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PERFORMANCE OF TRUE POTATO SEED (TPS) HYBRIDS IN GANGETIC ALLUVIAL ZONE OF WEST BENGAL

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ABSTRACT

The present experiment was conducted in the winter season during 2009-2010 and 2010-2011 at Seed Production Farm Adisaptagram, Govt of West Bengal, Hooghly, West Bengal with nine TPS collected from AICRP on potato, BCKV centre. The nine TPS hybrids were screened and evaluated for yield and other agronomic characters *viz*., plant height, number of leaves per plant, number of tubers per plant, germination%, plant vigour, tuber weight gradation: 5g, 5-10 g, 10-20 g, 20-40 g, >40 g, tuber weight in g, yield per plant (g). Heritability was found high for all the characters except tuber weight gradation >40 g, indicating that these characters for TPS hybrids were less influenced by the environmental effects. Selection would be effective for improvement of these characters in potato raised through TPS. Correlation coefficient and path coefficient analysis clearly revealed that number of tubers per plant and tuber weight had significantly positive correlations with tuber yield per plant and also showed high positive direct effect on tuber yield per plant. Hence, these characters could be considered as indicator of high tuber yield per plant in TPS and selection for any of these two characters would result correlated response for tuber yield per plant. Plant height and tuber weight gradation 20-40 g had strong negative indirect effect on tuber yield per plant of TPS but strong to very strong negative indirect effects of tuber length via other characters lead to significantly negative correlation between tuber yield per plant (g) and plant height. Among the twelve characters studied, only two characters, *viz*., number of tubers per plant and tuber weight were considered most reliable indicators of high tuber yield per plant in TPS. Selection or identification of promising TPS for tuber yield per plant was one of the most important jobs to be done from this experiment. The results revealed that TPS genotypes SM/04-816 identified as the highest performer in respect of yield per plant in both the year.

KEYWORDS: TPS, Potato, Correlation Coefficients, Genetic Advance, Path Analysis

INTRODUCTION

Potato (*Solanum tuberosum* L.) is the world`s third most important food crop after wheat and rice with 325 million tonnes fresh weight production in 2007 (Bradshaw, 2009) of which over half of the production obtained from Asia, Africa, Latin America. At present China is number one potato producer while India ranked third. There has been a phenomenal increase in area, production and per capita availability of potatoes in India in the last 50 years. The average production of potato in India is 20 t/ha of marketable tubers and per capita availability of potato has gone up to 23.5 kg/ year (Pandey *et al*., 2007). These increases have primarily been through increases in the area of potatoes planted, but accompanied by some increases in yield per hectare. In contrast, future increases in potato production, which are required to feed an increasing world population, particularly in Asia, Africa and Latin America, will need to come primarily from increases in yield per hectare as new land will not be so readily available. In future for large scale production of potato interest is growing in using botanical or true potato seed. Traditionally, potatoes have been propagated vegetatively using

tubers. Potato can also be propagated generatively with sexual seeds which are formed in berries. These seeds are botanically true seeds of potato, and it is called 'True potato seed' (TPS) in potato nomenclature. Production of TPS is an alternative technology that is agriculturally sound, technically feasible and economically viable. Low multiplication rate, high storage and transportation costs, carry-over of pathogens, and physiological degeneration are some of the constraints associated with the use of seed tubers. Inevitably, performance declines as viruses accumulate due to which an elaborate and complex system of disease-free seed production is necessary. Costs of healthy seed tubers may account for 50 percent of the total production costs. But, most important, seed tubers used for planting represent food that is being buried in the field when it could be eaten instead. The two tons of seed tuber needed to plant one hectare are enough to feed an average South East Asian family of five for 80 years or a similar highland Peruvian family for four years. Compared to seed tubers, TPS offers several advantages, such as low cost of planting material, reduced transmission of pathogens/pests, and convenience as well as inexpensiveness of storage and transport etc. With rare but important exceptions (e.g. potato spindle tuber viroid), TPS is indeed free of virtually all diseases including systemically transmitted viruses. By using TPS, a considerable amount of valuable potato stocks that is used as seed can be saved for consumption as food. The main objective of the study was to select the suitable TPS hybrids for better tuber yield and other desirable characters for Gangetic Alluvial Zone of West Bengal.

