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Character association and path coefficient analysis between tuber yield and yield components in potato (*Solanum tuberosum* L.) genotypes

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Abstract
An experiment was conducted under All India Coordinated Research project on potato at Research cum Instructional form, Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.) during *Rabi* 2021-22 in split plot design with three replications. For this research, the experimental materials consisting of twenty potato genotypes including two check variety *viz*., Kufri Khyati and Kufri Chipsona-1 was conducted to determine the character association and path coefficient analysis to examine direct and indirect effect of each character on tuber yield. Significant and highest positive correlation was found between tuber yield plant^{-1} and number of tubers plant^{-1}, harvest index (%) and number of branches plant^{-1}. The genotypic correlations were higher than the corresponding phenotypic correlation for most of the character including the inherent association among the characters. Path analysis of tuber yield and its components shows that number of tuber plant^{-1}, harvest index and number of branches plant^{-1} exerted highest positive direct effect on tuber yield is recorded that their importance as selection index for yield improvement of potato.

Keywords: Correlation, path analysis, potato, genotypes

Introduction
Potato (*Solanum tuberosum* L.) belongs to the solanaceae family with chromosome number 2n=48. Potato known as "The king of vegetable" has emerged, as fourth most important food crop in India after rice, wheat and maize. Potato is a crop that has always been a "poor man's food".

Potato is one of the most important staple food crops among the vegetables; which is utilized throughout the year in India. Potato is a self-pollinated crop with a cross-pollination rate of up to 2.54% (Wang *et al*., 1994) [32].

The potato is a nutrient-rich food that includes minerals, proteins, carbs, vitamins C and B, high-quality dietary fibres, and phenolic compounds (Woolfe, 1987) [33]. A raw potato has a water content of roughly 79%, 17% carbohydrates (88% of which are starch), 2% protein, and little fat. 100 grammes of raw potatoes have 322 kilojoules (77 kilocalories) of energy. With no significant amounts of any other vitamins or minerals, this is a high source of vitamin B6 (23%) and vitamin C (24%) only.

In case of Chhattisgarh, potato is considered as an important commercial crop. It is mainly cultivated in some parts of Surguja, Balrampur, Jashpur, Raigarh, Bilaspur, and Raipur districts with a total area: 42.54 ha, Production: 651.48 million tones and Productivity: 15.32 kg ha^{-1} (Anonymous 2022) [1]. In the present, the cultivated area for the potato has increased but still, there is scope for more suitable cultivars for the agro climatic conditions of the State, therefore it is an urgent need to evolve the potato genotypes suitable for Chhattisgarh Plains.

Correlation studies provide an opportunity to study the magnitude and direction of association of yield with its components and among various components. Knowledge of correlations among different characteristics is fundamental to designing an effective breeding program in selecting the breeding materials for improving complex characters through indirect selection (Teklewold *et al*., 2000) [27]. Tuber yield is a complicated and economically important characteristic, yet it is coupled with several interconnected components (Tuncturk and iftci, 2005) [29-30]. Furthermore, tuber yield is a quantitative attribute that is the result of various directly or indirectly influencing factors.

Selection can play a vital role in reaching breeding goals since it has a considerable impact on crop improvement programmes (Al-Tabbal, 2016) [3]. The correlation coefficient is critical for determining the degree and direction of linkage between various characteristics that affect the yield favorably or negatively (Kumar *et al*., 2013) [15]. As correlation coefficients describe linkages in a simple way, path coefficients are vital for accumulating the best combination of yield contributing characters and understanding the implications of the interrelationships of numerous characters in a single genotype.

Path coefficient analysis reveals the magnitude of the causative components' direct and indirect impacts on the response component (Singh *et al*., 2004) [26]. In most route analysis studies, researchers used predictor characteristics as first-order variables, analysing their impacts on a dependent or response variable such as yield (Bhagowat and Saikia, 2003) [7].

