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Analysis of genetic variability, heritability and genetic advance in Potato (*Solanum tuberosum* L.) Genotypes under Eastern Uttar Pradesh

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Abstract

The present study was conducted during *Rabi* 2024-25 at the Main Experimental Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, to assess genetic variability, heritability and genetic advance as a percentage of mean for eighteen growth, yield and quality traits in thirty-five potato genotypes. The experiment was laid out in a Randomized Block Design with three replications. Analysis of variance revealed highly significant differences among the genotypes for all eighteen characters studied, indicating the existence of substantial genetic variability. The phenotypic coefficient of variation (PCV) was consistently higher than the genotypic coefficient of variation (GCV) for all traits. High estimates of GCV and PCV were recorded for reducing sugar (53.59% and 66.32%), non-reducing sugar (52.71% and 64.59%), total sugar (52.84% and 58.94%) and average tuber weight (21.81% and 22.59%). Broad-sense heritability ranged from 51.56% for plant emergence to 93.25% for average tuber weight. High heritability coupled with high genetic advance as a percentage of mean was observed for average tuber weight (93.25%, 43.39%), tuber width (88.91%, 38.55%), tuber yield per plant (84.68%, 30.81%), tuber yield per plot (83.70%, 31.65%), total tuber yield (84.24%, 32.23%), total sugar (80.36%, 97.57%), non-reducing sugar (66.60%, 88.61%) and reducing sugar (65.29%, 89.21%), indicating the predominance of additive gene action. These traits can be efficiently improved through direct selection and may be utilized in future potato improvement programmes.

Keywords: Potato, genetic variability, heritability, genetic advance, yield traits, quality traits, additive gene action

Introduction

The potato (*Solanum tuberosum* L.) is a crucial food crop worldwide, ranking fourth after wheat, rice and maize, providing essential nutrition to billions (Aishwarya *et al.*, 2024; FAOSTAT, 2021) ^[1,5]. As a member of the Solanaceae family, it is often referred to as the “King of Vegetables” due to its significant utility (Reddy *et al.*, 2018) ^[15]. The cultivated potato is a tetraploid species ($2n = 4x = 48$), with wild relatives showing varied ploidy levels. Potatoes, originating from the Andes in Peru and Bolivia, were introduced to India in the 17th century by the Portuguese (Singh *et al.*, 2024) ^[17]. In 2024, global potato production reached approximately 390.429 million metric tons, with China and India as the leading producers, contributing around 93.49 million and 60.18 million metric tons, respectively (FAO, 2025) ^[5]. In India according to final report 2024-2025, potatoes is grown on 2.32 million hectares, yielding about 57.05 million metric tons, with Uttar Pradesh, West Bengal and Bihar being the top-producing states (MoA & FW, 2024-2025). Potato play a crucial part in improving food security by 2050 due to the estimated 10 billion people on the planet. Potato is a major staple in food-deficit nations, providing an inexpensive source of calories and being rich in vital micronutrients including vitamin C, iron and fiber. Particularly in areas with limited resources, its nutritional advantages and versatility make it essential for alleviating hunger and malnutrition and diversifying diets (Qasim *et al.*, 2013) ^[13]. Genetic variability is essential for crop improvement, particularly in enhancing growth, yield and nutritional quality. In potatoes, narrow genetic diversity limits progress, necessitating the

exploration of diverse germplasm to develop superior genotypes (Shekhawat, 2001) ^[16]. Estimates of heritability and genetic advance help identify traits for effective transmission to future generations, supporting targeted genetic enhancements. The investigation assessed genetic variability and heritability among potato genotypes for growth and yield traits, aiming to identify promising genotypes for hybridization programmes to enhance yield potential (Kumar *et al.*, 2023) ^[10].

