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GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN MORPHOLOGICAL AND BIOCHEMICAL TRAITS OF POTATO (*SOLANUM TUBEROSUM* L.) GENOTYPES

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ABSTRACT

This study aims to evaluate the genetic variability, heritability and genetic advance for fifteen morphological and biochemical traits related to productivity and quality in 32 genotypes of potatoes. The field experiment was conducted during the *rabi* season at the Vegetable Research Centre of GBPUAT, Pantnagar, Uttarakhand. Analysis of variance revealed that all the studied genotypes exhibited significant differences for various traits, indicating the presence of variability in the genotypes forall the studied traits. The highest PCV and GCV were recorded for weight loss of tuber 20 days after harvesting accompanied by plant height at 60 days after planting, number of tubers per plant, average weight of tuber per plant, tuber yield per plot and tuber yield kg per m^2 and protein content of tuber. Coefficient of variation estimates revealed that the magnitude of phenotypic variation was higher than the genotypic variation and the narrow difference between the phenotypic and genotypic coefficients of variation for all the traits under consideration indicates a higher genetic variability. The traits of plant height, number of tubers per plant, the average weight of tubers per plant, tuber yield per plot, and protein content of tubers have high heritability and high genetic advance. High heritability coupled with high genetic advance indicates that these yield components of potato genotypes can be improved through selection. This information is precious for breeders and their programs, as it can enhance the genetic diversity of potato genotypes and lead to the development of new, more productive lines and varieties.

Key words : Potato, Genetic variability, Coefficient variation, Yield, Genetic advance.

Introduction

The potato (*Solanum tuberosum* L.) is an important food crop for human populations and a significant source of nutrients (Aishwarya *et al*., 2024). Globally, it ranks fourth in importance as a strategic and economic crop, following wheat, rice, and corn (FAOSTAT, 2021). As global population expected to reach 10 billion by 2050, ensuring food security is a critical concern. Consequently, it is essential to substantially increase crop production to meet the growing global food demand (Ghosh *et al*., 2024). In 2019, China, India and Russia were the three leading countries in potato production. China produced 91,818,950 tons of potatoes, accounting for 24.78% of the world's total potato production. Similarly, India contributed 50,190,000 tons, accounting for 13.54% of the global potato production, while Russia produced 22,436,581 tons, representing 5.95% of global potato production. Collectively, these three countries accounted for over 44% of global potato production (FAOSTAT, 2019). India has emerged as the world's second-largest producer of potatoes, with a total production of 51.3 million tons from a cultivated area of 2.16 million hectares, achieving a productivity of 23.77 tons per hectare (FAOSTAT, 2022).

Genetic variability studies help in identify novel traits and genetic combinations that can enhance crop productivity, nutritional quality and resilience to stresses. By selecting genotypes with desirable traits (*e.g.*, high yield, disease resistance, drought tolerance), we can develop improved crop varieties that can contribute to food security (Spanoghe *et al*., 2022). Tuber yield is a polygenic trait. Breeding for genotypes solely based on tuber yield is not very effective. To enhance breeding efficiency, potato breeders must identify the traits contributing to the final yield (Dehari *et al*., 2024).

Genetic variability forms the fundamental prerequisite for any plant-breeding program to develop superior cultivars. The existence of genetic variation is a crucial factor for genetic improvement in plant breeding and plays a pivotal role in the utilization of germplasm in breeding programs (Kumar *et al*., 2023). Genetic parameters such as genotypic and phenotypic coefficients of variation, heritability, and genetic advance are key tools for dissecting total variability into heritable and non-heritable components. Genotypic and phenotypic coefficients of variation offer crucial insights into the level of variability present among genotypes (Likeng-Li-Ngue *et al*., 2023). Heritability refers to the degree to which a trait is inherited from one generation to the next. It measures how much of the observed variation in a trait is due to genetic factors. On the other hand, genetic advance represents the progress achieved through selective breeding. High values of both heritability and genetic advance across different yield components suggest promising prospects for selecting highly productive genotypes (Sahu *et al*., 2023). This combination implies a strong genetic influence on trait expression and substantial potential for improvement through selection cycles. By leveraging these genetic parameters effectively, breeders can identify and prioritize genotypes with superior performance, thereby enhancing agricultural productivity (Dragov *et al*., 2022). This study aims to evaluate the genetic variability, heritability, and genetic advance for fifteen morphological and biochemical traits related to productivity and quality in 32 genotypes of potatoes.

