International Journal of Advanced Biochemistry Research 2025; SP-9(10): 1414-1421

International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(10): 1414-1421
www.biochemjournal.com
Received: 01-07-2025
Accepted: 05-08-2025

Yamini Pritam
M.Sc. Scholar, Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, India

Dr. Pravin Kumar Sharma
Principal Scientist, Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, India

Dr. Vandana Yadav
Technical Assistant, Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, India

Corresponding Author:
Yamini Pritam
M.Sc. Scholar, Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, India

Studies on genetic variability and interrelationship of yield and yield attributing traits in processing genotypes of potato (*Solanum tuberosum* L.) at different harvesting dates under Chhattisgarh condition

Yamini Pritam, Pravin Kumar Sharma and Vandana Yadav

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i10Sr.6027

Abstract
The present study was carried out during the Rabi season of 2024-25 at the Research and Instructional Farm, College of Agriculture, IGKV, Raipur under AICRP-Potato. 13 genotypes, including three checks (Kufri Chipsona-1, Kufri Surya and Kufri Khyati), were evaluated in a randomized block design with three replications at 75 and 90 days after planting (DAP). Data on 15 agronomic traits were recorded to assess genetic variability, heritability and genetic advance for yield-associated traits. Significant genotypic differences were observed for most traits, with phenotypic variation exceeding genotypic variation, indicating moderate environmental influence.
At 75 DAP, dry weight of tubers plant^{-1} showed the highest PCV (36.15%) and GCV (34.76%), while at 90 DAP, dry weight of shoots plant^{-1} exhibited the highest PCV (37.00%) and GCV (35.84%). High heritability was observed for fresh weight of shoots plant^{-1}, dry weight of tubers plant^{-1} and dry weight of shoots plant^{-1} at 75 DAP, whereas at 90 DAP it was recorded for fresh weight of shoots plant^{-1}, dry weight of shoots plant^{-1} and marketable tuber yield (t ha^{-1}).
Tuber yield was positively correlated with number of leaves plant^{-1}, number of compound leaves plant^{-1}, dry and fresh tubers weight plant^{-1} at 75 DAP, while at 90 DAP it was associated with dry and fresh tubers weight plant^{-1}, number of primary branches plant^{-1} and plant height. Path analysis revealed that fresh weight tubers plant^{-1}, plant emergence and tuber girth had the strongest direct effects at 75 DAP, whereas dry weight of tubers plant^{-1}, number of leaves plant^{-1} and number of primary branches plant^{-1} were most influential at 90 DAP. These traits provide guidance for selecting promising high-yielding genotypes based on their phenotypic performance, as they are minimally influenced by the environment, with potential for future improvement in potato.

Keywords: Potato, quantitative traits, genetic variability, GCV, PCV, genetic advance correlation, path coefficient analysis, different harvesting intervals

Introduction

Vegetable crops play a crucial role in Indian agriculture, providing food, nutrition and economic support, as well as raw materials for processing industries (Anonymous, 2024) [2]. Potato (*Solanum tuberosum* L.) known as "the king of vegetables," it is a vital temperate crop widely cultivated in subtropical regions due to its high yield and utility (Lee *et al.*, 2021; Masoodi, 2009) [4, 17]. Cultivated potato genotypes are tetraploid (2n = 4x = 48), while wild species show ploidy variations including diploid, triploid, tetraploid, pentaploid and hexaploid forms (Lee *et al.*, 2021) [4]. Originating in the Andes of Peru and Bolivia, potatoes were introduced to India in the early 17th century and are now grown across diverse latitudes and altitudes. Propagation is mainly vegetative, though true potato seeds (TPS) are also used (Patil *et al.*, 2016) [23].

Globally, potato is the fourth most important staple food, rich in carbohydrates, proteins, vitamins, minerals and dietary fiber (Singh and Rana, 2013) [26]. A potato tuber contains 75-80% water and 20-25% dry matter, comprising protein (2.8 g), starch (16.3 g), sugars (0.6 g), fiber (0.5 g), fat (0.14 g), carbohydrates (22.6 g), vitamin C (25 mg), ash (1-1.5%), amylose (22-25%) and glycoalkaloids (<1 mg/100 g) per 100 g fresh weight. India is the second largest producer, with major cultivation in Uttar Pradesh, West Bengal, Bihar, Gujarat and other states (Anonymous, 2024) [3]. Optimal growth requires low day temperatures, high light intensity, short-day photoperiods and well-drained loamy soils (Swarup, 2012) [32].

Rising demand for processed products such as French fries, chips and dried potatoes highlights the need for high-quality and high-yielding genotypes (Rana *et al.*, 2010) [26]. Evaluating morphological, yield and quality traits is essential, as traits like dry matter, starch content and reducing sugars determine processing efficiency and product quality (Marwaha and Sandhu, 2002) [16]. Correlation and path coefficient analyses help identify key traits for selection and genetic improvement.

This study aims to evaluate processing potato genotypes to identify superior genotypes with high yield and desirable processing qualities, providing insights for breeders, farmers and the processing industry, thereby supporting sustainable production.

Materials and Methods

Study Framework

The experiment was carried out during the *Rabi* season of 2024-25 at the Research and Instructional Farm, Department of Vegetable Science, College of Agriculture, IGKV, Raipur (21°16′ N, 81°26′ E; 289.56 msl), located in the"Chhattisgarh Plains." The region receives 1200-1400 mm annual rainfall, predominantly during June-September, with occasional light showers in October-February. Temperatures ranged from 10.3 °C to 32.7 °C, relative humidity varied between 20 and 89%, sunshine duration was 3.2-9.5 h/day and mean open pan evaporation and vapour pressure were 2.9-24.9 mm/day and 6.1-15.7 mm Hg, respectively.