Materials and Methods

The present investigation was conducted during the *Rabi* season 2024-25 at the Main Experiment Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). Thirty-five potato genotypes were selected from the All India Coordinated Research Project (AICRP), Department of Vegetable Science, ANDUA&T, Kumarganj, Ayodhya. The experimental material was evaluated in Randomized Complete Block Design (RCBD) with three replications. Each genotype was planted in a plot of 3.0m × 2.4m, maintaining a spacing of 60 cm between rows and 20 cm between plants. Standard agronomic practices were followed. Observations were recorded on eighteen growth, yield and quality traits, namely Plant emergence (%), number of shoots per plant, number of compound leaves per plant, leaf length (cm), leaf width (cm), plant height (cm), tuber length (cm), tuber width (cm), average tuber weight (g), total soluble solids (°Brix), starch content (%), dry matter content (%), reducing sugar (%), non-reducing sugar (%), total sugar (%), tuber yield per plant (g), tuber yield per plot (kg) and total tuber yield (q/ha). Harvesting was carried out in February 2024 for the *Rabi* season. Statistical analysis was performed using analysis of variance (ANOVA) following the procedure described by Panse and Sukhatme (2000) ^[12] to determine the significance of differences among genotypes. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were estimated according to the method of Burton and DeVane (1953) ^[4]. Broad-sense heritability (h^2_{bs}) was computed following Hanson *et al.* (1956) ^[8], while genetic advance (GA) and genetic advance as per cent of mean were calculated using the methodology proposed by Johnson *et al.* (1955) ^[9] all performed using R statistical software (Rahman *et al.*, 2024) ^[14].

Results and Discussion

The analysis of variance (Table 1) revealed highly significant differences among the thirty-five potato genotypes for all eighteen traits studied, indicating the existence of substantial genetic variability in the experimental material. The mean sum of squares for genotypes exceeded the error mean squares, underscoring genetic influence over environmental factors. The presence of significant variation among genotypes suggests ample scope for selection and genetic improvement of tuber yield and associated traits in potato. Similar findings of significant genetic variability among potato genotypes have been documented by Hajam *et al.*, 2018 ^[7]; Kumar *et al.*, 2023 ^[10]; Aishwarya *et al.*, 2024 ^[1] and Singh *et al.*, 2024 ^[17].

The mean performance of thirty-five genotypes for eighteen characters is presented in Table 2. The estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for the eighteen characters are presented in Table 3. In general, PCV values were slightly higher than the corresponding GCV values for all traits, indicating the influence of environmental factors on trait expression. However, the narrow

disparities between GCV and PCV for most traits indicate that environmental effects were negligible and that observed variability was primarily due to genetic factors. High estimates (>20%) of both GCV and PCV were observed for reducing sugar (53.59% and 66.32%), non-reducing sugar (52.71% and 64.59%), total sugar (52.84% and 58.94%) and average tuber weight (21.81% and 22.59%), indicating significant genetic variability for these traits. Moderate estimates (10-20%) were recorded for tuber width (19.85% and 21.05%), total tuber yield (q/ha) (17.05% and 18.57%), tuber yield per plot (16.79% and 18.36%), tuber yield per plant (16.25% and 17.66%), tuber length (14.17% and 16.16%), total soluble solids (12.36% and 12.81%), plant height (11.13% and 12.36%) and starch content (10.58% and 11.00%). Low estimates were reported for dry matter content (9.40% and 9.91%), number of shoots per plant (9.30% and 10.95%), number of compound leaves (10.68% and 12.53%), leaf length (8.77% and 10.31%), leaf breadth (8.39% and 10.16%) and plant emergence (2.57% and 3.58%).

The broad-sense heritability estimates ranged from 51.56% for plant emergence to 93.25% for average tuber weight. Only plant emergence (51.56%) showed moderate heritability, while all other variables had high heritability values. Average tuber weight (93.25%), total soluble solids (93.08%), starch content (92.48%), dry matter content (89.91%), tuber width (88.91%), tuber yield per plant (84.68%), total tuber yield (84.24%), tuber yield per plot (83.70%), plant height (80.97%), total sugar (80.36%), tuber length (76.89%), number of compound leaves (72.62%), leaf length (72.23%), number of shoots per plant (72.06%), non-reducing sugar (66.60%) and reducing sugar (65.29%) all showed high heritability estimates. High heritability indicates that a large proportion of the observed variation in these traits is genetically controlled and less influenced by environmental factors. Similar findings were reported by Hajam *et al.*, 2018 ^[7]; Kumar *et al.*, 2023 ^[10] and Singh *et al.*, 2024 ^[18].