Material and Methods

The research sample consisted of eighteen potato genotypes and two checks namely Kufri Khyati and Kufri Chipsona-1. The tuber of potato genotypes was collected from the All India Coordinated Research Project on Potato, Dept. of Genetic and Plant Breeding, College of Agriculture, IGKV, Raipur (C.G.). The number of genotypes used in experiment is listed in Table- 1. The research was conducted in split plot design with three replications. Each genotype was accommodated in five rows of 3 m length. The row to row spacing of 60 cm and plant to plant spacing of 20 cm was adopted. The recommended package of practices was followed Five plants were selected randomly from each replication and data were recorded for the characters *viz.,* plant emergence, plant height at maturity, number of leaves plant^{-1}, number of branches plant^{-1}, number of shoot plant^{-1}, dry matter content of shoot, number of tubers plant^{-1}, marketable tuber yield plant^{-1}, unmarketable tuber yield plant^{-1}, Tuber yield plant^{-1}, number of eye tuber^{-1}, Total tuber yield, Tuberization efficiency and harvest index.

Statistical analysis

Genotypic and phenotypic correlation coefficients were determined as described by Kwon and Torrie (1964). Path coefficient analysis was carried out using the phenotypic correlation coefficients as well as genotypic correlation coefficients to determine the direct and indirect effects of the yield components and other morphological characters on seed yield. Path coefficient analysis was also conducted to determine the direct and indirect effect of various traits on seed yield using the general formula of according to Wright (1921) [35] as elaborated by Dewey and Lu (1959) [8]. Residual effect measures the role of other possible independent variables that were not included in the study on the dependent variable. The residual effect was estimated using direct effects and simple correlation coefficients.

Results and Discussion

Phenotypic and genotypic correlation coefficient

Knowledge of the correlation between yield and its contributing features allows for the selection of an effective breeding strategy. The correlation coefficient at the phenotype and genotypic levels were developed in all possible combinations of yield components to evaluate the relationship between two characters. The coefficient of correlation among tuber yield per plant and its attributing character were in Table 2.

The result showed that the plant height at maturity (0.481, 0.517), number of leaves plant^{-1} (0.455, 0.483), number of branches plant^{-1} (0.561, 0.656), number of shoots plant^{-1} (0.502, 0.602), dry matter content of shoot (0.434, 486), number of tubers plant^{-1} (0.713, 0.790), number of eye tuber^{-1} (0.440, 0.577), tuberization efficiency (0.676, 0.723) and nitrogen use efficiency (0.521, 0.535) had a positive significant association with total tuber yield at both genotypic and phenotypic level, total tuber yield exhibited negative significant association with harvest index (-0.548, -0.577) at genotypic and phenotypic level. According to above finding it can be concluded that an increase in the number of tubers plant^{-1}, Number of shoots plant^{-1}, dry matter content of shoot, number of tubers plant^{-1}, number of eye tuber^{-1}, tuberization efficiency and nitrogen use efficiency will contribute to the greater yield of tuber in potato.

Plant emergence exhibited a positive significant association at phenotypic and genotypic level with number of leaves plant^{-1} (0.228, 0.257), number of shoots plant^{-1} (0.198), dry matter content of shoot (0.230, 0.255), number of tubers plant^{-1} (0.252, 0.271), number of eye tuber^{-1} (0.223, 0.292), tuberization efficiency (tuber: haulm ratio) (0.149, 0.166), nitrogen use efficiency (0.384, 0.416) and nitrate reductase activity (0.226, 0.247). It can be determined as plant with better emergence (%) is expected to possess taller plant, high value of harvest index more number of leaves, more number of shoots, Number of tubers plant^{-1}.

Plant Height at maturity revealed positive significant association with number of leaves plant^{-1} (0.492, 0.529), number of branches plant^{-1} (0.701, 0.807), number of shoots plant^{-1} (0.389, 0.478), dry matter content of shoot (0.266, 0.303), number of tubers plant^{-1} (0.561, 0.640), number of eye tuber^{-1} (0.389, 0.477), tuberization efficiency (tuber: haulm ratio) (0.407, 0.432), nitrogen use efficiency (0.534, 0.536) and nitrate reductase activity (0.236, 0.253) at phenotypic and genotypic level.

Number of leaves Plant^{-1} showed the positive significant association at phenotypic and genotypic level with number of branches plant^{-1} (0.556, 0.635), number of shoots plant^{-1} (0.462, 0.547), dry matter content of shoot (0.496, 0.548), number of tubers plant^{-1} (0.610, 0.705), number of eye tuber^{-1} (0.428, 0.572), tuberization efficiency (tuber: haulm ratio) (0.356, 0.383), nitrogen use efficiency (0.651, 0.694) and nitrate reductase activity (0.504, 0.525). Above result told that increase in number of leaves per plant will in turn increase number of tuber per plant, maximum Number of eye tuber^{-1} and subsequently tuber yield in potato.