The experiment was laid out in a Randomized Block Design (RBD) with three replications and a plot size of 3 m × 3 m. Thirteen potato genotypes—AICRP-P-92, AICRP-P-107, AICRP-P-108, AICRP-P-106, AICRP-FF-04, AICRP-P-57, AICRP-P-77, AICRP-P-94, Kufri Chipsona 1, Kufri Surya, Kufri Khyati, Kufri Kiran and Kufri Ganga—were obtained from the All India Coordinated Research Project on Potato, CPRI, Shimla.

Seed tubers were treated with Dithane M-45 @ 25 g L^{-1} for 20 min to prevent fungal infection and dried under shade before planting. Well-sprouted tubers were planted on ridges with 60 cm inter-row spacing and 20 cm intra-row spacing on 21st November 2024. Fully decomposed FYM @ 20 t ha^{-1} was incorporated before planting and fertilizers were applied at 150:100:100 kg NPK ha^{-1}, with P and K and half of N as basal and the remaining N applied in two splits at 30 and 45 days after planting. The intercultural operations were done timely to raise a good crop. Observations on yield and yield-contributing traits were recorded from five randomly selected plants $plot^{-1}$ and tubers were harvested at two different intervals, 75 and 90 days after planting i.e. on 25th Feburary 2025 and 6th March 2025, to evaluate genotypic performance and yield.

Observations Recorded

13 Genotypes of potato were evaluated for different characters viz., plant emergence%, plant height, number of compound leaves $plant^{-1}$, number of leaves $plant^{-1}$, number of shoots $plant^{-1}$, fresh weight of shoots $plant^{-1}$, dry weight of shoots $plant^{-1}$, number of tubers $plant^{-1}$, tuber length, tuber girth, fresh weight of tubers $plant^{-1}$, dry weight of tubers $plant^{-1}$, marketable tuber yield ha^{-1}, unmarketable tuber yield ha^{-1} and total tuber yield ha^{-1}.

Statistical Analysis

The data were analyzed to estimate genotypic and phenotypic variations, coefficients of variation, broad-sense heritability, genetic advance and genotypic correlation coefficients, using the formula suggested by Johnson *et al.* (1955) [12] and Al-Jibouri *et al.* (1958) [1]. Path coefficient analysis was carried out according to Dewey and Lu (1959) [11]. All statistical analyses were performed using OPSTAT software.

Results and Discussion

A wide range of variability was observed among the genotypes, indicating the presence of diverse genetic materials that could be effectively utilized for yield improvement and its contributing traits through suitable breeding strategies. Monsang *et al.* (2010) [18] also highlighted significant variation among potato genotypes for yield and related traits. The phenotypic and genotypic coefficients of variation, heritability, genetic advance and genetic advance as a percentage of mean were estimated for all fifteen characters, as presented in Tables 1 and 2.

The estimates of phenotypic and genotypic variances were found to be very high (*i.e.* >20%) at 75 DAP for dry weight of tubers $plant^{-1}$ (34.76 and 36.15%, respectively), dry weight of shoots $plant^{-1}$ (33.73 and37.50%, respectively), fresh weight of shoots $plant^{-1}$ (33.45 and 34.31%, respectively), unmarketable tuber yield t ha^{-1} (29.42% and 31.71%, respectively), marketable tuber yield t ha^{-1} (22.10% and 23.95%, respectively), plant height (21.03% and 23.33%, respectively).

While, at 90 DAP, high magnitude were observed for dry weight of shoots $plant^{-1}$ (35.84 and 37.00%, respectively), fresh weight of shoots $plant^{-1}$ (31.99 and 2.97%, respectively), unmarketable tuber yield t ha^{-1} (24.54% and 25.57%, respectively), number of primary branches $plant^{-1}$ (21.77% and 23.86%, respectively), marketable tuber yield t ha^{-1} (20.97% and 22.30%, respectively).

Estimates of heritability revealed the highest values for traits such as fresh weight of shoots $plant^{-1}$ (95.07%), dry weight of tubers $plant^{-1}$ (92.4%), dry weight of shoots $plant^{-1}$ (90.8%), tuber girth (90.6%) and marketable tuber yield t ha^{-1} (85.2%) at 75 DAP. Similarly, at 90 DAP, the highest heritability was observed for fresh weight of shoots $plant^{-1}$ (94.15%), dry weight of shoots $plant^{-1}$ (93.82%), marketable tuber yield t ha^{-1} (88.42%) and plant height (87.59%).

At 75 DAP, relatively low heritability was recorded for traits such as tuber length (44.89%), number of compound leaves $plant^{-1}$ (41.70%), plant emergence% (40.40%) and number of leaves $plant^{-1}$ (15.50%).

Similarly, at 90 DAP, low heritability estimates were observed for fresh weight of tubers $plant^{-1}$ (47.72%), tuber girth (46.43%), tuber length (44.91%), number of compound leaves $plant^{-1}$ (36.19%) and number of leaves $plant^{-1}$ (24.82%), indicating a greater influence of environmental factors on the expression of these traits.

Similar observations were also reported by Patel *et al.* (2018) [22], Nasiruddin *et al.* (2014) [19], Pradhan *et al.* (2011) [25], Ummyiah *et al.* (2010) [33], Ara *et al.*, (2009) [5, 6], Chandrakar (2007) [9] and Basavaraj *et al.*, (2005) [8] in their experiment.

Genetic advance as a percentage of mean reflects the potential improvement over the population mean through selection, thereby indicating the effectiveness of selection for specific traits. In the present study, values ranged from 0.85% to 71.51%. At 75 DAP, high GAM was recorded for dry weight of shoots plant^{-1} (70.13%), dry weight of tubers plant^{-1} (68.84%), fresh weight of shoots plant^{-1} (67.19%), unmarketable tuber yield t ha^{-1} (56.23%) and marketable tuber yield t ha^{-1} (42.03%).

