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Genetic Variability Studies for Yield and it's Attributing Traits in Potato (*Solanum tuberosum* L.)

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A B S T R A C T

The present investigation was undertaken to estimate genetic variability, heritability, and genetic advance for important yield component characters among thirty eight genotypes of potato in a randomized block design with two replications during two Rabi seasons. The analysis of genetic variance revealed that there was significant genetic variability in the experimental materials. Among all the genotypes studied, genotype *CP 1994* showed highest tuber yield per plant, marketable tuber yield per plant and number of branches per plant and found suitable to further crop improvement programme. Among the characters studied, high PCV and GCV were observed for characters like total tuber yield (42.57 and 41.67 respectively), Leaf Area Index (41.39 and 31.62 respectively) and marketable tuber yield (40.83 and 33.89 respectively) indicating high variability available in the genotypes for these characters for further improvement. A high heritability (>60 %) coupled with high genetic advance was found for Leaf Area Index, marketable tuber yield and total tuber yield which suggested that there may be presence of additive gene action and selection will be rewarding for improvement of such traits.

Introduction

Potato is the 4th important food crop in the world after wheat, rice and maize. According to Visser *et al.,* (2009), by 2020 more than two billion people of Asia, Africa and Latin America will be depending on root and tuber crops for food, feed or income. It is known as 'King of Vegetables'. Potato has very good nutritional importance and it can produce more energy and protein per unit area per unit time than most other major food crops and contains substantial amounts of minerals. Parameters of genotypic and phenotypic coefficients of variation (GCV and PCV) are useful in detecting the amount of variability present in the available genotypes. Heritability and genetic advance help in determining the influence of environment expression of the characters and the extent to which improvement is possible after selection (Robinson *et al*., 1949). The total variability can be partitioned into heritable and non-heritable components with the help of genetic parameters like genotypic and phenotypic coefficients of variation, heritability and genetic advance. High heritability alone is not enough to make efficient selection in segregating generation, unless the information is accompanied for substantial amount of genetic advance (Johnson *et al*., 1955). 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).

When the variability in a population is largely of genetic nature with least environmental effect, the probability of isolating superior genotypes is high. Since information on potato progeny is not available in our country, the results reported in the study are related to select a suitable plant type having high yield with good natural keeping quality (Kanika, 2010).

Materials and Methods

Plant materials and field experimentation

The present investigation entitled "Genetic Variability Studies in potato (*Solanum tuberosum* L.)" was conducted at Instructional-Cum-Research (ICR) farm of Assam Agricultural University, Jorhat during Rabi season 2016-17 and 2017-18. Geographically, it is located at latitute-26°45' N, longitue-94°12' E, having an elevation of 87m above the mean sea level. The topography of the land was uniform. The experiment was laid out in a Randomized Block Design with two replications and plot size of 1m × 1m. The experimental material for the present investigation comprised of thirty seven genotypes of potato along with two check varieties (Table 1). These thirty seven genotypes and two check varieties were collected from AICRP on potato, AAU, Jorhat center with a spacing of 50cm × 20cm.

The tubers were planted on 15th November 2016. Well rotten Farm Yard Manure (FYM) was mixed in the field @ 20 t ha-1 before ridging along with N: P_2O_5: K_2O @ 150:100:100 kg/ha. The height of ridges was kept 15 cm and there were two ridges in each plot. The entire quantity of phosphorus and potassium was applied at the time of planting in the form of SSP and MOP, respectively. However, nitrogen was applied in each plot in two split doses in the form of Urea at 30 and 45 days after planting. Operation of weeding, earthing up, plant protection and irrigation were performed as per recommendations and when required. Data on yield and yield contributing characters were recorded from five randomly selected plants in each plot.

The same genotypes were raised during 2017-18 for another season evaluation and tubers were planted on 20th November 2017 with the same design and plot size and similar agronomic practices.

Characters recorded

Thirty seven genotypes of potato were evaluated for different characters *viz*., plant height (PH), number of branches per plant(BR), ground coverage (GC), leaf area index (LAI), total number of tubers plant^{-1}(TUB), average tuber weight plant^{-1}(ATW), marketable tuber yield plant^{-1}(MYP) total tuber yield plant^{-1}(TYP).

Statistical methods

Analysis of variance was carried out as per the procedure given by Fisher's method. Genotypic variances (σ^2g), phenotypic variance (σ^2p) and environmental variance (σ^2e) were computed according to Burton and Devane (1953) and Allard (1960).

Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were estimated from these variances in terms of standard deviation as percentage of the grand mean. Expected genetics advance for each character was calculated according to Johanson, Robinson and Comstock (1955).

Results and Discussion

Assessment of genetic variability and diversity is very crucial for plant breeding as well as for efficient management and conservation of germplasm resources. Plant germplasm of a crop provides greater genetic variability while furnishing useful traits to enhance the genetic base of that crop for the breeder.

Analysis of variance (ANOVA)

Parameters of genetic variability work out from pooled analysis of two season data in 2016-17 and 2017-18. The analysis of variance given in Table 2 revealed that the differences due to the genotypes were highly significant for plant height, number of branches per plant, ground coverage, leaf area index, number of tuber per plant, average tuber weight, marketable tuber yield and total tuber yield.

The mean performance of tuber yield and its components for all the thirty eight genotypes are shown in the Table 3 revealed that among the characters plant height, number of branches per plant, ground coverage, leaf area index, average tuber weight, total number of tubers per plant, marketable tuber yield, were the prominent yield contributing characters as evident from their high mean performance in conjuction with high total tuber yield. The present findings were in agreement with the findings of Dayal *et al.,* (1972) for total tuber yield, number of branches; Choudhary and Sharma (1984) for tuber yield, number of tubers per plant; Rana *et al.,* (1996) for average tuber weight; and Roy and Sharma (2000) for plant height and tuber yield; Asefa *et al.,* (2016) for leaf area index, average tuber weight and marketable tuber yield; Mishra *et al.,* (2017) for marketable tuber yield and total tuber yield.

Coefficient of variation

In present investigation variability parameters such as range, mean, genotypic coefficient of variation, phenotypic coefficient of variation, heritability in broad sense and genetic advance (percent mean) for tuber yield and its components are present in Table 4.High magnitude of phenotypic coefficient of variance and genotypic coefficient of variance (PCV and GCV) was observed for total tuber yield 42.57 and 41.67 respectively followed by marketable tuber yield (41.39 and 31.62 respectively) and leaf area index (40.83 and 33.89 respectively). The lowest PCV and GCV were observed in plant height (23.01 and 15.37 respectively).The high magnitude of PCV (i. e. >35%) recorded for LAI, average tuber weight, marketable tuber yield and total tuber yield and high GCV recorded for total tuber yield suggests the substantial improvement on potato through selection for these traits. However, the moderate GCV was recorded for the traits ground coverage, LAI, marketable tuber yield and total tuber yield suggest existence of considerable variability in the population. Selection for these traits may also be given the importance. These findings are in accordance with the findings by Garg(1988) for total tuber yield and average tuber weight, number of tuber plant^{-1}; Dixit *et al.,* (1991) for number of branches per plant; and Rasul *et al.,* (1995) for tuber yield per ha for average tuber weight Kumar *et al.,* (2005); for tuber number, plant height by Joseph (2005); whereas, Mishra *et al.,* (2006) recorded high magnitude of PCV and GCV for plant height, tuber yield, leaf area index, Haydar *et al.,* (2009), for plant height, total tuber and tuber yield, Khan *et al.,* (2011) for plant height, average tuber weight, The moderate PCV and GCV were reported by Luthra *et al.,* (2005).

Present study, indicating that total tuber yield, marketable tuber yield and average tuber weight, leaf area index, ground coverage, possessed high to moderate value of GCV and PCV suggesting the existence of considerable variability in potato genotypes. Hence, selection for these traits may useful for the improvement of tuber yield.

Heritability and Genetic advance

Heritability estimates in broad sense were calculated for tuber yield and its components and presented in Table 4. Estimate of heritability was recorded high for the character total tuber yield per plant (95.80). Heritability estimates in broad sense were calculated for tuber yield and its components. These are grouped into high (> 60 per cent) moderate (30 to 60 per cent) and low (< 30 per cent).