Materials and Methods

The field experiment was conducted during the *rabi* season of 2017-2018, at the Vegetable Research Centre of GBPUAT, Pantnagar, Uttarakhand. The study involved 32 diverse potato genotypes, along with three checks (Table 1), maintained at the Vegetable Research Centre. The experiment was conducted in a randomized block design with three replications. Each plot consisted of twenty tubers of uniform size per genotype, planted with a spacing of 60 cm between rows and 20 cm within rows.

Table 1 : List of potato (*Solanum tuberosum* L.) genotypes under study.

S. no.	Genotype	Source
1	K. Surya	CPRI, Shimla
2	P-29	CPRI, Shimla
3	PH-3	CPRI, Shimla
4	C-8	CPRI, Shimla
5	P-33	CPRI, Shimla
6	P-11	CPRI, Shimla
7	P-7	CPRI, Shimla
8	P-12	CPRI, Shimla
9	P-14	CPRI, Shimla
10	K.Sindhuri	CPRI, Shimla
11	C-17	CPRI, Shimla
12	C-20	CPRI, Shimla
13	P-9	CPRI, Shimla
14	P-22	CPRI, Shimla
15	C-15	CPRI, Shimla
16	C-28	CPRI, Shimla
17	K.Khyati	CPRI, Shimla
18	P-25	CPRI, Shimla
19	P-23	CPRI, Shimla
20	P-30	CPRI, Shimla
21	P-31	CPRI, Shimla
22	P-40	CPRI, Shimla
23	P-27	CPRI, Shimla
24	C-14	CPRI, Shimla
25	MM-11	CPRI, Shimla
26	P-34	CPRI, Shimla
27	C-6	CPRI, Shimla
28	K.Lalit	CPRI, Shimla
29	P-4	CPRI, Shimla
30	K.Puskar	CPRI, Shimla
31	K.Frysona	CPRI, Shimla
32	P-15	CPRI, Shimla

Observations were taken on various growth parameters, biochemical parameters, and yield-related traits from five randomly chosen plants within each plot across all replications. The average values from these five plants were used for further statistical analyses. During the study, recommended cultural practices, agronomic operations and plant protection measures were undertaken.

The following observations were recorded: plant emergence percentage at 30 days after planting, plant height at 60 days after planting, tuber girth, tuber length, number of tubers per plant, average weight of tuber yield per plant and total tuber yield per plot, tuber dry matter, total soluble solids (TSS), specific gravity, ascorbic acid, and protein. Standard statistical procedures were employed to conduct the analysis of variance (Cocharan and Cox, 1957), genotypic and phenotypic coefficients of variation (Burton, 1952; Johnson *et al*., 1995), heritability (Johnson *et al*., 1995; Hanson *et al*., 1956), and genetic advance (Johnson *et al*., 1995; Lush, 1940).

Results and Discussion

In this study analysis of variance was performed on fifteen characters for thirty-two genotypes. Analysis of variance revealed that all the studied genotypes exhibited significant differences for various traits studied (Table 2), indicating the presence of variability in the genotypes for all the studied traits.

Table 2 : Analysis of variance (ANOVA) for tuber yields and its component.