Similarly, at 90 DAP, the highest estimates were observed for dry weight of shoots plant^{-1} (71.51%), fresh weight of shoots plant^{-1} (63.94%), unmarketable tuber yield t ha^{-1} (40.94%) and marketable tuber yield t ha^{-1} (40.61%). These high values suggest predominance of additive gene action, indicating that selection for these traits would be highly effective. High GAM values coupled with high heritability (as observed in the present study) suggest that direct selection would lead to substantial improvement in these characters.

At 75 DAP, Low GAM was recorded for fresh weight of tubers plant^{-1} (24.31%), total tuber yield t ha^{-1} (20.70%), number of tubers plant^{-1} (19.80%), number of compound leaves plant^{-1} (12.66%), tuber length (10.32%), plant emergence (2.37%) and number of leaves plant^{-1} (0.95%).

while at 90 DAP, it was observed for total tuber yield t ha^{-1} (24.12%), fresh weight of tubers plant^{-1} (16.90%), tuber length (12.70%), tuber girth (12.45%), number of tubers plant^{-1} (11.29%), number of compound leaves plant^{-1} (10.64%), plant emergence (7.58%) and number of leaves plant^{-1} (1.63%). This indicates the presence of non-additive gene effects.

Similar results were also reported by Singh (2008) [29] and Barik *et al.*, (2007) [7] in their experiment.

Table 1: Estimates of genetic parameters of variation for tuber yield and its attributing traits in potato at 75 DAp

			Coefficient of Variation			Genetic	Genetic
					Heritability	Advance	Advance%
S. No.	Parameters	Mean	Genotypic	Phenotypic	(H2b)%	K = 20.6	of mean
1	Plant emergence%	95.32	1.81	2.84	40.41	2.26	2.37
2	Plant height (cm)	59.15	21.03	23.33	81.20	20.05	39.03
3	No. of primary branches plant^{-1}	6.66	19.02	22.26	73.01	2.23	33.48
4	No. of compound leaves plant^{-1}	45.66	9.52	14.75	41.67	5.78	12.66
5	No. of leaves plant^{-1}	311.01	1.17	2.98	15.46	2.95	0.95
6	Fresh wt. of shoots plant^{-1}	213.88	33.45	34.31	95.07	143.71	67.19
7	Dry wt. of shoots plant^{-1}	30.60	33.73	37.50	90.78	21.46	70.13
8	No. of tubers plant^{-1}	7.97	11.88	14.67	65.59	1.58	19.82
9	Tuber length	6.14	7.48	11.16	44.89	0.63	10.32
10	Tuber girth	4.43	9.62	10.10	90.60	0.84	18.86
11	Fresh wt. of tubers plant^{-1}	336.83	13.68	15.86	74.40	81.89	24.31
12	Dry wt. of tubers plant^{-1}	98.98	34.76	36.15	92.44	68.14	68.84
13	Marketable tuber yield (t/ha)	14.61	22.10	23.95	85.20	6.14	42.03
14	Unmarketable tuber yield (t/ha)	6.89	29.42	31.71	86.08	3.88	56.23
15	Total tuber yield (t/ha)	22.45	13.04	16.90	59.52	4.65	20.73

Table 2: Estimates of genetic parameters of variation for tuber yield and its attributing traits in potato at 90 DAP

			Coefficient of Variation			Genetic	Genetic
					Heritability	Advance	Advance%
S. No.	Parameters	Mean	Genotypic	Phenotypic	(H2b)%	K = 20.6	of mean
1	Plant emergence%	93.19	4.42	5.32	69.11	7.06	7.58
2	Plant height (cm)	62.39	16.24	17.35	87.59	19.53	31.30
3	No. of primary branches plant^{-1}	6.71	21.77	23.86	83.29	2.75	40.93
4	No. of compound leaves plant^{-1}	48.26	8.59	14.27	36.19	5.14	10.64
5	No. of leaves plant^{-1}	315.34	1.59	3.19	24.82	5.15	1.63
6	Fresh wt. of shoots plant^{-1}	242.87	31.99	32.97	94.15	155.29	63.94
7	Dry wt. of shoots plant^{-1}	30.12	35.84	37.00	93.82	21.54	71.51
8	No. of tubers plant^{-1}	8.77	8.38	12.82	42.72	0.99	11.29
9	Tuber length	6.43	9.20	13.73	44.91	0.82	12.70
10	Tuber girth	4.84	8.87	13.02	46.43	0.60	12.45
11	Fresh wt. of tubers plant^{-1}	385.44	11.88	17.20	47.72	65.15	16.90
12	Dry wt. of tubers plant^{-1}	124.11	17.44	21.52	65.70	36.15	29.12
13	Marketable tuber yield (t/ha)	18.98	20.97	22.30	88.42	7.71	40.61
14	Unmarketable tuber yield (t/ha)	6.01	22.54	25.57	77.72	42.74	40.94
15	Total tuber yield (t/ha)	25.70	13.27	15.03	77.88	6.20	24.12

Correlation coefficient analysis serves as an important statistical approach to evaluate the strength and direction of relationships among different traits. The associations between various yield-contributing characters and total yield were analyzed at both phenotypic (P) and genotypic (G) levels, as presented in Tables 3 and 4. The character-wise correlation results were interpreted separately for genotypic and phenotypic levels. The findings revealed that phenotypic correlation coefficients were generally higher than their corresponding genotypic values, suggesting that most of the observed associations among traits were more influenced by environmental factors than by inherent genetic relationships.