MATERIALS & METHODS

The field experiments were conducted during rabi season at two consecutive years (2009-2010 and 2010-2011) at seed production farm Adisaptagram, Govt of West Bengal situated in district of Hooghly, West Bengal. It was done in Randomized Block Design with 3 replications with plot size of 2 x 3m with a spacing of 25 x 4cm. Nine TPS were supplied and collected from All India Co-Ordinated Project on Potatoes, Simla through the BCKV centre for the investigation. The nine TPS varieties are HPS-II/67, CP2333, CP2370, CP2378, PS/6-88, PS/5-75, SM/04-816, PS/5-73 and HPS-7/67.

Seedlings were grown in raised nursery beds of 1.2 m in width. Seedlings were allowed in the nursery bed for 40-50 days. Hardening of seedlings were started a week before transplanting by regulating water to the nursery. The selected land of the experimental site was thoroughly prepared and properly leveled and divided by the irrigation channels into several plots as per lay out. Farm yard manure @ 10-15 tonne/ha were mixed with soil by harrowing during final land preparation. The chemical fertilizer @ 250:125:125 (N: P: K) Kg/ha were applied. Whole amount of phosphate and potash were applied at time of land preparation. Remaining half dose of N (125kg/ha) was split into two equal parts to apply at the time of 1^{st} and 2^{nd} earthing up. Two seeds per hole at 0.5 depths (with 25cm row to row and 4cm seed to seed spacing) were sown and then covered with well-screened FYM. One week after emergence, 0.1% urea solution was also sprayed at weekly intervals until the crop is 45-45 days old. When seedlings were 35 days old, ridges and furrows were made at the time of first earthing up. Three foliar sprays of Thiodan 35 EC and Dithane M 45 were done against insect and fungal diseases with 15 days intervals. Generally for true potato seeds 3-4 hand weeding are sufficient. Irrigation was applied at 8-10, 40-45 and 60-65 days after sowing. It was maintained $2/3^{rd}$ depth of the furrow.

Generally data were recorded from five randomly selected plants (excluding the border plants) per replication for yield and other agronomic characters *viz*., plant height, number of leaves per plant, number of tubers per plant, germination%, plant vigour, tuber weight: 5gm, 5-10 gm, 10-20 gm, 20-40 gm, >40 gm, tuber weight in g and yield per plant (g). The data were subjected to Analysis of Variance (Singh and Chaudhary, 1985), Genotypic and Phenotypic

Co-efficient of Variation (Burton, 1952), Genetic Advance (Johnson *et al.*, 1955 and Lush, 1949), broad sense Heritability (Hanson *et. al.*, 1956), Correlation Co-efficient and Path Co-efficient analysis (Dewey and Lu, 1959).

RESULTS AND DISCUSSION

In the present investigation nine TPS genotypes were collected from AICRP on Potato and were evaluated for several quantitative and qualitative characters including yield and yield attributing characters. Data were recorded on twelve characters *viz*., plant height (cm), number of leaves , number of tubers per plant, germination percentage, tuber weight gradation: 5g, 5-10 g, 10-20 g, 20-40 g, >40 g, plant vigour, tuber weight in g, yield per plant (g).

PHENOTYPIC VARIABILITY

Estimation of mean, range, coefficient of variation (CV), phenotypic variance (Vp), genotypic variance (Vg), environmental variance (Ve), environmental coefficient of variation (ECV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense), genetic advance (GA) at 5% selection intensity and genetic advance as percent over mean, of twenty three genotypes are presented in Table No 1, 2 and 3 respectively. SM/04-816 showed highest performance for yield per plant (351.08g) and better performance for tuber weight gradation >40 g, 20-40 g, 10-20 g, 5-10 g, number of tubers per plant (27.73), number of leaves per plant (36.36) and plant height (47.67 cm). Based on *per* se performance of genotypes, considerable variability was observed for all the characters, except tuber weight gradation >40 g. There were narrow differences between PCV and corresponding GCV values, for all the characters studied, indicating little influence of environment in expression of these characters. Moderate to high range of variations for all the characters were found, which might give scope for selection on the basis of phenotypic values of characters under study. But range did not able to reflect the actual variability present in the population for different characters, because it represents the extreme values only. In the present investigation, heritability was high for all the characters except the character tuber weight gradation >40 gm (8.07%), under study, indicating that these characters were less influenced by the environmental effect. Hence selection would be effective for improvement of these characters. The genetic advance observed for most of the traits was low, except yield per plant (39.53) which was high in magnitude. The genetic advance as percentage of mean was also moderate for most of the traits, except for plant height (24.49), tuber weight of 5 g (30.72) and tuber weight in g (22.49). Heritability and genetic advance are important selection parameters. Heritability estimates along with genetic advance are more helpful in predicting the genetic gain under selection, than heritability estimates alone (Smita *et al*., 2009). High heritability coupled with high genetic advance indicates the importance of additive gene effects in controlling such character (Panse, 1957). In the present investigation yield per plant showed high heritability coupled with high genetic advance (90.87, 39.53) among other characters. This indicated that for this character the heritability is due to additive gene effect or additive gene action is predominant for controlling all the characters under study. Therefore, selection may be rewarded in improvement of this character. High heritability accompanied with low genetic advance indicates non-additive gene action, so selection for such traits may not be rewarding.