Number of branches plant^{-1} showed positive significant association with number of shoots plant^{-1} (0.417, 0.550), dry matter content of shoot (0.396, 0.478), number of tubers plant^{-1}(0.578, 0.693), number of eye tuber^{-1} (0.480, 0.670), Tuberization efficiency (tuber: haulm ratio) (0.459, 0.536), nitrogen use efficiency (0.543, 0.632) and nitrate reductase activity (0.236, 0.279), whereas, it had showed significant negative association with harvest index (-0.163, -0.179), at genotypic and phenotypic level respectively.

Number of shoots plant^{-1} revealed the positive significant association at phenotypic and genotypic level with dry matter content of shoot (0.498, 0.648), number of tubers plant^{-1} (0.570, 0.730), number of eye tuber^{-1} (0.454, 0.649), tuberization efficiency (tuber: haulm ratio) (0.348, 0.437), nitrogen use efficiency (0.498, 0.594) and nitrate reductase activity (0.229, 0.263).

Dry matter content of shoot found positive significant association at phenotypic and genotypic level with number of tubers plant^{-1} (0.549, 0.664), number of eye tuber^{-1} (0.442, 0.606), tuberization efficiency (tuber: haulm ratio) (0.336, 0.389) and nitrogen use efficiency (0.512, 0.576).

Number of tubers plant^{-1} showed positive significant association at phenotypic and genotypic level with number of eye tuber^{-1} (0.567, 0.747), tuberization efficiency (tuber: haulm ratio) (0.575, 0.656), nitrogen use efficiency (0.715, 0.792) and nitrate reductase activity (0.211, 0.235).

Number of eye tuber^{-1} revealed a positive significant association at phenotypic and genotypic levels with tuberization efficiency (tuber: haulm ratio) (0.251, 0.338), nitrogen use efficiency (0.596, 0.759) and nitrate reductase activity (0.113, 0.148).

Tuberization efficiency (Tuber: haulm ratio) found the positive significant phenotypic and genotypic level with nitrogen use efficiency (0.366, 0.394), and nitrate reductase activity (0.219, 0.235), whereas, it showed significant negatively association with harvest index (-0.377, -0.402), at genotypic and phenotypic level respectively.

Harvest index found positive significant association at phenotypic and genotypic levels with nitrogen use efficiency (0.177, 0.187). Nitrate reductase activity (0.151) was noted positive significant at genotypic level.

Nitrogen use efficiency showed that positive significant association at phenotypic and genotypic level with Nitrate reductase activity (0.338, 0.351) only.

Nitrate reductase activity found positive significant association at phenotypic and genotypic level with plant emergence (0.226, 0.247), plant height at maturity (0.236, 0.253), number of leaves plant^{-1} (0.504, 0.525), number of branch plant^{-1} (0.236, 0.279), number of shoots plant^{-1} (0.229, 0.263), number of tubers plant^{-1} (0.211, 0.235), tuberization efficiency (0.219, 0.235) and nitrogen use efficiency (0.338, 0.351).

The correlation analysis revealed that tuber yield showed a positive significant association at genotypic and phenotypic level with plant height at maturity, number of leaves plant^{-1}, number of branch plant^{-1}, number of shoots plant^{-1}, dry matter content of shoot, number of tubers plant^{-1}, number of eye tuber^{-1}, tuberization efficiency and nitrogen use efficiency showed a positively significance association at genotypic and phenotypic level. The tuber yield showed a negative significant association at genotypic and phenotypic level with harvest index these characters are useful in direct selection for enhancing the development of total tuber yield of potato.

Similar results were also reported by Asefa *et al*. (2016) [5], Rangare and Rangare (2017) [23], Panigrahi *et al*. (2017) [36], Patel *et al*. (2018) [22], Mishra *et al*. (2018) [19], Getahum *et al*. (2019) [10], Workayehu *et al*. (2021) [34], Annigeri and Hiremath (2022) [4] and Kumar *et al*. (2022) [16].