S. no.	Characters	Mean sum of squares		
		Replication (2)	Germplasm/ Treatment (31)	Error (62)
1	Plant emergence per cent at 30 DAP	7.125	4.833**	2.264
2	Number of branches per plant	1.397	7.242**	0.631
3	Plant height at 60 DAP (cm)	1.168	306.860**	18.532
4	Tuber girth (cm)	0.360	6.723**	0.349
5	Tuber length (cm)	0.263	6.115**	0.190
6	Number of tubers per plant	0.182	7.856**	0.300
7	Average weight of tuber per plant (g)	722.500	23,716.090**	548.133
8	Tuber yield per plot (Kg)	2.586	85.378**	1.974
9	Tuber yield (Kg per m^2)	0.345	1.162**	0.027
10	Tuber dry matter (%)	3.395	17.490**	0.215
11	Specific gravity of tuber (g per cm^3)	0.202	0.004**	0.000
12	Total soluble solid of tuber (%)	0.488	1.079**	0.013
13	Ascorbic acid content of tuber (mg/100g)	0.955	11.725**	0.486
14	Protein content of tuber (%)	0.581	0.471**	0.017
15	Weight loss of tuber at 20 DAH (%)	2.020	8.709**	1.324

The performance of thirty-two potato genotypes for fifteen traits is summarized in Table 3. The lowest percentage of plant emergence (93%) was recorded in genotype P-14, whereas the genotypes P-25 and C-15 had the highest plant emergence percentage (98 %). The number of branches per plant varied from a minimum value of (8.11) in C-6 to a maximum value of 13.78 in C-8. Plant height (60 days after planting) varied from a minimum value of 17 cm in P-12 to a maximum value of 53.33 cm in Kufri Khyati. Tuber girth across the potato genotypes ranged from the lowest value of 12.23 in Kufri Puskar to the highest value of 19.70 in P-29. Tuber length was minimum (7.10 cm) in Kufri Puskar and maximum (12.49 cm) in C-28. Genotype P-12 had a minimum (2.62), and genotype P-14 had a maximum (10.79) number of tubers per plant. Average tuber weight per plant ranged from the lowest value of 81.67g (P-12) to the highest value of 504.50g (C-28). Tuber yield per plot ranged from 4.90 kg in P-12 to 30.27 kg in C-28. Genotype Kufri Khyati had the minimum tuber dry matter content (13.87%) and maximum tuber dry matter content (22.83%) was in C-20. The specific gravity of the tuber ranged from 1.03 g/cm^3 in Kufri Puskar, P-33 and P-7 to 1.23 g/cm^3 in C-14. The genotype Kufri frysona exhibits the lowest total soluble solid content (4.51%) and highest total soluble solid content (7%) observed in P-12. C-28 has the lowest ascorbic acid content in the tuber (16.48 mg/100g), whereas Kufri Lalit has the highest ascorbic acid content (23.03 mg/100g) in the tuber. Genotype C-28 has the lowest protein content in the tuber (1.08%) and maximum protein content (2.53%) found in P-25. Additionally, P-11 has the highest weight loss of the tuber (20 days after harvesting), while P-4 has the lowest weight loss. Numerous researchers have identified significant differences among genotypes in various morphological and biochemical traits (Kumar *et al*., 2023; Likeng-Li-Ngue *et al*., 2023; Sahu *et al*., 2023; Dragov *et al*., 2022).

Breeders need to assess variability using parameters like the phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h^2 bs%) and genetic advance (GA%). Therefore, studying the genetic variability of tuber yield components among potato genotypes is crucial for selecting desired genotypes to enhance yield and improve other agronomical characteristics. In order to identify traits with significant variability, it is crucial to analyse both PCV and GCV (Zeleke *et al*., 2021). The coefficients of variation only account for the overall variation of the trait and cannot distinguish between heritable and non-heritable traits (Basavaraj *et al*., 2017).