Genetic advance as a percentage of mean ranged from 3.80% for plant emergence to 97.57% for total sugar. High genetic advance (>20%) was observed for total sugar (97.57%), reducing sugar (89.21%), non-reducing sugar (88.61%), average tuber weight (43.39%), tuber width (38.55%), total tuber yield (32.23%), tuber yield per plot (31.65%), tuber yield per plant (30.81%), tuber length (25.59%), total soluble solids (24.56%), starch content (20.96%) and plant height (20.62%). Moderate genetic advance (10–20%) was recorded for number of compound leaves (18.75%), dry matter content (18.35%), number of shoots per plant (16.26%), leaf length (15.35%) and leaf breadth (14.29%), while plant emergence (3.80%) demonstrated low genetic advance.

High heritability coupled with high genetic advance as per cent of mean was observed for average tuber weight, tuber width, starch content, total soluble solids, tuber yield per plant, tuber yield per plot, total tuber yield, total sugar, non-reducing sugar and reducing sugar. This combination indicates the predominance of additive gene action governing these traits and suggests that direct phenotypic selection would be highly effective for their improvement. Similar results were reported by Hajam *et al.* (2018) ^[7], Kumar *et al.* (2023) ^[10] and Singh *et al.* (2024) ^[18]. Plant emergence showed moderate heritability but poor genetic advance, indicating that selection based on yield-contributing characteristics and quality metrics will be extremely useful for potato genetic development in Eastern Uttar Pradesh environments.

Table 1: List of potato genotypes/varieties used in the study

Genotypes/ Varieties	Source	Genotypes/ Varieties	Source
K. Arun	CPRI, Shimla	K. Sangam	CPRI, Shimla
K. Ashoka	CPRI, Shimla	K. Himalini	CPRI, Shimla
K. Bahar	CPRI, Shimla	K. Thar-3	CPRI, Shimla
K. Bhaskar	CPRI, Shimla	K. Lohit	CPRI, Shimla
K. Badami	CPRI, Shimla	K. Uday	CPRI, Shimla
K. Ganga	CPRI, Shimla	P-53	CPRI, Shimla
K. Jyoti	CPRI, Shimla	P-73	CPRI, Shimla
K. Tejas	CPRI, Shimla	K. Ratan	CPRI, Shimla
K. Neelkanth	CPRI, Shimla	K. Chip Bharat-1	CPRI, Shimla
K. Kesar	CPRI, Shimla	K. Jamunia	CPRI, Shimla
K. Pushkar	CPRI, Shimla	P-83	CPRI, Shimla
K. Pukhraj	CPRI, Shimla	P-101	CPRI, Shimla
K. Sindhuri	CPRI, Shimla	P-103	CPRI, Shimla
NDSP-24-1	A.N.D.U.A&T, Ayodhya	P-105	CPRI, Shimla
NDSP-24-2	A.N.D.U.A&T, Ayodhya	P-108	CPRI, Shimla
K. Mohan	CPRI, Shimla	P-116	CPRI, Shimla
Atlantic	CPRI, Shimla	K. Khayati	CPRI, Shimla
K. FryoM	CPRI, Shimla		