At 75 DAP, total tuber yield (t ha^{-1}) exhibited a positive and significant association at both genotypic and phenotypic levels with number of leaves plant^{-1} (0.998 and 0.467), number of compound leaves plant^{-1} (0.976 and 0.471), dry weight of tubers plant^{-1} (0.897 and 0.800), fresh weight of tubers plant^{-1} (0.812 and 0.757), number of primary branches plant^{-1} (0.788 and 0.549), plant emergence percentage (0.677 and 0.340) and fresh weight of shoots plant^{-1} (0.357 and 0.344). Additionally, number of tubers plant^{-1} showed a positive and significant correlation with total tuber yield (t ha^{-1}) only at the phenotypic level (0.461). In contrast, tuber length displayed a negative association with total tuber yield (t ha^{-1}) at the phenotypic level (-0.1085) only.

At 90 DAP, total tuber yield (t ha^{-1}) maintained a positive and significant relationship at both genotypic and phenotypic levels with dry weight of tubers plant^{-1} (0.7991 and 0.620), fresh weight of tubers plant^{-1} (0.7479 and 0.810), number of primary branches plant^{-1} (0.5504 and 0.646), plant height (0.5372 and 0.555), number of compound leaves plant^{-1} (0.4692 and 0.444), number of leaves plant^{-1} (0.4683 and 0.519), fresh weight of shoots plant^{-1} (0.3425 and 0.317) and plant emergence percentage (0.3302 and 0.491). Moreover, tuber girth (0.504) and number of tubers plant^{-1} (0.4613) showed a significant positive association only at the genotypic level. However, tuber length exhibited a negative correlation with total tuber yield (t ha^{-1}) at both genotypic and phenotypic levels (-0.1062 and-0.0465), respectively.

These findings are consistent with the reports of Singh *et al.* (2015) [31], Darabad *et al.* (2014) [10], Ummyiah *et al.* (2013) [34], Barik (2007) [7], Sattar *et al.* (2007) [27] and Patel *et al.* (2002) [20].

Table 3: Phenotypic coefficient (PVC) and Genotypic (GCV) of correlation for tuber yield and its attributing traits in potato at 75 DAP

Characters		1	2	3	4	5	6	7	8	9	10	11	12	13
1	G		0.491*	0.443*	0.602**	0.431*	0.562**	0.476*	-0.1529	-0.635**	-0.508**	0.678**	0.1637	0.677**
	P		0.318*	0.2362	0.3051	0.3003	0.383*	0.342*	0.2128	0.1553	0.1634	0.2453	0.472*	0.340*
2	G			0.484*	0.986**	0.347*	0.578**	0.592**	0.1603	-0.243	0.1935	0.720**	0.633**	0.612**
	P			0.2974	0.567**	0.2808	0.548**	0.505*	0.451*	-0.2028	0.447*	0.619**	0.719**	0.555**
3	G				0.633**	0.698**	0.617**	0.480*	0.2307	0.2027	-0.1362	0.912**	0.843**	0.788**
	P				0.404*	0.450*	0.384*	0.2836	0.2208	0.0169	0.0906	0.633**	0.504*	0.549**
4	G					0.464*	0.570**	0.522**	0.0023	-0.1413	0.346*	0.845**	0.832**	0.976**
	P					0.366*	0.442*	0.357*	0.371*	-0.0341	0.2676	0.523**	0.594**	0.471*
5	G						-0.1449	-0.3103	0.708**	-0.1523	-0.0745	0.996**	0.822**	0.998**
	P						0.2927	0.2155	0.2641	0.0141	0.0241	0.450*	0.395*	0.467*
6	G							0.907**	-0.2362	-0.518**	-0.329*	0.418*	0.143	0.357*
	P							0.856**	-0.0302	-0.1891	0.0573	0.358*	0.366*	0.344*
7	G								-0.2744	-0.520**	-0.2428	0.309	0.228	0.2833
	P								-0.048	-0.0339	0.183	0.3041	0.328*	0.3032
8	G									0.447*	0.1741	0.391*	0.633**	0.3155
	P									-0.252	0.339*	0.556**	0.606**	0.461*
9	G										0.865**	-0.0819	0.319*	0.0209
	P										0.0215	0.1536	0.087	-0.1085
10	G											0.447*	0.556**	0.3071
	P											0.520**	0.607**	0.504*
11	G												0.924**	0.812**
	P												0.826**	0.757**
12	G													0.897**
	P													0.800**
13	G													
	P													

*Significant at 5% level of significance, ** Significant at 1% level of significance

1 = Plant emergence%	7 = Dry weight of shoots plant^{-1} (g)
2 = Plant height (cm) at 65 DAS	8 = No. of tubers plant^{-1}
3 = No. of primary branches plant^{-1}at 65 DAS	9 = Tuber length (cm)
4 = No. of compound leaves plant^{-1} at 65 DAS	10 = Tuber girth (cm)
5 = No. of leaves plant^{-1}at 65 DAS	11 = Fresh weight of tubers plant^{-1} (g)
6 = Fresh weight of shoots plant^{-1} (g)	12 = Dry weight of tubers plant^{-1} (g)
13 = Total Yield (t/ha)	

Table 4: Phenotypic coefficient (PVC) and Genotypic (GCV) of correlation for tuber yield and its attributing traits in potato at 90 DAP