Path coefficient analysis

Simply dividing the correlation coefficient into direct and indirect effects, the standardized component regression coefficient is used to analyze a path coefficient. In other words, it assesses the direct and indirect effects of a number in independent characteristics on a dependent character. Using the method proposed by Dewey and Lu (1959) [8], the amount and direction of the direct and indirect effects of various characteristics contributing to yield were estimated. Working with rice, Lenka and Mishra (1973) [37] have suggested scales for path coefficient analysis 0.00 to 0.09 (Negligible), 0.10 to 0.19 (Low), 0.20 to 0.29 (Moderate), 0.30 to 0.99 (High), > 1.00 (Very high). More precise and useful information for crop improvements is provided by the combination of correlation coefficients and path coefficients. If the relationship between yield and a character is due to a character's direct effects, it indicates that their true relationship is beneficial for this character's improvement in yield. In the current examination, path coefficient analysis was carried out about direct and indirect effects of independent variables on dependent variable. It also estimated residual effect. The total of twelve characters are independent, one is dependent.

Path coefficient analysis estimates direct and indirect effects of various independent traits on dependent traits. It shows whether the association of these independent traits with tuber yield plot^{-1} is due to their direct effect on yield or is consequence of their indirect effect through other component traits. The estimates of genotypic path coefficient are furnished in Table 3.

The highest direct positive effect was contribution by number of tubers plant^{-1}, nitrogen use efficiency, number of branch plant^{-1}, number of shoots plant^{-1}, number of leaves plant^{-1} and tuberization efficiency (tuber: haulm ratio).

The direct effect of total tuber yield plot^{-1}was positive (1.000), it shows positive indirect contribution through plant height at maturity (0.517), number of leaves plant^{-1} (0.483), number of branches plant^{-1} (0.656), number of shoots plant^{-1} (0.602), dry matter content of shoot (0.486), number of tubers plant^{-1} (0.790), number of eye tuber^{-1} (0.577), Tuberization efficiency (tuber: haulm ratio) (0.723) and nitrogen use efficiency (0.535). It shows negative indirect effects via harvest index (-577) for tuber yield.

Plant Emergence (%)

It had expressed the direct contribution of Plant emergence on tuber yield plot^{-1} was negative (-0.0223). This trait exhibited positive and indirect effect through Plant height (0.0002). It revealed negative indirect effects *via* number of leaves plant^{-1} (-0.0057), number of branches plant^{-1} (-0.0024), number of shoots plant^{-1} (-0.0044), dry matter content of tuber (-0.0057), number of tubes plant^{-1} (-0.0060), number of eyes tube^{-1}(-0.0065), Tuberization efficiency (-0.0037), harvest index (-0.0026), nitrogen use efficiency (-0.0092) and nitrate reductase activity (-0.0055).

Plant Height at maturity (cm)

It was showed the direct contribution of plant height at maturity on tuber yield plot^{-1} was negative (-0.1889). This trait exhibited positive and indirect effect through harvest index (0.0156). It was found negative indirect effects *via* number of leaves plant^{-1} (-0.0999), number of branches plant^{-1} (-0.1525), number of shoots plant^{-1} (-0.0902), dry matter content of tuber (-0.0572), number of tubers plant^{-1} (-0.1209), number of eyes tube^{-1} (-0.0902), Tuberization efficiency (-0.0815), nitrogen use efficiency (-0.1063) and nitrate reductase activity (-0.0477).

Number of leaves Plant^{-1}

It was showed the direct contribution of number of leaves plant^{-1} on tuber yield plot^{-1} was positive (0.1184). This trait exhibited positive and indirect effect through number of branches plant^{-1}(0.0752), number of shoots plant^{-1}(0.0648), dry matter content of shoot (0.0649), number of tubers plant^{-1}(0.0835), number of eye tuber^{-1}(0.0677), Tuberization efficiency (tuber: haulm ratio) (0.0453), harvest index (0.0173), nitrogen use efficiency (0.0821) and nitrate reductase activity (0.0622).

Number of branches plant^{-1}

It had expressed the direct contribution of number of branches plant^{-1} on tuber yield plot^{-1} was positive (0.2090). This trait exhibited positive and indirect effect through number of shoots plant^{-1} (0.1150), dry matter content of shoot (0.0998), number of tubers plant^{-1} (0.1448), number of eye tuber^{-1}(0.1401), Tuberization efficiency (tuber: haulm ratio) (0.1119), nitrogen use efficiency (0.1320) and nitrate reductase activity (0.0583). It whereas negative indirect effects *via* harvest index (-0.0373).

