The Pharma Innovation Journal 2023; 12(7): 1336-1339

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(7): 1336-1339

www.thepharmajournal.com
Received: 20-04-2023
Accepted: 26-05-2023

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Study on genetic variability, correlation and path analysis in F_1 potato genotypes (*Solanum tuberosum* L.)

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Abstract
The experiment was conducted in Department of Vegetable Science, Indira Gandhi Vishwavidyalaya, Raipur (C.G.) during *Rabi* season 2022-23 at the experimental field of All India Coordinated Research Project on Potato (AICRP). The ten potato genotypes of F_1 generation, together with the two check variety, i.e., Kufri Khyati and Kufri Garima planted in RBD for the experiment. Genotypes were raised in three replications that were spaced 60 and 20 cm apart in five rows that were in this plot size (3.0 x 2.4 m^2). Total Twelve characters were used to record all observations where from each replication cross all genotypes, five competitive, well-grown plants at random had been chosen. The experiment's data were selected statistically evaluated to estimate genetic variability in F_1 potato, correlation coefficients, path coefficient analysis and identify best F_1 generation (s) suitable for the Raipur Agro-climate.
In the genetic variability, analysis of variance expressed that all traits which had been taken in breeding programme found extremely considerable variability a cross all genotypes. Maximum PCV and GCV recorded for unmarketable tuber yield per plot, marketable tuber yield per plot, dry weight of shoots per plant. High heritability (bs) incorporate with high genetic advance as % of mean had recorded at dry weight of shoots per plant, number of tubers per plant, number of total leaves per plant, marketable tuber yield per plot and unmarketable tuber yield per plot, indicates that the selection of these characters will be rewarding for improvement of yield in breeding programme.

Keywords: Genetic variability, path analysis, F_1 potato genotypes, *Solanum tuberosum* L.

1. Introduction
Potato (*Solanum tuberosum* L.) belongs to the family *Solanaceae* and genus *Solanum*, which comprises about 2000 species and sub-section potato contain 19 series and 235 species (Hawkers, 1944) [9]. Potato the most important non-cereal food crops of the world is cultivated in nearly 150 countries. Potato is the main source of diet and basic nutrients in many developing countries, besides the developed nations, and also generates employment and income for livelihood of farmers. India is the second largest producer of potato after China in the world. In India Uttar Pradesh is the leading producer of potato's followed by West Bengal and Bihar. Nowadays, potatoes are farmed on six different continents and are among fourth-most significant food crop in the world, after maize, rice, and wheat, in terms of overall production (FAO Stat Data 2007). Being a short duration crop, it produces more quantity of dry matter, edible energy and edible protein in lesser duration of time compared to cereals. So it is one the most important vegetable for food security and nutrition. It contributes 26.53 percent to the total vegetable production and occupying 21.24 percent to the total area of vegetables in India.

2. Material and Methods
The present investigation was conducted at AICRP (Potato), Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) Raipur. This experiment consist of ten F_1 genotypes of potato, obtained from CPRI – Modipuram (U.P.) through AICRP on Potato, along with two check variety (K. Khyati and K. Garima) were evaluated during *Rabi* 2022-23. All genotypes were planted in Randomized Block Design (RBD) with spacing of 60cm (Row to Row) X 20cm (Plant to Plant). Observations like plant height (PH), number of shoots per plant, number of compound leaves per plant, fresh weight of shoots per plant (g), dry weight of shoots per plant (g) , the number of tubers per plant, the fresh weight of tubers per plant, harvest index (HI %), Marketable tuber yield (kg/plot), Unmarketable tuber yield per plot (kg), and total tuber yield per plant (g) were recorded on specific growth parameters and yield attributing characters from each replication.

The statistical parameters like ANOVA, GCV, PCV, Heritability, Genetic advance, Correlation Co- efferent and path coefficient analysis were done by mean data of all the parameters.

3. Results and Discussions

3.1 Analysis of variance: Analysis of variance revealed that, mean sum of squares due to genotypes was found to be significant for all the traits. The analysis of variance for various yield and yield contributing attributes shows that breeding materials reveals that breeding materials were extremely significant variability for all the characters among the genotypes at 1% level of significance.