Table.1 Genotypes included in the present study

SL. NO.	GENOTYPES	SL. NO.	GENOTYPES
1	CP 1913	22	CP 1962
2	CP 2012	23	CP 1902
3	CP 1901	24	CP 1994
4	CP 1893	25	CP 1997
5	CP 1918	26	CP 1987
6	CP 1964	27	CP 1982
7	CP 2017	28	CP 2048
8	CP 1909	29	CP 2016
9	CP 1915	30	CP 1916
10	CP 1936	31	CP 2008
11	CP 1908	32	CP 2015
12	CP 2038	33	CP 1981
13	CP 1933	34	CP 2045
14	CP 2052	35	CP 1914
15	CP 1999	36	CP 1924
16	CP 1911	37	CP 1986
17	CP 2021	38	*KufriJyoti*
18	CP 1998	39	*KufriKhyati*
19	CP 2023		
20	CP 1931		
21	CP 2010		

*Source of all genotypes–AICRP on potato, AAU, Jorhat center

Table.2 Pooled ANOVA for different characters of 2016-17 and 2017-18

Characters	Mean sum squares						CV (%)
	Genotypes *df* -37	Replication *df*- 1	Environments *df*- 1	Interactions *df*- 1	Overall Sum *df*- 3	Error *df*- 111	
Plant height	72.59**	0.46	406.79	43.21	150.15	17.19	17.13
No. of branches per plant	1.34**	6.32**	0.16	0.80	2.43	0.66	36.69
Ground coverage	264.54**	5.53	5532.17	15.80	1851.16	42.98	18.19
Leaf area index	14.82**	11.42**	29.09	0.65	13.72	1.50	22.76
Total no. of tubers per plant	8.62**	3.79**	121.68	0.00	41.82	1.29	16.31
Average tuber weight	66.41**	14.09**	27.54	0.20	13.94	18.13	27.24
Marketable tuber yield	1614.60**	3.66	4539.89	2.04	1515.20	244.40	26.71
Total tuber yield	4128.04**	3.18	2912.00	0.44	971.88	44.57	8.71

*, ** Significant at 5% and 1% probability level respectively
CV- Coefficient of variation

Table.3 Mean performance of different genotypes of potato for tuber yield and its components evaluated during 2016-17 and 2017-18

Clones	PH	BR	GC	LAI	TUB	ATW	MYP	TYP
CP 1913	22.44	3.75	34.50	5.95	5.00	12.06	49.85	47.65
CP 2012	19.92	3.50	41.75	6.05	9.25	13.15	33.90	51.55
CP 1901	20.47	3.00	46.50	5.20	8.50	13.51	55.10	122.65
CP 1893	29.45	2.50	38.00	5.57	5.50	22.00	58.28	108.18
CP 1918	26.13	2.75	29.00	4.89	6.75	16.67	52.13	83.20
CP 1964	19.20	2.00	29.50	4.25	5.25	16.31	39.60	40.33
CP 2017	31.60	2.75	47.50	3.43	5.75	11.55	32.85	65.98
CP 1909	26.55	2.25	44.00	4.93	8.50	14.75	47.65	47.50
CP 1915	28.84	2.75	51.50	3.88	6.75	14.10	66.50	78.63
CP 1936	21.83	1.50	23.50	3.19	3.75	17.98	42.98	45.15
CP 1908	24.72	2.75	46.00	5.31	7.75	13.68	73.78	71.48
CP 2038	19.24	1.75	30.00	7.28	7.25	10.60	46.83	47.85
CP 2052	26.21	2.50	31.00	4.45	7.50	14.28	44.18	59.05
CP 1999	21.44	2.00	31.50	7.70	5.25	14.66	30.55	20.38
CP 1911	28.02	2.75	40.50	6.96	7.50	15.05	55.55	72.93
CP 2021	27.60	2.75	26.50	6.34	8.50	13.34	79.35	97.30
CP 1998	28.92	2.25	40.50	5.12	7.25	10.82	73.73	78.75
CP 2023	21.08	2.50	26.50	10.48	7.25	16.27	72.58	81.23
CP 1931	20.52	2.50	44.00	11.16	9.00	16.34	28.90	71.23
CD (5%)	5.81	1.14	9.19	1.72	1.59	5.97	21.91	9.35

Cont…..