Number of shoots plant^{-1}

It was showed the direct contribution of number of shoots plant^{-1} on tuber yield plot^{-1} was positive (0.1723). This trait exhibited positive and indirect effect through dry matter content of shoot (0.1116), number of branches plant^{-1} (0.0948) number of tubers plant^{-1} (0.1257), number of eye tuber^{-1} (0.1119), Tuberization efficiency (tuber: haulm ratio) (0.0754), nitrogen use efficiency (0.1024) and nitrate reductase activity (0.0454). It however negative indirect effects *via* harvest index (-0.0046).

Dry matter content of shoot (%)

It was showed the direct contribution of number of shoots plant^{-1} on tuber yield plot^{-1} was negative (-0.1212). This trait exhibited negative and indirect effect through plant height at maturity (-0.0367), number of leaves plant^{-1}(-0.0664), number of branches plant^{-1} (-0.0579), number of shoots plant^{-1} (-0.0785), number of tubers plant^{-1}(-0.0805), number of eye tuber^{-1} (-0.0734), Tuberization efficiency (tuber: haulm ratio) (-0.0471), harvest index (-0.0013), nitrogen use efficiency (-0.0698) and nitrate reductase activity (-0.0135).

Number of tubers plant^{-1}

It had expressed the direct contribution of number of tubers plant^{-1} on tuber yield plot^{-1} was positive (0.5704). This trait exhibited positive and indirect effect through plant emergence (0.1546), plant height at maturity (0.3651), number of leaves plant^{-1}(0.4024), number of branches plant^{-1}(0.3953), number of shoots plant^{-1}(0.4161), dry matter content of shoot (0.3788), number of eye tuber^{-1}(0.4259), Tuberization efficiency (tuber: haulm ratio) (0.3739), nitrogen use efficiency (0.4515) and nitrate reductase activity (0.1338). A negative indirect effect was recorded for harvest index (-0.0393).

Number of eye tuber^{-1}

It was showed the direct contribution of number of eye tuber^{-1} on total tuber yield plot^{-1} was negative (-0.1902). This trait exhibited positive and indirect effect through harvest index (0.0074), It revealed negative indirect effects *via* plant emergence (-0.055), plant height at maturity (-0.0908), number of leaves plant^{-1} (-0.1087), number of branches plant^{-1} (-0.1275), number of shoots plant^{-1} (-0.1235), dry matter content of shoot (-0.1152), number of tubers plant^{-1} (-0.1420), Tuberization efficiency (tuber: haulm ratio) (-0.0642), nitrogen use efficiency (-0.1443) and nitrate reductase activity (-0.0281).

Tuberization efficiency (Tuber: haulm ratio)

It had expressed the direct contribution of Tuberization efficiency (tuber: haulm ratio) on tuber yield plot^{-1} was positive (0.0444). This trait exhibited positive and indirect effect through plant emergence (0.0074), plant height at maturity (0.0191), number of leaves plant^{-1} (0.0170), number of branches plant^{-1} (0.0238), number of shoots plant^{-1} (0.0194), dry matter content of shoot (0.0172), number of tubers plant^{-1} (0.0291), number of eye tuber^{-1} (0.0150), nitrogen use efficiency (0.0175) and nitrate reductase activity (0.0104) It revealed negative indirect effects for harvest index (-0.0179).

Harvest index (%)

It was showed the direct contribution of harvest index (), on total tuber yield plot^{-1}, was negative (-0.5337). This trait exhibited positive and indirect effect through Tuberization efficiency (tuber: haulm ratio) (0.2148), number of branches plant^{-1}(0.0953), plant height at maturity (0.0441), number of tubers plant^{-1} (0.0368), number of eye tuber^{-1} (0.0207) and number of shoots plant^{-1}(0.0142). It revealed negative indirect effects *via* plant emergence (-0.0615), number of leaves plant^{-1} (-0.0780), dry matter content of shoot (-0.0056), nitrogen use efficiency (-0.0996) and nitrate reductase activity (-0.0808).