Table 1: Estimates of genetic parameters of variation for tuber yield and its components in potato

Characters Genetic Parameters	Plant Height (cm)	Number of shoots per plant	Number of compound leaves per plant	Fresh weight of shoots per plant (gm)	Dry weight of shoots per plant (g)	Number of tubers per plant	Harvest index (%)	Marketable tuber yield per plot (kg)	Unmarketable tuber weight per plot (kg)	Total tuber yield per plot (kg)	Total tuber yield per plant (g)
GCV	9.20	13.03	16.93	16.45	21.52	17.16	6.59	19.09	21.42	18.32	14.63
PCV	12.21	15.71	18.13	17.95	22.19	20.31	8.69	21.16	24.18	20.35	19.07
h2 (Broad Sense)	56.74	68.84	87.18	84.01	93.99	71.42	57.51	81.36	78.44	81.06	58.81
Genetic Advancement 5%	6.27	0.98	15.13	65.12	14.11	2.94	6.56	6.90	0.62	7.14	85.17
Gen. Adv. as % of Mean 5%	14.28	22.27	32.55	31.07	42.94	29.88	10.30	35.47	39.08	33.98	23.10

3.2 Mean Performance

Number of compound leaves per plant, number of tubers per plant, harvest index (%), marketable tuber yield per plot (kg), unmarketable tuber yield per plot, total tuber yield per plant (g), illustrated maximum mean value by check variety of potato K. Khyati. Genotype 2022 IGP-2 had maximum mean value for number of shoots per plant, fresh weight of shoots per plant. Genotype 2022 IGP-2 had maximum mean value for plant height (cm). Dry weight of shoots per plant showed maximum mean value 2022 IGP-2 genotype. Genotype 2022 IGP-1 had maximum mean value for number of tubers per plant and harvest index.

Table 2: Genotypic correlation coefficient between tuber yield and its contributing traits in potato

	Plant height (cm)	Number of shoots/plant	Number of compound leaves/plant	Fresh weight of shoots/ plant (g)	Dry weight of shoots/ plant (g)	Number of tubers/ plant	Harvest Index (%)	Marketable tuber yield/plot (kg)	Unmarketable tuber yield/plot (kg)	Total tuber yield/plot (Kg)	Total Tuber yield/plant (gm)
Plant height (cm)	1.000	0.633**	0.599**	0.2910	0.606**	0.631**	0.0079	0.624**	0.1920	0.580**	0.573**
Number of shoots /plant		1.000	0.648**	0.2383	0.804**	0.709**	0.2394	0.657**	0.1656	0.634**	0.726**
Number of compound leaves/plant			1.000	0.474*	0.898**	0.597**	0.2216	0.815**	0.387*	0.807**	0.788**
Fresh weight of shoots/plant (g)				1.000	0.386*	0.1276	-0.690**	0.2253	0.520*	0.2631	0.1822
Dry weight of shoots/plant (g)					1.000	0.675**	0.2873	0.811**	0.2946	0.797**	0.830**
Number of tubers/plant						1.000	0.336*	0.806**	0.471*	0.808**	0.725**
Harvest index (%)							1.000	0.412*	-0.1943	0.370*	0.495*
Marketable tuber yield/plot (kg)								1.000	0.418*	0.969**	0.909**
Unmarketable tuber yield/plot(kg)									1.000	0.506*	0.2687
Total tuber yield/plot (Kg)										1.000	0.874**
Total tuber yield/plant (gm)											1.000

3.3 Noetic parameters: Among all examined yield aspect trait *viz*., Dry weight of shoots per plant (g), unmarketable tuber yield per plot (kg) demonstrated higher magnitude of GCV, similarly higher magnitude of PCV showing characters are dry weight of shoots per plant (g), marketable tuber yield per plot (kg), unmarketable tuber yield per plot (kg), total tuber yield per plot, number of tuber per plant. These characters are exploited for enhancing the yield of population. Highest heritability had been seen in dry weight of shoots per plant, number of number of compound leaves per plant, fresh weight of shoots per plant, number of tubers per plant, marketable tuber yield per plot (kg) and unmarketable tuber yield per plot (kg) and total tuber yield per plant (g). It showing that the least influenced by the influenced by environmental effects and can be useful in predicting the effectiveness of selecting the genotypes in population. Highest genetic advance as a % of mean was found in dry weight of shoots per plant (g), unmarketable tuber yield plot (kg), marketable tuber yield per plot (kg), total tuber yield per plot (kg), number of compound leaves per plant and fresh weight of shoots per plant.