Table 4 presents the findings regarding PCV and GCV. The values for the phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were classified as low (<10%), moderate (10-20%) and high (>20%) according to Sivasubramanian and Menon (1973). The highest PCV was recorded for weight loss of tuber 20 days after harvesting (36.97 %)

Table 3 : Mean performance of 32 genotypes of potato (*Solanum tuberosum* L.) for fifteen characters.

S. no.	Genotypes	Plant emergence per cent at 30 DAP	Number of branches per plant at 45 DAP	Plant height at 60 DAP (cm)	Tuber girth (cm)	Tuber length (cm)	Number of tubers per plant	Average weight of tuber per plant (g)	Tuber yield per plot (Kg)	Tuber yield (Kg per m^2)	Tuber dry matter (%)	Specific gravity of tuber (g/cm^3)	Total soluble solid of tuber (%)	Ascorbic acid content (mg/ 100g)	Protein percentage of tuber	Weight loss of tuber (%)
1	K.Surya	96.33	10.67	31.00	15.62	12.11	5.98	355.89	21.35	2.49	19.07	1.08	4.92	20.43	2.45	2.74
2	P-29	96.67	11.33	17.67	19.70	10.67	5.43	323.67	19.42	2.27	15.83	1.05	6.07	21.33	2.30	2.54
3	PH-3	95.00	9.22	40.33	16.58	10.74	5.54	304.22	18.25	2.13	20.53	1.09	5.19	20.70	1.75	3.37
4	C-8	94.33	13.78	34.33	15.54	11.12	5.40	286.56	17.19	2.01	21.50	1.13	5.40	17.10	1.65	3.41
5	P-33	96.33	13.56	35.33	15.67	8.11	3.30	181.78	10.91	1.27	18.20	1.03	5.06	22.63	1.72	6.94
6	P-11	94.33	11.00	29.67	16.16	10.62	4.05	236.44	14.19	1.66	18.70	1.08	5.01	17.83	1.76	8.52
7	P-7	96.33	9.78	19.00	14.53	7.29	4.76	260.11	15.61	1.82	18.07	1.03	6.00	20.90	2.22	3.34
8	P-12	95.00	9.67	17.00	15.93	8.77	2.62	81.67	4.90	0.57	16.30	1.04	7.00	21.12	1.37	3.06
9	P-14	93.00	10.56	29.67	13.71	7.84	10.79	337.78	20.27	2.36	19.67	1.06	4.82	18.51	2.40	3.56
10	K.Sinduri	95.33	11.33	40.33	16.51	8.71	6.25	330.07	19.80	2.31	21.72	1.07	6.07	18.07	1.47	6.72
11	C-17	94.67	9.67	19.00	15.90	9.74	7.84	437.22	26.23	3.06	14.25	1.07	5.04	18.93	1.42	3.32
12	C-20	94.33	8.89	46.33	15.33	10.71	4.97	435.64	26.14	3.05	22.83	1.09	5.28	18.32	1.39	5.06
13	P-9	96.33	8.78	19.00	18.27	10.01	7.80	433.56	26.01	3.03	17.77	1.06	4.96	17.10	1.71	6.07
14	P-22	97.00	10.56	27.67	14.56	8.69	6.47	360.84	21.65	2.53	15.83	1.06	5.20	19.31	1.65	4.73
15	C-15	98.00	11.00	45.67	15.90	7.81	5.22	327.89	19.67	2.30	20.11	1.09	5.38	19.27	1.85	2.76
16	C-28	96.00	13.78	44.00	18.39	12.49	4.13	504.50	30.27	3.53	21.02	1.05	6.02	16.48	1.08	6.67
17	K.Khyati (Check)	97.00	12.78	53.33	17.89	11.28	7.25	482.73	28.96	3.38	13.87	1.09	5.38	18.36	2.17	2.60
18	P-25	98.00	11.22	44.00	17.54	10.57	5.90	421.89	25.31	2.95	17.70	1.05	6.00	22.00	2.53	6.47
19	P-23	96.00	10.56	43.00	15.38	10.64	4.63	400.00	24.00	2.80	19.46	1.08	5.90	19.07	1.55	7.63
20	P-30	94.00	9.89	26.00	15.67	9.93	5.69	333.84	20.03	2.34	17.30	1.08	5.07	17.30	1.87	3.32
21	P-31	96.00	9.11	21.00	14.57	8.02	3.76	326.00	19.56	2.28	21.41	1.05	6.38	16.91	1.78	4.60
22	P-40	97.00	9.00	19.33	13.01	7.97	5.38	217.84	13.07	1.52	18.60	1.08	6.02	16.83	1.69	4.42
23	P-27	95.00	11.78	27.33	15.12	8.40	4.95	316.29	18.98	2.21	20.28	1.06	6.00	17.10	1.86	5.05
24	C-14	96.67	8.78	20.67	16.07	9.20	7.50	422.56	25.35	2.96	22.50	1.23	6.07	19.50	2.17	4.02
25	MM-11	95.00	10.00	29.67	15.54	10.36	5.51	300.07	18.00	2.10	21.17	1.05	5.00	17.25	1.72	6.43
26	P-34	95.00	10.22	31.00	17.03	10.78	4.47	307.60	18.46	2.15	20.66	1.10	6.58	20.12	1.33	5.07