Table 2: Analysis of variance (mean squares) for eighteen characters in potato

Sl. No.	Traits D.f.	Source of variation		
		Replication	Genotypes/ varieties	Error
		2	34	68
1.	Plant emergence (%)	3.10	23.01**	5.49
2.	No. of shoots per plant	0.56	0.39**	0.04
3.	Number of compound leaves	33.01	103.09**	11.51
4.	Leaf length (cm)	4.89	4.75**	0.54
5.	Leaf width (cm)	0.02	1.22**	0.16
6.	Plant height (cm)	4.69	99.28**	7.21
7.	Tuber length (cm)	0.14	2.46**	0.22
8.	Tuber width (cm)	0.8	2.96**	0.12
9.	Average tuber weight (g)	0.32	532.72**	12.56
10.	Total soluble solids (°Brix)	0.04	1.56**	0.04
11.	Starch content (%)	0.48	9.76**	0.26
12.	Dry matter content (%)	0.46	9.64**	0.35
13.	Reducing sugar (%)	0.0002	0.10**	0.01
14.	Non-reducing sugar (%)	0.0006	0.40**	0.06
15.	Total sugar (%)	0.0006	0.82**	0.06
16.	Tuber yield per plant (g)	96.19	15210.65**	36.02
17.	Tuber yield per plot (kg)	0.53	36.02**	2.2
18.	Total tuber yield (q/ha)	90.48	5754.89**	33.77

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

Table 3: Estimates of mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in broad sense, genetic advance (GA) and GA in per cent of mean for eighteen characters in potato germplasm

Characters	Mean	Min.	Max.	GCV (%)	PCV (%)	Heritability (%)	GA% mean
Plant emergence (%)	94.06	88.14	97.66	2.57	3.58	51.56	3.80
No. of shoots per plant	3.66	2.82	4.40	9.30	10.95	72.06	16.26
Number of compound leaves	51.74	37.33	58.53	10.68	12.53	72.62	18.75
Leaf length (cm)	13.52	6.91	14.50	8.77	10.31	72.23	15.35
Leaf width (cm)	7.06	3.68	7.54	8.39	10.16	68.30	14.29
Plant height (cm)	49.79	30.18	58.81	11.13	12.36	80.97	20.62
Tuber length (cm)	6.10	2.49	7.21	14.17	16.16	76.89	25.59
Tuber width (cm)	4.91	1.47	5.68	19.85	21.05	88.91	38.55
Average tuber weight (g)	60.37	2.87	72.48	21.81	22.59	93.25	43.39
Total soluble solids (°Brix)	5.76	3.22	6.75	12.36	12.81	93.08	24.56
Starch content (%)	16.82	13.35	20.99	10.58	11.00	92.48	20.96
Dry matter content (%)	18.73	14.52	23.90	9.40	9.91	89.91	18.35
Reducing sugar (%)	0.31	0.10	0.72	53.59	66.32	65.29	89.21
Non-reducing sugar (%)	0.64	0.12	1.40	52.71	64.59	66.60	88.61
Total sugar (%)	0.95	0.25	1.91	52.84	58.94	80.36	97.57
Tuber yield per plant (g)	425.43	47.15	496.91	16.25	17.66	84.68	30.81
Tuber yield per plot (kg)	20.00	2.34	24.86	16.79	18.36	83.70	31.65
Total tuber yield (q/ha)	249.26	29.21	310.71	17.05	18.57	84.24	32.23

GCV: Genotypic co-efficient of variation, PCV: Phenotypic co-efficient of variation, h²: Heritability (broad sense), GA: Genetic advance, GAM: Genetic advance over percent mean.

Conclusion

The research revealed high genetic variability among thirty-five potato genotypes in Eastern Uttar Pradesh, with notable differences across eighteen growth, yield and quality parameters. The phenotypic coefficient of variation (PCV) was consistently higher than the genotypic coefficient of variation (GCV) for all traits; however, the narrow differences between PCV and GCV for most traits indicated that the observed variability was predominantly genetic in nature. High estimates of both GCV and PCV were recorded for average tuber weight, reducing sugar, non-reducing sugar and total sugar, reflecting substantial genetic variability and greater scope for improvement through selection. High heritability coupled with high genetic advance as per cent of mean for average tuber weight, tuber width, starch content, total soluble solids, tuber yield per plant, tuber yield per plot, total tuber yield, total sugar, non-reducing sugar and reducing sugar indicates the predominance of additive gene action. Therefore, direct phenotypic selection for these traits is likely to be highly effective and may be used in future potato improvement programmes in Eastern Uttar Pradesh.