Characters		1	2	3	4	5	6	7	8	9	10	11	12	13
1	G		0.2692	0.2336	0.284	0.2802	0.3645	0.3413*	0.2007	0.1684	0.1591	0.2558	0.4474*	0.3302*
	P		0.399*	0.328*	0.251	0.3002	0.450*	0.392*	-0.0375	-0.2943	-0.337*	0.518**	0.1753	0.491*
2	G			0.2799	0.5652*	0.2631	0.544	0.4833*	0.4438*	-0.2137	0.4361*	0.5549**	0.7096**	0.5372*
	P			0.412*	0.513**	0.1512	0.499*	0.524**	0.1472	-0.2032	0.1649	0.439*	0.476*	0.555**
3	G				0.4005*	0.4531	0.3805	0.2864	0.2212	0.0205	0.0919	0.632**	0.5022**	0.5504**
	P				0.410*	0.335*	0.555**	0.463*	0.1603	-0.0057	-0.0177	0.525**	0.575**	0.646**
4	G					0.3623	0.4428*	0.3534	0.3715*	-0.0385	0.2667	0.5019*	0.5945**	0.4692*
	P					0.2624	0.329*	0.367*	0.1969	-0.0621	0.1176	0.352*	0.378*	0.444*
5	G						0.289	0.2177	0.2654	0.0151	0.0268	0.6559**	0.3953*	0.4683**
	P						-0.0758	-0.11	0.451*	0.0187	-0.0145	0.535**	0.2984	0.519**
6	G							0.8519*	-0.0297	-0.1913	0.0568	0.343*	0.3665*	0.3425*
	P							0.846**	-0.1544	-0.362*	-0.2379	0.2521	0.1574	0.317*
7	G								-0.0478	-0.0292	0.1837	0.3093	0.3259	0.3047
	P								-0.1455	-0.339*	-0.129	0.2029	0.1315	0.2204
8	G									-0.2523	0.339*	0.5442**	0.6061**	0.4613*
	P									0.1017	0.1273	0.1974	0.1376	0.2658
9	G										0.0222	-0.1357	-0.0897	-0.1062
	P										0.2609	0.0571	0.2548	-0.0465
10	G											0.5123**	0.6061**	0.504*
	P											-0.011	0.219	0.098
11	G												0.8043**	0.7479**
	P												0.629**	0.810**
12	G													0.7991**
	P													0.620**
13	G													
	P													

*Significant at 5% level of significance, ** Significant at 1% level of significanc

1 = Plant emergence%	7 = Dry weight of shoots plant^{-1} (g)
2 = Plant height (cm) at 65 DAS	8 = No. of tubers plant^{-1}
3 = No. of primary branches plant^{-1}at 65 DAS	9 = Tuber length (cm)
4 = No. of compound leaves plant^{-1} at 65 DAS	10 = Tuber girth (cm)
5 = No. of leaves plant^{-1}at 65 DAS	11 = Fresh weight of tubers plant^{-1} (g)
6 = Fresh weight of shoots plant^{-1} (g)	12 = Dry weight of tubers plant^{-1} (g)
13 = Total Yield (t/ha)	

Table 5: Genotypic path coefficient showing direct and indirect effects of different characters on tuber yield in potato at 75 DAP

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.508	0.250	0.225	0.306	0.219	0.286	0.242	-0.078	-0.323	-0.258	0.345	0.083	0.677**
2	-0.272	-0.553	-0.268	-0.546	-0.192	-0.320	-0.328	-0.089	0.135	-0.107	-0.398	-0.350	0.612**
3	0.059	0.064	0.133	0.084	0.092	0.082	0.064	0.031	0.027	-0.018	0.121	0.112	0.788**
4	0.106	0.173	0.111	0.176	0.082	0.103	0.092	0.004	-0.025	0.061	0.199	0.181	0.976**
5	-0.017	-0.013	-0.026	-0.018	-0.038	0.006	0.012	-0.027	0.006	0.003	-0.037	-0.039	0.998**
6	-0.010	-0.010	-0.011	-0.010	0.003	-0.017	-0.015	0.004	0.009	0.006	-0.007	-0.003	0.357*
7	0.024	0.030	0.025	0.027	-0.016	0.046	0.051	-0.014	-0.027	-0.013	0.016	0.012	0.284
8	-0.013	0.013	0.019	0.001	0.059	-0.020	-0.023	0.083	0.037	0.015	0.032	0.052	0.316
9	0.052	0.021	-0.017	0.012	0.013	0.043	0.043	-0.037	-0.083	-0.072	0.007	-0.026	0.021
10	-0.162	0.062	-0.043	0.110	-0.024	-0.105	-0.077	0.056	0.275	0.319	0.142	0.177	0.307
11	0.295	0.313	0.397	0.493	0.433	0.182	0.134	0.171	-0.036	0.194	0.435	0.402	0.812**
12	0.049	0.191	0.254	0.312	0.312	0.044	0.069	0.191	0.096	0.168	0.279	0.302	0.897**

*Significant at 5% level of significance, ** Significant at 1% level of significance

Residual value-0.191

1 = Plant emergence%	7 = Dry weight of shoots plant^{-1} (g)
2 = Plant height (cm) at 65 DAS	8 = No. of tubers plant^{-1}
3 = No. of primary branches plant^{-1}at 65 DAS	9 = Tuber length (cm)
4 = No. of compound leaves plant^{-1} at 65 DAS	10 = Tuber girth (cm)
5 = No. of leaves plant^{-1}at 65 DAS	11 = Fresh weight of tubers plant^{-1} (g)
6 = Fresh weight of shoots plant^{-1} (g)	12 = Dry weight of tubers plant^{-1} (g)
13 = Correlation coefficient with Total tuber Yield (t/ha)	

Table 6: Genotypic path coefficient showing direct and indirect effects of different characters on tuber yield in potato at 90 DAP