Table 3 continued...

Table 3 continued...

27	C-6	94.67	8.11	19.33	16.22	10.28	5.94	369.00	22.14	2.58	16.97	1.05	6.02	16.70	1.18	6.36
28	K.Lalit	95.00	9.00	26.33	16.36	8.38	6.56	422.33	25.34	2.96	16.09	1.07	5.03	23.03	2.25	4.59
29	P-4	95.33	9.67	40.33	15.43	8.27	4.50	303.83	18.23	2.13	19.43	1.06	6.00	20.44	2.51	1.21
30	K.Puskar (Check)	95.33	8.22	28.33	12.23	7.10	8.51	384.51	23.07	2.69	15.50	1.03	4.82	21.25	1.69	4.40
31	K.Frysona (Check)	93.33	8.89	24.00	16.30	8.57	6.17	434.89	26.09	3.04	20.57	1.05	4.51	22.80	2.22	4.36
32	P-15	97.67	8.89	36.67	15.94	10.31	5.67	311.17	18.67	2.18	16.20	1.12	5.42	17.82	1.51	4.18
	General mean	**95.62**	**10.30**	**30.82**	**15.89**	**9.55**	**5.71**	**342.26**	**20.54**	**2.40**	**18.72**	**1.07**	**5.55**	**19.20**	**1.82**	**4.61**
	Sem±	**0.869**	**0.459**	**2.485**	**0.341**	**0.252**	**0.316**	**13.517**	**0.811**	**0.948**	**0.268**	**0.712**	**0.646**	**0.403**	**0.751**	**0.664**
	CD at 5%	**2.456**	**1.30**	**7.026**	**2.456**	**1.30**	**7.026**	**38.212**	**2.293**	**0.268**	**0.756**	**0.201**	**0.183**	**1.138**	**0.212**	**1.878**

accompanied by plant height at 60 days after planting (32.81%), number of tubers per plant (28.31%), average weight of tuber per plant, tuber yield per plot and tuber yield kg per m^2 (25.98%) and protein content of tuber (21.79%). Moderate PCV was noticed for the traits *viz.*, number of branches per plant (15.09%), tuber length (14.95%), dry matter content of tuber (12.90%), total soluble solid content of tuber (10.80%) and ascorbic acid content of tuber (10.30%). Whereas, low PCV was observed in the traits *viz.*, tuber girth (9.41%), the specific gravity of tuber (3.41%) and plant emergence % 20 days after planting (1.33%).