Clones	PH	BR	GC	LAI	TUB	ATW	MYP	TYP
CP 2010	20.09	1.75	24.50	4.60	5.00	13.19	32.75	50.80
CP 1962	28.56	2.75	42.00	5.75	7.00	18.07	61.45	121.15
CP 1902	28.85	3.25	31.50	5.83	6.75	20.11	76.60	81.53
CP 1994	26.41	4.25	36.00	7.44	7.25	27.52	97.05	157.55
CP 1997	16.32	2.00	23.00	3.63	7.75	10.11	34.90	40.80
CP 1987	22.75	3.00	30.50	3.52	4.00	16.46	94.65	137.95
CP 1982	25.13	2.25	42.50	4.61	6.25	16.31	49.70	72.20
CP 2048	22.81	2.75	31.50	2.22	7.00	14.14	34.50	43.35
CP 2016	26.89	2.00	39.50	4.53	7.50	12.44	50.35	88.70
CP 1916	16.03	2.00	22.50	3.92	7.50	13.54	68.55	61.10
CP 2008	19.81	1.75	40.50	3.75	10.25	14.92	63.98	84.30
CP 2015	22.73	1.75	35.50	3.51	8.25	18.99	59.03	67.73
CP 1981	23.76	2.00	31.00	3.17	5.00	9.91	34.70	23.08
CP 2045	19.06	2.25	28.00	3.41	6.75	14.27	75.00	66.10
CP 1914	29.40	2.25	37.50	7.78	6.50	20.18	67.15	83.73
CP 1924	22.18	2.75	32.50	6.51	5.75	16.49	86.05	94.98
CP 1986	22.69	2.25	42.50	5.46	7.00	12.95	62.45	92.85
KufriJyoti (Check)	30.63	2.25	44.00	5.52	8.50	19.40	94.88	107.70
KufriKyati (Check)	31.82	2.50	52.50	7.32	8.75	27.91	96.55	146.98
CD (5%)	5.81	1.14	9.19	1.72	1.59	5.97	21.91	9.35

Table.4.3 Genetic parameters of various characters during 2016-17 and 2017-18

Table 4.3: Genetic parameters of various characters during 2016-17 and 2017-18								
Character	Range		Mean± SEm	GCV (%)	PCV (%)	h^2_{bs} (%)	GA (5%), as % of mean	Expected mean next generation
	Min	Max						
PH	16.03	31.82	24.21 ±2.07	15.37	23.01	44.60	21.15	29.33
BR	1.50	4.25	2.48 ± 0.41	16.69	36.70	20.70	15.64	2.87
GC	22.50	52.50	36.05 ±3.28	20.65	27.52	56.30	31.92	47.55
LAI	2.22	11.16	5.38 ± 0.61	33.89	40.83	68.90	57.97	8.51
TUB	3.75	10.25	6.97 ± 0.57	19.41	25.35	58.60	30.61	9.11
ATW	9.91	27.91	15.63 ±2.13	22.23	35.16	40.00	28.94	20.16
MYP	28.90	97.05	58.54 ±7.82	31.62	41.39	58.40	49.76	87.67
TYP	20.38	157.55	76.67 ±3.34	41.67	42.57	95.80	84.03	141.10

GCV = Genotypic coefficient of variation
PCV = Phenotypic coefficient of variation
h^2bs = Broad sense heritability
GA = Genetic advance

A high heritability was found for total tuber yield per plant and LAI while all other characters except number of branch showed moderate heritability. Number of branch had low heritability. These findings are in accordance with the finding of Fekadu *et al.*, (2013) for plant height and total tuber yield, Asefa *et al.*, (2016) for leaf area index, average tuber weight and marketable tuber yield, Tripura *et al.*, (2016) for number of branches per plant and number of tubers per plant, Nasiruddin *et al.*, (2017) for plant height, leaf area index, number of tubers, Panigrahi and Pradhan (2017) for marketable tuber yield, Mishra *et al.*, (2017) for marketable tuber yield and total tuber yield.

In the present study highest estimates of genetic advance (Table 4) as percentage of mean was obtained for characters namely total tuber yield per plant (84.03). Genetic advance is high for all the characters except branches per plant. Hayder *et al.*, (2009) and Mishra *et al.*, (2006), suggested that high heritability with high genetic advance is indicative of additive gene action and selection based on these parameters would be more reliable. In the studies high heritability with high genetic advance was found for LAI and tuber yield and moderate heritability with moderate genetic advance was found in plant height, ground coverage, number of tubers and average tuber weight which suggested that there may be presence of dominant and epistatic interactions. In agreement to the present results, similar findings were also supported by Ikbal& Khan (2003) reported high genetic advance for plant height and number of branches per plant, Ahmed *et al.*, (2005) for average tuber weight, number of branches and number of tuber per plant.

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