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13
1	-0.026	-0.007	-0.007	-0.008	-0.007	-0.009	-0.009	-0.005	-0.004	-0.004	-0.007	-0.012	0.330*
2	-0.014	-0.052	-0.015	-0.030	-0.014	-0.028	-0.025	-0.023	0.011	-0.023	-0.029	-0.037	0.537**
3	0.031	0.038	0.135	0.053	0.061	0.051	0.038	0.030	0.003	0.012	0.084	0.067	0.550**
4	-0.013	-0.024	-0.017	-0.043	-0.015	-0.019	-0.015	-0.016	0.002	-0.011	-0.021	-0.025	0.469*
5	0.044	0.042	0.072	0.058	0.158	0.046	0.034	0.042	0.002	0.004	0.072	0.063	0.468*
6	0.006	0.008	0.006	0.007	0.004	0.015	0.013	-0.001	-0.003	0.001	0.005	0.006	0.343*
7	0.010	0.015	0.009	0.011	0.007	0.026	0.030	-0.002	-0.001	0.005	0.009	0.010	0.305
8	-0.005	-0.011	-0.006	-0.010	-0.006	0.001	0.002	-0.025	0.006	-0.009	-0.014	-0.016	0.462*
9	-0.011	0.014	-0.001	0.003	-0.001	0.013	0.002	0.017	-0.066	-0.002	0.009	0.011	-0.107
10	0.021	0.057	0.012	0.035	0.004	0.008	0.024	0.044	0.003	0.130	0.067	0.080	0.504**
11	0.030	0.063	0.072	0.057	0.052	0.039	0.035	0.062	-0.015	0.058	0.114	0.091	0.748**
12	0.255	0.404	0.286	0.339	0.226	0.209	0.186	0.345	-0.051	0.345	0.458	0.570	0.799**

*Significant at 5% level of significance, ** Significant at 1% level of significance
Residual value-0.242

1 = Plant emergence%	7 = Dry weight of shoots plant^{-1} (g)
2 = Plant height (cm) at 65 DAS	8 = No. of tubers plant^{-1}
3 = No. of primary branches plant^{-1}at 65 DAS	9 = Tuber length (cm)
4 = No. of compound leaves plant^{-1} at 65 DAS	10 = Tuber girth (cm)
5 = No. of leaves plant^{-1}at 65 DAS	11 = Fresh weight of tubers plant^{-1} (g)
6 = Fresh weight of shoots plant^{-1} (g)	12 = Dry weight of tubers plant^{-1} (g)
13 = Correlation coefficient with Total tuber Yield (t/ha)	

Path analysis was conducted considering total yield as the dependent variable and all other traits as independent variables. The direct and indirect influences of tuber yield and its associated traits in potato are summarized in Table 5 and 6, providing a comprehensive understanding of trait contributions.This analysis partitions the overall correlation into components reflecting the direct and indirect contributions of each trait. The path coefficient technique proposed by Wright (1921) [35] serves as a powerful statistical approach to differentiate and evaluate the specific causal factors underlying observed correlations.

At 75 DAP, the highest positive direct effects on total tuber yield were recorded for plant emergence per cent (0.5083), followed by fresh weight of tubers plant^{-1} (0.4348), tuber girth (0.3186), dry weight of tubers plant^{-1} (0.3017), number of compound leaves plant^{-1} (0.1752), number of primary branches plant^{-1} (0.1323), number of tubers plant^{-1} (0.0825) and dry weight of shoots plant^{-1} (0.0509). Negative direct effects were observed via plant height (−0.5533), tuber length (−0.0827), number of leaves plant^{-1} (−0.0376) and fresh weight of shoots plant^{-1} (−0.0169).

Plant emergence per cent showed strong positive indirect effects on total tuber yield through fresh weight of tubers plant^{-1} (0.3448), number of compound leaves plant^{-1} (0.3062), fresh weight of shoots plant^{-1} (0.2855), plant height (0.2496) and dry weight of shoots plant^{-1} (0.2421), while negative effects were observed via tuber length (−0.3229), tuber girth (−0.258) and number of tubers plant^{-1} (−0.0777). Plant height had a positive indirect effect through tuber length (0.1345) but negative effects via number of compound leaves plant^{-1} (−0.5453), dry weight of tubers plant^{-1} (−0.3504) and fresh and dry weights of shoots plant^{-1} (−0.3198 and −0.3277).

Number of primary branches plant^{-1} exerted positive indirect effects through fresh and dry weights of tubers plant^{-1} (0.1206 and 0.1115) and number of leaves plant^{-1} (0.0923), while a minor negative effect occurred via tuber girth (−0.018). Number of compound leaves plant^{-1} showed positive indirect effects through fresh and dry weights of tubers plant^{-1} (0.1986 and 0.1809) and plant height (0.1727), with a slight negative effect via tuber length (−0.0248). Number of leaves plant^{-1} exhibited minor positive effects through dry weight of shoots plant^{-1} (0.0117) and tuber length (0.0057), but negative effects through dry and fresh weights of tubers plant^{-1} (−0.0389 and −0.0374). Fresh and dry weights of shoots plant^{-1} had positive indirect effects via plant height (0.0301) and fresh weight of tubers plant^{-1} (0.0157), while negative effects were observed through tuber length (−0.0265).

Number of tubers plant^{-1} contributed positive indirect effects through number of leaves plant^{-1} (0.0584), dry weight of tubers plant^{-1} (0.0523) and tuber length (0.0369), with negative effects via dry and fresh weights of shoots plant^{-1} (−0.0227 and −0.0195). Tuber length and tuber girth showed positive indirect effects through plant emergence per cent (0.0525 and −0.1617), fresh weight of tubers plant^{-1} (0.0068 and 0.1423) and dry weight of tubers plant^{-1} (0.043 and 0.1771), but negative effects via each other (−0.0715 and −0.3229).

Overall, fresh and dry weights of tubers plant^{-1} exhibited the strongest positive indirect effects on total tuber yield through number of compound leaves plant^{-1} (0.4927 and 0.3114), number of leaves plant^{-1} (0.4332 and 0.3122), plant height (0.3128 and 0.1911) and tuber girth (0.1942 and 0.1677), indicating their major contribution to total tuber yield.

At 90 DAP, the highest positive direct effects on total tuber yield were recorded for dry weight of tubers plant^{-1} (0.5696), followed by number of leaves plant^{-1} (0.1581), number of primary branches plant^{-1} (0.1334), tuber girth (0.1304), fresh weight of tubers plant^{-1} (0.1135), dry weight of shoots plant^{-1} (0.0207) and fresh weight of shoots plant^{-1} (0.0150). Negative direct effects were observed via tuber length (−0.0662), plant height (−0.0514), number of compound leaves plant^{-1} (−0.0425), plant emergence per cent (−0.0255) and number of tubers plant^{-1} (−0.0250).