CORRELATION COEFFICIENT ANALYSIS

From the above discussion on correlation coefficient in TPS genotypes, it is evident that the characters *viz*., tuber weight in g (1.190^{**}, 0.869^{**}) and number of tubers per plant (0.872^{**}, 0.694^{**}) are important characters in determining tuber yield per plant (Table 4). Plant height was negatively and significantly correlated with no of tubers per plant (-0.961^{**}, -0.667^{*}) and germination percentage ($-0/978^{**}$, -0.771^{**}). The complex natures of relationship among characters

with tuber yield per plant become evident from the above discussion. Such estimates of correlations alone do not provide a comprehensive picture of the relative importance of the direct and indirect influences of each character to the fruit yield per plant. As correlation coefficients are insufficient to explain the relationship between characters for an efficient manipulation of characters, path coefficient analysis was done. Generally genotypic correlation coefficients were higher than their corresponding phenotypic correlation coefficients, revealing the strong genetically or true relationship between the characters. The difference between genotypic and phenotypic correlation coefficients were narrow and as the breeders are mainly concerned with genotypic correlation coefficients, therefore in the following discussion genetic correlation coefficients were given the main emphasis. In our present experiment, also we have obtained similar type of results.

PATH COEFFICIENT ANALYSIS

The direct and indirect effects of individual characters on fruit yield per plant at genotypic level are presented in Table No 5. Number of leaves per plant (0.61), number of tubers per plant (0.68), plant vigour (0.58) and tuber weight in g (1.98) had very high positive direct effect on tuber yield per plant. Besides these, the characters plant height (-1.59) and tuber weight gradation 20-40 g (-0.84) had strong negative effect on tuber yield per plant. Hence, selection for number of leaves per plant, number of tubers per plant, plant vigour and tuber weight in g is likely to improve tuber yield per plant (g). High negative direct effects on tuber yield per plant (g) were observed in characters like, plant height (cm), tuber weight gradation of 20-40 gm may be helpful for negative selection of these traits. The present investigation on correlation coefficient and path coefficient analysis clearly revealed that number of tubers per plant and tuber weight in g had significantly positive correlations with tuber yield per plant (g) and also showed high positive direct effect on tuber yield per plant (g). Hence, these characters could be considered as indicator of high tuber yield per plant (g) in TPS and selection for any of these two characters would result correlated response for tuber yield per plant (g). From the above discussion it is evident that both number of tubers per plant and tuber weight in g had significantly positive correlation with tuber yield per plant (g) and their direct effect on tuber yield per plant (g) were also high but association among themselves were negative and their indirect effect on tuber yield per plant via each other were also negative. Among the twelve characters studied, only two characters, *viz*., number of tubers per plant and tuber weight in g arise as most reliable indicators of high tuber yield per plant (g) in TPS. The results of the present study on correlation and path coefficient analysis were in close agreement with the earlier reports of Kumar *et al*., (2003).

Selection or identification of promising TPS for tuber yield per plant as well as specific TPS for chips is one of the most important jobs to be done from this experiment. From the present experiment the TPS genotypes SM/04-816 and PS/6-88 were identified as the highest and lowest performer respectively in respect of yield pre plant.

CONCLUSIONS AND RECOMMENDATION

On the basis of this study, it is concluded that number of tubers per plant and tuber weight in g could be considered as indicator of high tuber yield per plant (g) in TPS and selection for any of these two characters would result correlated response for tuber yield per plant and the TPS genotypes SM/04-816 and PS/6-88 were identified as the highest and lowest performer respectively in respect of yield pre plant (g).