High magnitude of genotypic coefficient of variation (GCV) was noticed for weight loss of tuber 20 days after harvesting (36.07%) accompanied by plant height at 60 days after planting (31.81%), number of tubers per plant (27.76%), average weight of tuber per plant and tuber yield per plot (25.68%), tuber yield kg per m^2 (25.67%) and protein content of tuber (21.40%). Moderate GCV was recorded for characters like tuber length (14.72%), number of branches per plant (14.41%), dry matter content of tuber (12.82%), total soluble solid content of tuber (10.74%), ascorbic acid content of tuber (10.08%). Whereas, low GCV was observed in the traits *viz.*, tuber girth (9.17%), the specific gravity of tuber (3.35%) and plant emergence % 20 days after planting (0.97%). In the present study coefficient of variation estimates revealed that the magnitude of phenotypic variation was higher than the genotypic variation for all the characters. It was a result of the impact of the environment on their expression (Dragov *et al.*, 2022). Conversely, most of the PCV values for the characteristics were similar to the corresponding GCV values, indicating minimal environmental influence on their expression (Kumar *et al.*, 2023). Similar results for the studies traits also observed by Seid *et al.* (2020), Zeleke *et al.* (2021), Annigeri and Hiremath (2022), Anoumaa *et al.* (2022) and Gebreselassie (2023).

Heritability assessment serves as a predictive tool to measure the reliability of phenotypic values. The heritability values, as presented in Table 4 were classified by Johnson *et al.* (1995) as low (<30%), moderate (30-60%) and high (>60%). The broad-sense heritability ranges from 16.10% to 96.08%, with most of the studied traits exhibiting high heritability. In the present study, high estimates of heritability are observed for the traits: dry matter content of tuber and total soluble solid content of tuber (99%), the average weight of tuber per plant, tuber yield per plot, and tuber yield kg per m^2 (98%), tuber length (97%), number of tubers per plant, specific gravity of tuber (96%), ascorbic acid content of tuber and protein

Table 4 : Estimates of genetic parameters of variation for tuber yield and its attributing traits in potato.

Character	Range		Coefficient of variation (%)			Heritability in broad sense (h^2) %	Genetic advance % of mean	
	Minimum	Maximum	Phenotypic	Genotypic	Environmental			
Plant emergence per cent (30 DAP)	93.00	98.00	1.33	0.97	1.57	53	1.45	1.86
Number of branches per plant	8.11	13.78	15.09	14.41	7.71	91	28.36	36.35
Plant height at 60 DAP (cm)	17.00	53.33	32.81	31.81	13.97	94	63.51	81.39
Tuber girth (cm)	12.23	19.70	9.41	9.17	3.72	95	18.40	23.57
Tuber length (cm)	7.10	12.49	14.95	14.72	4.56	97	29.85	38.26
Number of tubers per plant	2.62	10.79	28.31	27.76	9.58	96	56.08	71.87
Average weight of tuber per plant(g)	81.67	504.50	25.98	25.68	6.84	98	52.28	67.00
Tuber yield per plot (Kg)	4.90	30.27	25.98	25.68	6.84	98	52.28	67.00
Tuber yield (Kg per m^2)	0.57	3.53	25.98	25.67	6.85	98	52.27	66.99
Tuber dry matter (%)	13.87	22.83	12.90	12.82	2.48	99	26.24	33.63
Specific gravity of tuber (g/cm^3)	1.03	1.23	3.41	3.35	1.57	96	6.77	8.67
Total soluble solid content of tuber (%)	4.51	7.00	10.80	10.74	2.02	99	22.00	28.19
Ascorbic acid content of tuber (mg per 100g)	16.48	23.03	10.30	10.08	3.63	96	20.33	26.05
Protein per cent of tuber (%)	1.08	2.53	21.79	21.40	7.15	96	43.28	55.46
Weight loss of tuber at 20 DAH (%)	1.21	8.52	36.97	36.07	14.03	95	72.49	92.9