Plant emergence per cent showed slight positive indirect influence through other traits and negative effects through shoot and tubers weight plant^{-1} traits. Plant height had a positive indirect effect through tuber length (0.0110) but negative effects through dry weight of tubers plant^{-1} (−0.0365) and number of compound leaves plant^{-1} (−0.0291).

Number of primary branches plant^{-1} positively influenced total tuber yield through fresh and dry weights of tubers (0.0843 and 0.0670), number of leaves (0.0605) and other growth traits, whereas number of compound leaves plant^{-1} had mostly negative indirect effects. Number of leaves plant^{-1} exhibited positive indirect effects mainly via fresh and dry weights of tubers plant^{-1} (0.0721 and 0.0625) and other associated characters. Fresh and dry weights of shoots plant^{-1} also showed positive indirect effects through each other (0.0256 and 0.0128) and through plant height and foliage traits.

Number of tubers plant^{-1} showed positive indirect effects through tuber length (0.0063) but negative ones through dry and fresh weights of tubers. Tuber length had a small positive indirect influence via plant height (0.0141), while tuber girth displayed notable positive indirect effects through dry (0.0790) and fresh weights of tubers (0.0668). Fresh and dry weights of tubers plant^{-1} exerted the strongest positive indirect effects on total tuber yield through plant height (0.4042), tuber girth (0.3453), number of compound leaves (0.3386) and related characters.

Path analysis indicated that plant emergence per cent, dry and fresh weights of tubers plant^{-1}, tuber girth, number of compound leaves plant^{-1}, number of primary branches plant^{-1}, number of tubers plant^{-1} and dry weight of shoots plant^{-1} had strong positive direct effects and significant correlations with total tuber yield at both 75 and 90 DAP. Negative direct effects were observed for plant height, tuber length, number of leaves plant^{-1} and fresh weight of shoots plant^{-1}. However, their overall contribution remained positive due to substantial indirect effects through traits such as fresh and dry weights of tubers, plant height, tuber girth and foliage-related characters. Among the indirect contributors, fresh and dry weights of tubers plant^{-1}, number of leaves plant^{-1}, number of compound leaves plant^{-1}, and plant height exerted the strongest poitive influence on total tuber yield at both growth stages. The genotypic residual effects were minimal (0.191 at 75 DAP and 0.242 at 90 DAP), indicating that the majority of variation in total tuber yield was effectively explained by the traits included in this study. These results highlight the key growth and yield components that significantly enhance total tuber production, emphasizing the importance of both direct and indirect trait contributions across the growth period.

These results are in strong agreement with the observations of Lamboro *et al.* (2014) [15], Ummyiah *et al.* (2013) [34], Khayatnezhad *et al.* (2011) [13], Ara *et al.* (2009) [5, 6], Sattar *et al.* (2007) [27], Patel *et al.* (2002) [20] and Rajkumar *et al.* (2000) [24].

Conclusion

The present study revealed considerable variability among the genotypes for various growth and yield-attributing traits. Genotype AICRP-P-57 exhibited the highest total and marketable tuber yield, while AICRP-P-94, AICRP-P-77 and AICRP-P-106 also performed well for specific yield-related traits. Genotypes AICRP-P-57, AICRP-P-94 and AICRP-P-77 were particularly promising at both 75 and 90 DAP, displaying superior yield-associated characteristics and offering potential for use in breeding programs alongside other high-yielding genotypes to enhance productivity.

At 90 DAP genotypes are giving higher yield as compared to 75 DAP. High GCV, PCV, heritability and genetic advance were observed for traits such as of fresh and dry wt. of tubers plant^{-1}, no. of tubers plant^{-1}, dry wt. of shoots plant^{-1}, no. of compound leaves plant^{-1} and marketable yield t ha^{-1}, indicating the predominance of additive gene action and the effectiveness of direct selection. Overall, traits like fresh and dry tuber weight plant^{-1}, plant height and number of leaves plant^{-1} can serve as key selection criteria for future yield improvement.

Future Suggestions

Evaluating these genotypes under diverse agro-climatic conditions across India to identify stable and high-yielding lines for varietal improvement. Promising and distinct genotypes can be utilized as donor parents in hybridization programs, while molecular markers (e.g., SSRs, SNPs) may assist in identifying genes associated with superior yield and quality traits. Furthermore, exploring untested regions of India for potential genotypes and prioritizing traits with strong positive associations, high heritability and substantial genetic advance will be essential for enhancing tuber yield in future breeding programs.

Acknowledgement

The authors express their sincere gratitude to Dr. Brajesh Singh, Director and Project Coordinator, ICAR-Central Potato Research Institute, Shimla and Dr. Jagdev Sharma, Head of Crop Production, ICAR-Central Potato Research Institute, Shimla, along with their team, for their invaluable support, guidance and for providing the seed material and essential facilities for this study.