The results of the present experiment may help to formulate some long term breeding programme aimed at improving the important quantitative characters of potato including tuber yield by using TPS. It is recommended that more TPS parental lines may be included in the further research programme and suitable parents may be selected that is

acceptable to end consumers. The potato genotypes as well as TPS genotypes may be screened in multi locations and multi seasons to study the stability of genotypes, to identify the resistant or tolerant genotypes against diseases and insects and the TPS genotypes may be thoroughly evaluated for different important quality characters which are required for the industrial purposes. Potato has to play tremendous role for elevation of hunger in the world in near future. So, intensive research on this crop is very much essential to feed the starving of world in future.

Table 1: Mean of Twelve Yield and Yield Attributing Traits for Nine TPS Genotypes

TPS	PH	NL	NTP	PV	G%	5 g	5-10 g	10-20 g	20-40 g	>40 g	TWG	YP
HPS-II/67	11	28.09	30.06	3.57	85.72	7.07	9.32	10.62	10.19	9.14	11.1	321.69
CP2333	45.66	41.34	23.61	3.54	78.78	6.95	9.3	9.4	11.13	10.35	12.32	287.52
CP2370	46.59	35.12	25.28	4.69	81.52	5.34	8.13	9.49	9.27	9.7	13.01	324.91
CP2378	43.45	33.07	28.12	3.97	86.41	6.33	10.18	9.6	8.4	10.61	9.4	289.03
PS/6-88	37.03	35.06	31.97	4.15	85.01	6.49	8.06	10.31	10.22	10.64	8.9	274.55
PS/5-75	51.75	35.2	25.98	3.87	77.18	7.22	7.78	8.98	9.5	10.68	12.13	308.78
SM/04-816	47.67	36.36	27.73	3.79	79.54	6.63	9.25	10.33	7.82	9.59	12.97	**351.08**
PS/5-73	53.43	34.14	21.44	4.02	76.69	9.73	7.93	10.07	10.38	9.54	13.79	291.72
HPS-7/67	46.21	45.9	26.9	4.72	76.4	6.53	8.67	11.41	12.27	9.58	12.12	319.63
SEd	**1.556**	**2.475**	**1.863**	**0.244**	**2.318**	**0.74**	**0.549**	**0.594**	**0.869**	**0.803**	**0.865**	**5.211**
CD(p=0.05)	**3.298**	**5.247**	**3.95**	**0.518**	**4.913**	**1.569**	**1.164**	**1.26**	**1.842**	**1.701**	**1.833**	**11.047**

Table 2: Analysis of Variance (ANOVA) for G × E Interaction for Twelve Different Characters of TPS Genotypes

Source of Variation	d.f	Mean Sum of Square											
		PH	NL	NTP	PV	G%	5gm	5-10 gm	10-20 gm	20-40 gm	>40 gm	TWG	YP
Envt.	1	300.27**	129.53**	219.43*	1.16**	0.24	3.27**	1.15**	3.72	0.69**	16.89**	41.79**	0.49
Geno.	8	62.75**	32.69**	19.68**	0.46**	31.61**	3.62**	1.18**	0.66*	3.75**	0.81	6.06**	838.35**
Envt. × Geno.	8	13.37**	15.11**	2.39	0.15	13.85	0.33	0.4	1.34**	0.16	1.21*	0.54	845.70**
Pooled Error	16	2.22	3.11	1.76	0.09	6.15	0.38	0.24	0.28	0.44	0.39	0.53	85.93

* Significant at 5% ** Significant at 1% level

Envt: Environment **Geno:** Genotype **PH:** Plant height (cm) **NL:** Number of leaves

NTP: Number of Tubers per Plant

PV: Plant vigour **TWG:** Tuber weight in (g) **YP:** Yield per plant (g) **G%:** Germination percentage

Tuber Weight Gradation: 5 g, 5 - 10 g, 10 - 20 g, 20 - 40 g and > 40 g

Table 3: Genetic Variability Parameters for Twelve Different Characters of Nine TPS Genotypes