Furthermore, number of tubers per plant, total tuber yield per plant, number of shoots per plant and plant height (cm), reported moderate genetic advance measured as a percentage of the mean. These characters are important for breeder to consider these characters for selection. High heritability coupled with high genetic advance as percentage of means was observed that in dry weight of shoot per plant (g) after that number of compound leaves per plant, fresh weight of shoots per plant, marketable tuber yield per plot (kg), total tuber yield per plot and unmarketable tuber yield per plot (kg) it indicates that heritability due to non additive gene effect selection may be effective. High heritability coupled with moderate genetic advance as a % of means was observed in total tuber yield. Indicates that presence of additive gene effect and less influence by environment. Similar findings were validated by the research of Fekadu and Petros *et al.* (2013) [5], Pradhan and Sarkar *et al.* (2014) [13], Panigrahi and Konar. (2014) [12], Sharma *et al.* (2015) [15], Bhadauriya and Chandra *et al.*, (2018) [2], Hajam *et al.* (2018) [8], Getahun and Linden *et al.* (2019) [7].

Table 3: Path coefficient showing the direct and indirect effect of yield contributing traits on tuber yield of potato

	Plant Height (cm)	**Number of shoots per plant**	**Number of compound leaves per plant**	**Fresh weight of shoots per plant (gm)**	**Dry weight of shoots per plant (g)**	**Number of tubers per plant**	**Harvest index (%)**	**Market able tuber yield per plot (kg)**	**Unmarketable tuber weight per plot (kg)**	**Total tuber yield per plot (kg)**	**Total tuber yield per plant (g)**
Plant Height (cm)	0.1397	0.0904	0.0833	0.0408	0.0849	0.0922	0.0012	0.0871	0.0281	0.0819	0.575**
Number of shoots per plant	0.1343	0.2076	0.1381	0.0492	0.1685	0.1463	0.0517	0.1379	0.0319	0.1308	0.740**
Number of compound leaves per plant	-0.1603	-0.1788	-0.2688	-0.1279	-0.2427	-0.1695	-0.0599	-0.2191	-0.1081	-0.2198	0.792**
Fresh weight of shoots per plant (gm)	0.2138	0.1735	0.3487	0.7327	0.2819	0.0917	-0.5055	0.1648	0.3828	0.1916	0.1824
Dry weight of shoots per plant (g)	-0.0557	-0.0744	-0.0828	-0.0353	-0.0916	-0.0629	-0.0265	-0.0744	-0.0270	-0.0731	0.831**
Number of tubers per plant	-0.0537	-0.0574	-0.0513	-0.0102	-0.0559	-0.0814	-0.0285	-0.0678	-0.0371	-0.0661	0.745**
Harvest index (%)	0.0066	0.1983	0.1774	-0.5488	0.2297	0.2783	0.7955	0.3298	-0.1550	0.2978	0.495*
Marketable tuber yield per plot (kg)	0.3159	0.3368	0.4133	0.1140	0.4118	0.4221	0.2101	0.5069	0.2161	0.4940	0.912**
Unmarketable tuber weight per plot (kg)	-0.0220	-0.0167	-0.0439	-0.0570	-0.0321	-0.0498	0.0213	-0.0465	-0.1091	-0.0547	0.2704
Total tuber yield per plot (kg)	0.0560	0.0602	0.0781	0.0250	0.0762	0.0776	0.0358	0.0931	0.0479	0.0956	0.878**
Total tuber yield per plant (g)	0.575**	0.740**	0.792**	0.1824	0.831**	0.745**	0.495*	0.912**	0.2704	0.878**	1.0000
Partial R2	0.0803	0.1535	-0.2129	0.1336	-0.0761	-0.0606	0.3940	0.4621	-0.0295	0.0839	