References

1. Al-Jibouri HA, Miller P, Robinson HF. Genotypic and environmental variation and correlation in upland cotton cross of interspecies origin. Agron J. 1958;50:633-637.
2. Anonymous. National Horticulture Board, Department of Agriculture Cooperation and Farmers Welfare, Government of India. 2024.
3. Anonymous. Horticulture Statistics Division, Department of Agriculture Cooperation and Farmers Welfare, Government of India. 2024.
4. Anonymous. Horticulture Statistics Division, Ministry of Agriculture and Farmers' Welfare, Government of India. 2024.
5. Ara T, Haydar A, Islam MA, Azad MAS, Khokan EH. Path analysis in potato. Journal of Soil and Nature. 2009;3(2):20-23.
6. Ara T, Hayder A, Islam MA, Khokan EH, Khalequzzaman MM. Studies on genetic variability, correlation and path analysis in potato. Int J Sustainable Agric Res. 2009;5(5):40-44.
7. Barik SB. Genetic diversity in potato (*Solanum tuberosum* L.) (M.Sc. Thesis). Indira Gandhi Krishi Vishwavidyalaya, Raipur, C.G.; 2007. p. 54.
8. Basavaraj N, Nay KR, Naik KS, Gayatri GN. Genetic variability studies in potato (*Solanum tuberosum* L.). Potato J. 2005;32(3-4):233-256.
9. Chandrakar A. Genetic analysis of clonal hybrids (C1 progenies) for tuber yield and its components in potato

(*Solanum tuberosum* L.) (M.Sc. Thesis). Indira Gandhi Krishi Vishwavidyalaya, Raipur, C.G.; 2007.
10. Darabad GR. Study the relationships between yield and yield components of potato varieties using correlation, regression and causality analysis. Int J Plant Anim Environ Sci. 2014;4(2):584-589.
11. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron J. 1959;5:515-518.
12. Johnson HW, Robinson HF, Comstock RE. Estimates of genetic and environmental variability in soybean. Agron J. 1955;47:314-318.
13. Khayatnezhad M, Shahriari R, Gholamin R. Correlation and path analysis between yield and yield components in potato (*Solanum tuberosum* L.). Middle-East J Sci Res. 2011;7(1):17-21.
14. Lee KJ, Sebastin R, Cho GT, Yoon M, Lee GA, Hyun DY. Genetic diversity and population structure of potato germplasm in RDA-Gene bank: Utilization for breeding and conservation. Plants. 2021;10(4):752.
15. Lamboro A, Petros Y, Andargie M. Correlation and path coefficient analysis between yield and yield components in potato (*Solanum tuberosum* L.). Plant Sci Today. 2014;1(4):196-200.
16. Marwaha RS, Sandhu SK. Yield, growth components and processing quality of potatoes as influenced by crop maturity under short and long days. Adv Hortic Sci. 2002;16(2):79-87.
17. Masoodi UH, Khan SH, Jabeen N, Hussain K, Nazir J. Evaluation of various potato (*Solanum tuberosum* L.) genotypes for quality traits. Environ Ecol. 2009;28(2):947-949.
18. Monsang TL, Sarkar KK, Mandal AB, Dewanjee S. Genetic assessment on some important traits in potato with their correlation. Environ Ecol. 2010;28:259-261.
19. Nasiruddin M, Haydar FMA, Islam AKMR, Hossain MM. Study of genetic variability and correlation of potato (*Solanum tuberosum* L.) genotypes grown in Bangladesh. Plant Environ Dev. 2014;3(2):9-13.
20. Patel PB, Patel NH, Patel RN. Correlation and path analysis of some economic characters in potato. J Indian Potato Assoc. 2002;29(3/4):163-164.
21. Patel AB, Patel RN, Gami RA, Patel JA, Patel PC. Genetic variability among the potato (*Solanum tuberosum* L.) genotypes as affected by harvesting period for processing purpose and tuber yield. Curr Agric Res. 2018;6(3).
22. Patel AB, Patel RN, Gami RA, Patel PC, Patel JA. Trait association studies in potato (*Solanum tuberosum* L.) for processing purpose under two different harvesting periods. Int J Adv Biol Res. 2018;8(3):353-357.
23. Patil V, Sundaresha S, Kawar P, Bhardwaj V. Biology of *Solanum tuberosum* (Potato), Series of Crop-Specific Biology Documents. 2016.
24. Rajkumar Kang GS, Kumar R. Path coefficient and stability analysis in andegena potato (*Solanum tuberosum* subsp. *andegena* L.). Indian J Agric Sci. 2000;70:158-162.
25. Pradhan AM, Nandeshwar BC, Sarkar KK, Konar A. Estimation of genetic parameters and association of traits related to yield in potato (*Solanum tuberosum* L.). J Crop Weed. 2011;7(2):229-231.
26. Rana RK, Arun P, Pandey NK. Demand for processed potato products and processing quality potato tubers in India. Potato Res. 2010;53:181-197.
27. Sattar MA, Sultana N, Hossain MM, Rashid MH, Islam IKMA. Genetic variability, correlation and path analysis in potato (*Solanum tuberosum* L.). Bangladesh J Plant Breed Genet. 2007;20(1):33-38.
28. Singh SV, Marwaha RS, Kumar D, Kumar P, Pandey SK. Suitability of potato varieties grown in North-Eastern Indian plains for processing. Potato J. 2008;36(1-2):25-34.
29. Singh G. Studies on genetic variability, association and divergence in potato (*Solanum tuberosum* L.) (M.Sc. thesis). Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India; 2008. p. 61.
30. Singh S, Kaur SK. Suitability of potato varieties grown in North-Eastern Indian plains for processing. Potato J. 2009;36(1-2):25-34.
31. Singh P, Sharma PK, Banjara NC, Sahu NP, Sharma R. Variability, heritability, genetic advance, correlation and path analysis between yield and yield components in potato (*Solanum tuberosum* L.). Ecol Environ Conserv. 2015;21(2):1093-1097.
32. Swarup V. Vegetable science and technology in India. Kalyani Publishers, Ludhiana; 2012. p. 310, 541, 604-605.
33. Ummyiah HM, Khan SH, Wani KP, Hussain K, Junaif N. Genetic variability in potato (*Solanum tuberosum* L.). Asian J Hortic. 2010;5(1):61-63.
34. Ummyiah HM, Khan SH, Jabeen N, Junaif N, Hussain K. Inter-trait relationship and path analysis in potato. Prog Hortic. 2013;45(1):201-205.
35. Wright S. Correlation and causation. J Agric Res. 1921;20:557-585.