Character	Mean	Range		Variance			ECV	GCV	PCV	$h^2_{(BS)}$	GA	GA as % of mean
				Pheno.	Geno.	Envt						
PH	43.64	35.13	51.57	33.798	30.17	3.63	4.36	12.58	13.31	89.26	10.68	24.49
NL	34.69	27.75	42.37	22.46	13.28	9.19	8.73	10.5	13.66	59.11	5.76	16.63
NTP	25.04	20.12	30.58	13.3	8.10	5.21	9.11	11.36	14.56	60.86	4.57	18.26
PV	3.90	3.24	4.62	0.29	0.20	0.09	7.65	11.47	13.79	69.17	0.76	19.65
G%	80.86	75.79	86.22	21.18	13.12	8.06	3.51	4.47	5.69	61.95	5.87	7.26
5 g	6.70	5.05	9.99	2.36	1.54	0.82	13.51	18.47	22.88	65.16	2.05	**30.72**
5-10 g	8.61	7.80	9.93	0.89	0.44	0.45	7.81	7.69	10.96	49.24	0.95	11.12
10-20 g	10.25	9.50	11.08	0.68	0.15	0.53	7.10	3.81	8.06	22.40	0.38	3.72
20-40 g	9.81	7.74	12.24	2.63	1.49	1.13	10.84	12.46	16.52	56.89	1.89	19.36
>40 g	10.46	9.41	11.71	1.05	0.08	0.97	9.39	2.78	9.79	8.07	0.16	1.62
TWG	12.50	9.36	14.53	1.12	2.66	3.78	8.46	13.02	15.53	70.32	2.81	22.49
YP	309.14	281.69	345.23	446.31	405.59	40.73	2.06	6.51	6.83	90.87	39.53	12.79

PH: Plant height (cm) **NL:** Number of leaves **NTP:** Number of Tubers per Plant **PV:** Plant vigour
TWG: Tuber weight in (g) **YP:** Yield per plant in **G%:** Germination percentage
Tuber Weight Gradation: 5 g, 5 - 10 g, 10 - 20 g, 20 - 40 g and > 40 g

Table 4: Genotypic (G) and Phenotypic (P) Correlation Coefficients between Different Characters of Nine TPS Genotypes on Yield per Plant

Characters		P.H.	NL	NTP	PV	G%	5 g	05-Oct g	Oct-20 g	20 - 40 g	>40 g	TWG	YP
PH	G	1	0.524	**-0.961****	0.252	**-0.978****	**0.553***	**-0.643****	0.069	0.032	**0.850****	**0.883****	-0.097
	P	1	0.377	**-0.667***	0.316	**-0.771****	0.386	-0.459	0.163	-0.025	**0.559***	**0.669****	-0.064
NL	G		1	**-0.563***	0.53	**-0.859****	-0.172	-0.224	0.333	**0.611***	0.256	0.416	-0.296
	P		1	-0.351	0.263	-0.355	-0.109	-0.177	0.026	0.313	0.183	0.269	-0.193
NTP	G			1	-0.279	**1.036****	**-0.654****	0.452	0.188	-0.08	-0.48	**-0.815****	**0.872****
	P			1	-0.076	**0.895****	-0.279	0.375	0.165	-0.12	-0.114	**-0.760****	**0.694****
PV	G				1	-0.325	-0.149	-0.486	0.234	0.262	**-0.663***	0.247	-0.077
	P				1	-0.31	-0.117	-0.262	0.39	0.14	-0.151	0.088	-0.033
G%	G					1	-0.519	**0.711****	-0.099	**-0.577***	**-0.586***	**-0.957****	0.227
	P					1	-0.373	0.443	0.015	-0.296	-0.144	**-0.561***	0.136
5g	G						1	-0.487	0.085	0.085	-0.313	0.508	-0.369
	P						1	0.014	0.217	0.26	0.331	0.252	-0.292
5-10 g	G							1	0.301	-0.442	**-1.066****	-0.555	0.48
	P							1	0.401	0.012	**-0.868****	-0.427	0.307
Oct-20 g	G								1	-0.211	**-1.063****	0.115	**0.571***
	P								1	0.134	**-0.765****	-0.035	0.259
20-40 g	G									1	**-1.122****	0.191	-0.3
	P									1	**-0.809****	0.162	-0.292
>40 g	G										1	-0.212	0.202
	P										1	-0.076	0.206
TWG	G											1	**1.190****
	P											1	**0.869****
YP	G												1
	P												1