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References

1. Aishwarya KR, Singh D, Pradeep SD, Mehta T, Singh K, Fandan R, *et al.* Genetic variability, heritability and genetic advance in morphological and biochemical traits of potato (*Solanum tuberosum* L.) genotypes. *Plant Archives*. 2024;24(2):583-590.
2. Allard RW. Principles of plant breeding. New York: John Wiley and Sons Inc.; 1960. 430 p.
3. Asefa G. Genetic variability studies in potato (*Solanum tuberosum* L.) genotypes in Bale Highlands, South Eastern Ethiopia. *Journal of Biology, Agriculture and Healthcare*. 2016;6:117-119.
4. Burton GW, DeVane EW. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agronomy Journal*. 1953;45:478-481.
5. Food and Agriculture Organization of the United Nations. FAOSTAT statistical database. Rome: FAO; 2025.
6. Ministry of Agriculture and Farmers Welfare. Final estimates of area and production of horticultural crops 2024-25. New Delhi: Government of India; 2025.
7. Hajam M, Khan SH, Bhat TA, Pararay EA, Rather AM, Hajam MA, *et al.* To estimate the phenotypic, genotypic variability, heritability (bs) and genetic advance for quantitative characters of potato. *The Pharma Innovation Journal*. 2018;7(7):346-350.
8. Hanson CH, Robinson HF, Comstock RE. Biometrical studies of yield in segregating populations of Korean lespezea. *Agronomy Journal*. 1956;48(6):268-272.
9. Johnson HW, Robinson HF, Comstock RE. Estimates of genetic and environmental variability in soybean. *Agronomy Journal*. 1955;41:314-318.
10. Kumar R, Prakash S, Singh J, Kumar S, Singh DB, Gautam P, *et al.* Assessment of genetic variability, heritability and genetic advance for quantitative traits in potato (*Solanum tuberosum* L.). *International Journal of Environment and Climate*. 2023;13(12):820-829.
11. Nath P, Swamy KRM. Textbook of vegetable crops. New Delhi: Dr. Rameshwar Singh; 2016. p. 280-282.
12. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. 4th ed. New Delhi: Indian Council of Agricultural Research; 2000. p. 187-197.
13. Qasim M, Khalid S, Naz A, Khan MZ, Khan SA. Effect of different planting systems on the yield of the potato crop in Kaghan Valley: A mountainous region of Pakistan. *Agricultural Science*. 2013;4(4):175-179.
14. Rahman A, Abdulla F, Hossain MM. Scientific data analysis with R: biostatistical applications. Boca Raton: Chapman and Hall/CRC; 2024.
15. Reddy BJ, Mandal R, Chakroborty M, Hijam L, Dutta P. A review on potato (*Solanum tuberosum* L.) and its genetic diversity. *International Journal of Genetics*. 2018;10(2):360-364.
16. Shekhawat GS. Potato production, utilization and marketing in India. *Journal of the Indian Potato Association*. 2001;28(2-4):34-36.
17. Singh J, Kumar D, Bhardwaj V, Sood S, Daroch RK. Biochemical profiling of tetraploid potato (*Solanum tuberosum*) genotypes. *Indian Journal of Agricultural Sciences*. 2024;94(10):1069-1074.
18. Singh J, Kumar D, Sood S, Bhardwaj V, Kumar R, Kumar S. Genetic variability and association studies for yield and its attributes in cultivated potato (*Solanum tuberosum* L.). *Vegetable Science*. 2024;51(1):148-153.
19. Tessema GL, Mohammed AW, Abebe DT. Genetic variability studies for tuber yield and yield attributes in Ethiopian released potato (*Solanum tuberosum* L.) varieties. *PeerJ*. 2022;10:e12860.
20. Zeleke AA, Getahun BB. Association and path coefficient analysis studies in potato (*Solanum tuberosum* L.) genotypes at Adet, Northwestern Ethiopia. *International Journal of Bio-resource and Stress Management*. 2024;15(6):1-14.