3.4 Correlation coefficient: The analysis of correlation coefficient reported that character tuber yield had positive significant correlation with number of compound leaves per plant, dry weight of shoots per plant, number of tubers per plant, and harvest index (%), marketable tuber yield per plot, and unmarketable tuber yield per plot at genotypic level and at phenotypic level it showed positive significant correlation with number of tubers per plant. Very strong (> 0.65) correlation coefficients upon tuber yield per plant found at dry weight of shoots per plant (g), number of shoots per plant, number of compound leaves per plant and number of tubers per plant, marketable tuber yield per plot (kg). Moderately strong (0.50 to 0.64) correlation coefficients found at plant height. Moderately weak (0.30 to 0.49) correlation coefficients at harvest index (%). Very weak (< 0.30) correlation coefficients found at fresh weight of shoots per plant (g), unmarketable tuber yield per plot (kg). At phenotypic level tuber yield exhibited positive significant correlation with plant height, number of shoots per plant, number of compound leaves per plant, dry weight of shoots per plant and number of tubers per plant and harvest index. According to above result, this can be concluded that increase in the plant height, number of shoots per plant, number of compound leaves per plant, dry weight of shoots per plant, number of tubers per plant will contribute to the greater yield of tuber. Number of shoots per plant demonstrated that a positive significant association at genotypic level with number of compound leaves per plant, dry weight of shoots per plant and number of tubers per plant. At phenotypic level Number of shoots per plant exhibited a positive significant association with number of compound leaves per plant, dry weight of shoots per plant and number of tubers per plant. The above results acclaimed that plant type having more number of shoots per plant, will lead to more number of compound leaves per plant subsequently greater the number of tuber per plant. Fresh weight of shoots per plant revealed that a positive significant relation at genotypic level with dry weight of shoot per plant, whereas negative significance correlation found with harvest index. At phenotypic level it shows positive significant relation dry weight of shoot per plant, whereas negative significance correlation found with harvest index. The above result conclusions can be determined as increase in fresh weight of shoot per plant will lead to increase in fresh weight of shoot per plant but increase in fresh weight of shoots per plant will lead to decrease the harvest index, it means it fresh weight of shoots shows negative correlation with harvest index at phenotypic as well as genotypic level both. The number of compound leaves per plant revealed that a positive significant correlation at genotypic level with fresh weight of shoots per plant, dry weight of shoot per plant, number of tubers per plant. At phenotypic level it showed that positive significant correlation with fresh weight of shoots per plant, dry weight of shoots per plant and number of tubers per plant. Above result revealed that increaser in number of compound leaves per plant will be increase fresh weight of shoots per plant, dry weight of shoots per plant and number of tubers per plant. Dry weight of shoots per plant revealed that a positive significant relation at phenotypic level with number of tubers per plant, marketable tuber yield per plot and total tuber yield per plot. At genotypic level it shows positive significant association with number of tubers per plant, marketable tuber yield per plot and total tuber yield per plot. The above mentioned conclusion that determined as increase in dry weight of shoots per plant will lead to increase in number of tuber per plant and total tuber yield per plant. Number of tubers per plant revealed that, a positive significant association at genotypic level with harvest index, marketable tuber yield and total tuber yield per plot. At phenotypic level it shows positive significant association with harvest index, marketable tuber yield and total tuber yield per plot. It can be concluded more number of tuber per plant will lead to high harvest index and greater marketable tuber yield altimetry increase in total tuber yield per plot. Harvest index showed that a positive significant connotation at genotypic level with marketable tuber yield, total tuber yield per plot whereas negative correlation with unmarketable tuber yield per plant. At phenotypic level it shows positive significant association with marketable tuber yield per plot and total tuber yield per plot whereas, negative correlation with unmarketable tuber yield per plant. The above findings can be concluded as increase in harvest index (%) will decrease the unmarketable tuber yield. The result revealed that tuber yield showed a positive significant association at genotypic level with number of compound leaves per plant, marketable tuber yield per plot, number of tubers per plant, unmarketable tuber yield per plot, fresh weight of shoots per plant, dry weight of shoots per plant, harvest index and total tuber yield. Thus, these characters are useful in direct selection for enhance the development of total tuber yield of potato. Similar result observed in the present study was also found in research of Fekadu *et al*. (2020) [6], Ummyiah and Khan. (2013) [16], Ara and Haydar. (2009) [1], Zelalem. (2009) [18].

3.5 Path coefficient analysis: Path coefficient analysis represents that the traits *viz*. harvest index, fresh weight of shoots per plant, plant height, marketable tuber yield per plot, number of shoots per plant, plant height, reported positive direct effects on total tuber yield. It means that direct selection of these traits would be beneficial for future research work. Negative direct effects on total tuber yield was also reported by dry weight of shoots per plant, number of compound leaves per plant, number of tubers per plant, unmarketable tuber yield per plot. As a cause of correlation so indirect selection through such traits will be efficacious.

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