* Significant at 5 % ****** Significant at 1% level
PH: Plant height (cm) **NL**: Number of leaves **NTP**: Number of Tubers per Plant **PV**: Plant vigour
TWG: Tuber weight in (g) **YP**: Yield per plant in (g) **G%:** Germination percentage
Tuber Weight Gradation: 5 g, 5 - 10 g, 10 - 20 g, 20 - 40 g and > 40 g

Table 5: Direct (Diagonal Bold) and Indirect Effects between Different Characters of Nine TPS Genotypes on Tuber Yield/ Plant

Characters	P.H.	NL	NTP	PV	G%	5 g	5-10 g	10-20 g	20-40 g	>40 g	TWG
PH	**-1.6**	0.32	-0.46	0	-0.07	0.07	-0.11	0	-0.03	0.02	1.75
NL	-0.84	**0.61**	-0.27	0.01	-0.06	-0.02	-0.04	-0.01	-0.51	0.01	0.82
NTP	1.53	-0.34	**0.68**	0	0	-0.09	0.08	-0.01	0.07	-0.01	-1.51
PV	-0.4	0.32	-0.13	**0.58**	-0.02	-0.02	-0.08	-0.01	-0.22	-0.02	0.49
G%	1.56	-0.53	0.5	0	**0.07**	-0.07	0.12	0	0.48	-0.02	-1.9
5 g	-0.88	-0.11	-0.31	0	-0.04	**0.13**	-0.08	0	-0.07	-0.01	1.01
5-10 g	1.03	-0.14	0.22	-0.01	0.05	-0.06	**0.17**	-0.01	0.37	-0.04	-1.1
10-20 g	-0.11	0.2	0.09	0	-0.01	0.01	0.05	**-0.03**	0.18	-0.05	0.23
20-40 g	-0.05	0.37	-0.04	0	-0.04	0.01	-0.08	0.01	**-0.84**	-0.03	0.38
>40 g	-1.36	0.16	-0.23	-0.01	-0.04	-0.04	-0.27	0.05	0.94	**0.03**	-0.42
TWG	-1.41	0.25	-0.37	0	-0.07	0.07	-0.1	0	-0.16	-0.01	**1.98**

PH: Plant height (cm) **NL**: Number of leaves **NTP**: Number of Tubers per Plant **PV**: Plant vigour
TWG: Tuber weight in (g) **YP**: Yield per plant in (g) **G%:** Germination percentage
Tuber Weight Gradation: 5 g, 5 - 10 g, 10 - 20 g, 20 - 40 g and > 40 g

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REFERENCES

1. Bradshaw, J.E.; Dale, M.F.B. and Mackay, G.R.(2009).Improving the yield, processing quality and disease and pest resistance of potatoes by genotypic recurrent selection. *Euphytica* **170**:215-27.
2. Burton, G. W. (1952). Quantitative Inheritance in grasses, Proc. 6th Int. grassland. Congr., **1** : 277-283.
3. Dewey, D. R. and Lu, H. K. (1959). A correlation and path coefficient analysis of component of crested wheat grass production. *Agron. J.*, **51**: 515-518.
4. Hanson, C. H.; Robinson, H. F. and Comstock, R. E. (1956). Biometrical studies of yield in segregating population of Korean lespedza. *Agron. J.*, **48**: 268-272.
5. Johnson, H. W., Robinson, H. F. and Comstock, R. E. (1955). Estimate of genetic and environmental variability in soybean. *Agron. J.*, **47**: 314-318.
6. Kumar, D.; Singh, S.V. and Pandey, S.K. (2003). Chemical maturity of potato processing cultivars grown in western Uttar Pradesh. J Indian Potato Assoc 30(3-4): 225-32
7. Lush, J. L. (1949). Heritability of quantitative characters in farm animals. *Proc. 8th Inter. Congr. Genet.*, 1948, pp. 356-357.

8. Pandey, N.K.; Pandit, Arun.; Chandran, K.P. and Pandey, S.K. (2007). *Potato Statistics: India and World*.

9. Panse, V. G. (1957). Genetics of quantitative characters in relation to plant breeding. *Indian J. Genet.*, **17**: 317-328.

10. Singh, R. K. and Chaudhary, B. D. (1985). Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.

11. Smita Bala Barik, Satish K. Verma, H.C. Nanda And S. K. Tamrakar(2009). Genetic Variability, Heritability And Genetic Advance For Yield And Its Attributes In Potato (Solanum tuberosum L). *Ann. Agric. Res. New Series Vol. 30 (1&2):* 39-42.