Nitrogen use efficiency (%)

It had expressed the direct contribution of nitrogen use efficiency on tuber yield plot^{-1} was positive (0.2383). This trait exhibited positive and indirect effect through plant emergence (0.0990), plant height at maturity (0.1341), number of leaves plant^{-1} (0.1653), number of branches plant^{-1} (0.1505), number of shoots plant^{-1} (0.1416), dry matter content of shoot (0.1373), number of tubers plant^{-1} (0.1887), number of eye tuber^{-1} (0.1809), Tuberization efficiency (tuber: haulm ratio) (0.0939), harvest index (0.0445) and nitrate reductase activity (0.0835).

Nitrate reductase activity (μ mol/hour/g fresh weight)

It had expressed the direct contribution of nitrate reductase activity on tuber yield plot^{-1} was negative (-0.1692). This trait exhibited negative and indirect effect through plant emergence (-0.0417), plant height at maturity (-0.0428), number of leaves plant^{-1} (-0.0888), number of branches plant^{-1} (-0.0472), number of shoots plant^{-1} (-0.0446), dry matter content of shoot (-0.0188), number of tubers plant^{-1} (-0.0397), number of eye tuber^{-1} (-0.0250), Tuberization efficiency (tuber: haulm ratio) (-0.0398), harvest index (-0.0256) and nitrogen use efficiency (-0.0593) with tuber yield in potato.

In the present investigation on tuber yield, plot^{-1} was highly positive with significantly associated with all yield and yield attributing traits *viz*., plant height at maturity, number of leaves plant^{-1}, number of branches plant^{-1}, number of shoots plant^{-1}, dry matter content of shoots, number of tubers plant^{-1}, number of eyes tuber^{-1}, tuberization efficiency (tuber: haulm ratio) and nitrogen use efficiency. It revealed positive with significantly associated with indirect effects *via* harvest index. This indicates that traits are heritable with governing of additive gene action for effective selection criteria direct effect was found positive and high for number of tuber plant^{-1}, nitrogen use efficiency, number of branches plant^{-1}, number of shoots plant^{-1}, number of leaves plant^{-1} and Tuberization efficiency observed as the most important direct influencing yield contributing character. Thus, the selection pressure on these traits may lead to overall increase in the yield.

The residual effects (0.247) in the analysis are less which indicates that in present investigation most of the important characters were included in the expression of tuber yield. Similar results were reported by Subha and Singh, (2018) [38] for tuber yield. The positive with significant association on total tuber yield plot^{-1} similar results to the finding by Yuncturk and Cftc (2005) [29-30] for number of tubers plant^{-1}, Haydar *et al*. (2009) for plant height at maturity, number of leaves plant^{-1} and number of tubers plant^{-1}, Khayatnezhad *et al*. (2011) [14] for number of tuber plant^{-1}, Ummyiah *et al*. (2013) [31] for number of tuber plant^{-1}, Bhadauriya *et al*. (2018) [6] for number of branch plant^{-1} and number of tuber plant^{-1}, Rao *et al*. (2018) for tuber yield. Kashyap *et al*. (2021) [13] for number of leaves plant^{-1}, number of tubers plant^{-1} and number of shoots plant^{-1}, Kumar *et al*. (2022) [16] for number of tubers plant^{-1}.

Table 1: Potato genotypes/varieties used in the study and their sources

S.N.	Varieties/genotypes	Source
1	P-45	CPRI, Shimla
2	P-46	CPRI, Shimla
3	P-53	CPRI, Shimla
4	P-73	CPRI, Shimla
5	P-21	CPRI, Shimla
6	K. SURYA	CPRI, Shimla
7	K. JYOTI	CPRI, Shimla
8	K. SINDURI	CPRI, Shimla
9	K. MOHAN	CPRI, Shimla
10	K. LALIT	CPRI, Shimla
11	K. NEELKANTH	CPRI, Shimla
12	K. CHIPSONA-3	CPRI, Shimla
13	K. HIMALINI	CPRI, Shimla
14	K. ASHOKA	CPRI, Shimla
15	K. GARIMA	CPRI, Shimla
16	K. ARUN	CPRI, Shimla
17	K. LALIMA	CPRI, Shimla
18	K. LIMA	CPRI, Shimla
19	K. KHYATI	CPRI, Shimla
20	K. CHIPSONA-1	CPRI, Shimla

Table 2: Phenotypic and Genotypic Correlation for yield and yield attributing traits in potato genotypes