content of tuber (96%), weight loss of tuber 20 days after harvesting and tuber girth (95%), plant height 60 days after planting (94%) and number of branches per plant (91%). Moderate heritability is observed for the parameter plant emergence % 30 days after planting (53%). High heritability facilitates effective selection for specific traits. When heritability values are high, it indicates that the expression of traits is primarily influenced by genotype rather than environmental factors. Breeders can use this information to select individual plants and employ selection methods based on the phenotypic manifestations of these traits. Our result is aligning with those of Khan *et al.* (2021), Rohit *et al.* (2022), Narayan *et al.* (2022), Hunde *et al.* (2022) Rathore *et al.* (2022) and Singh *et al.* (2023).

Genetic advance refers to enhancing the average genotypic value of chosen plants compared to the parental population. The estimates of Genetic advance as a percentage of mean values classified (Johnson *et al.*, 1995) into low (<10%), moderate (10-20%) and high (>20%). In the current investigation, the highest estimates of genetic advance, expressed as a percentage of the mean, were recorded for several traits: weight loss of tuber at 20 days after harvesting (72.49%), plant height 60 days after planting (63.51%), number of tubers per plant (56.08%), average weight of tuber per plant (52.28%), tuber yield per plot (52.28%), tuber yield kg per m^2 (52.27%) and protein content of tuber (43.28%). The high value in the genetic advance as a percentage of the mean observed across these traits, indicates the influence of additive genes on their expression. It suggests that selective breeding efforts targeting these traits could yield substantial improvements, thereby enhancing overall trait performance and quality.

The traits such as tuber length (29.85%), number of branches per plant (28.36%) and dry matter content of tuber (26.24%) showed moderate genetic advances. It suggests that these traits were governed by both additive and non-additive gene effects. On the other hand, the lowest genetic advance as a percentage of the mean was recorded for parameters like total soluble solid content of tuber (22%), ascorbic acid content of tuber (20.33%), tuber girth (18.40%), specific gravity of tuber (6.77%) and plant emergence 30 days after planting (1.45%). It indicates the presence of non-additive gene effects for these traits. Similar findings are also reported by Luthra *et al.* (2018), Narasimhamurthy *et al.* (2018), Prajapati *et al.* (2020), Gadissa *et al.* (2020), Tessema *et al.* (2022) and Zanzam *et al.* (2023).

The combination of high heritability and high genetic advance indicates that a trait is controlled by additive gene effects, allowing for effective selection (Singh and Narayanan, 1993). The traits plant height, number of tubers per plant, the average weight of tubers per plant, tuber yield per plot and protein content of tubers have high heritability and high genetic advance. Tuber length, number of branches per plant and dry matter content of tuber coupled high heritability and moderate genetic advance. Therefore, these traits are governed by additive gene effects, making it possible to conduct effective genotype selection based on phenotype. In consideration of the above results, similar findings were also supported by other researchers are Hunde *et al.* (2022), Rathore *et al.* (2022), Tessema *et al.* (2022), Singh *et al.* (2023) and Zanzam *et al.* (2023).

Conclusion

The analysis of variance revealed that all the studied genotypes exhibited significant differences for various traits under study. The coefficient of variation estimates indicated that phenotypic variation was greater than genotypic variation for all traits, highlighting the influence of the environment. Traits such as plant height, number of tubers per plant, average weight of tubers per plant, tuber yield per plot, and protein content of tubers coupled with high heritability and high genetic advance. Meanwhile, tuber length, number of branches per plant and dry matter content of tubers coupled with high heritability and moderate genetic advance. These findings suggest that these traits are governed by additive genetic effects, enabling effective genotype selection based on phenotype. High heritability coupled with high or moderate genetic advance (GA) % indicates that these yield components of potato genotypes can be improved through selection. This information is highly valuable for breeders and their programs, as it can enhance the genetic diversity of potato genotypes and lead to the development of new, more productive lines and varieties.

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