1.245)

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

Table 8: Mean performance of different clusters for tuber yield and its contributing traits in potato

Characters / Cluster No.	No. of Genotype Included	Plant height (c.m.)	No. of shoots plant^{-1}	No. of leaves plant^{-1}	No.of branches plant^{-1}	No. of compound Leaves plant^{-1}	Fresh weight of shoot g plant^{-1}	Dry weight of shoot g plant^{-1}	Fresh weight of tuber g plant^{-1}	Harvest Index (%)	No. of tuber plant^{-1}	Dry weight of tubers g plant^{-1}	Per Cent emergence (%)	Un-marketable yield Kg plot^{-1}	Marketable yield Kg plot^{-1}	Total Yield Kg plot^{-1}
I	12	41.58	5.33	74.4	15.60	32.03	151.80	20.44	0.49	336.14	9.04	86.12	88.30	1.11	6.88	7.88
II	4	41.15	4.53	68.5	18.00	29.68	100.40	14.81	0.42	386.57	7.62	110.44	45.21	0.47	3.67	4.10
III	16	43.65	4.49	60.3	12.73	31.96	167.52	24.21	0.03	287.66	8.78	75.35	90.61	0.94	7.15	7.99
IV	10	41.68	4.59	68.6	16.56	29.71	136.32	18.26	0.39	294.91	9.35	62.62	75.77	1.18	4.79	5.67
V	2	42.98	4.97	84.2	14.17	33.34	121.01	16.10	0.54	409.48	11.56	104.1	95.39	2.04	9.52	11.82

3.5 Genetic Divergence

Based on the D^2 analysis, all the forty four genotypes were grouped into five clusters. The maximum numbers of sixteen genotypes were included in cluster-III and maximum genetic divergence was noted between cluster V and II. The highest cluster mean values recorded for premium characters *viz.* plant height in cluster-III, total yield in cluster-V, marketable yield in cluster-V and number of tubers plant^{-1} in cluster-V, dry weight of tubers in cluster-II, per cent plant emergence in cluster-III and fresh weight of tubers in cluster- V. While making the heterotic crosses for getting better segregating genotypes like J/93-86 for tuber yield plant^{-1} from cluster-V, MP/97-637 for plant height, number of leaves plant^{-1} and number of branches plant^{-1} from cluster-II, K. Chipsona-3 of cluster-IV for number of tubers plant^{-1} and J/95-227 of cluster-I for fresh weight of tubers plant^{-1} will be exploit or use. While making the heterotic crosses for getting better segregants genotypes like J/93-86 for tuber yield plant^{-1} from cluster-V, MP/97-637 for plant height, number of leaves plant^{-1} and number of branches plant^{-1} from cluster-II, K. Chipsona-3 of cluster-IV for number of tubers plant^{-1} and J/95-227 of cluster-I for fresh weight of tubers plant^{-1} may be involved in hybridization programme. The similar trend in diversity among potato genotypes has also been suggested by (Desai and Jaimini 1997) [6] (Joseph *et al.* 2005) [11] (Barik, 2007) [2] and (Barik *et al*., 2010) [3] in potato.

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