Characters		PH	NLPP	NBPP	NSPP	DM	NTPP	NEPT	TE(HR)	HI	NUE	NRA	TTY(Kg/Plot)
Plant Emergence	P	0.0029	0.228*	0.0855	0.1389	0.230*	0.252**	0.223*	0.149*	0.1046	0.384**	0.226*	0.1228
	G	-0.0105	0.257**	0.1058	0.198*	0.255**	0.271**	0.292**	0.166*	0.1153	0.416**	0.247**	0.138
Plant Height at maturity	P		0.492**	0.701**	0.389**	0.266**	0.561**	0.389**	0.407**	-0.0763	0.534**	0.236*	0.481**
	G		0.529**	0.807**	0.478**	0.303**	0.640**	0.477**	0.432**	-0.0827	0.563**	0.253**	0.517**
Number of leaves Plant^{-1}	P			0.556**	0.462**	0.496**	0.610**	0.428**	0.356**	0.133	0.651**	0.504**	0.455**
	G			0.635**	0.547**	0.548**	0.705**	0.572**	0.383**	0.1462	0.694**	0.525**	0.483**
Number of branches plant^{-1}	P				0.417**	0.396**	0.578**	0.480**	0.459**	0.163*	0.543**	0.236*	0.561**
	G				0.550**	0.478**	0.693**	0.670**	0.536**	0.179*	0.632**	0.279**	0.656**
Number of shoots plant^{-1}	P					0.498**	0.570**	0.454**	0.348**	-0.0251	0.498**	0.229*	0.502**
	G					0.648**	0.730**	0.649**	0.437**	-0.0267	0.594**	0.263**	0.602**
Dry matter content of shoot	P						0.549**	0.442**	0.336**	0.0072	0.512**	0.094	0.434**
	G						0.664**	0.606**	0.389**	0.0106	0.576**	0.1113	0.486**
Number of tubers plant^{-1}	P							0.567**	0.575**	-0.059	0.715**	0.211*	0.713**
	G							0.747**	0.656**	-0.0689	0.792**	0.235*	0.790**
Number of eyes tuber^{-1}	P								0.251**	-0.005	0.596**	0.1128	0.440**
	G								0.338**	-0.0389	0.759**	0.148*	0.577**
Tuberization efficiency (HR)	P									0.377**	0.366**	0.219*	0.676**
	G									0.402**	0.394**	0.235*	0.723**
Harvest index	P										0.177*	0.1445	0.548**
	G										0.187*	0.151*	0.577**
Nitrogen use efficiency	P											0.338**	0.521**
	G											0.351**	0.535**
Nitrate reductase activity	P												0.0469
	G												0.0488

(* and ** at 5% and 1% significant respectively)

PE- Plant Emergence (%), PH-Plant Height at maturity (cm), NLPP-Number of leaves Plant^{-1}, NBPP- Number of branches plant^{-1}, NSPP- Number of shoots plant^{-1}, DMCS-Dry matter content of shoot (%), NTPP-Number of tubers plant^{-1}, NEPT- Number of eyes tuber^{-1}, TTY-Total tuber yield (Kg plot^{-1}), TE(HR)-Tuberization efficiency (Tuber: haulm ratio), HI- Harvest index (%).

Table 3: Genotypic Path for yield and yield attributing traits in potato genotypes

Character	PE	PH	NLPP	NBPP	NSPP	DM	NTPP	NEPT	TE(HR)	HI	NUE	NRA	TTY(Kg/Plot)
PE	-0.0223	0.0002	-0.0057	-0.0024	-0.0044	-0.0057	-0.0060	-0.0065	-0.0037	-0.0026	-0.0092	-0.0055	0.1380
PH	0.0020	-0.1889	-0.0999	-0.1525	-0.0902	-0.0572	-0.1209	-0.0902	-0.0815	0.0156	-0.1063	-0.0477	0.517**
NLPP	0.0305	0.0626	0.1184	0.0752	0.0648	0.0649	0.0835	0.0677	0.0453	0.0173	0.0821	0.0622	0.483**
NBPP	0.0221	0.1687	0.1327	0.2090	0.1150	0.0998	0.1448	0.1401	0.1119	-0.0373	0.1320	0.0583	0.656**
NSPP	0.0342	0.0823	0.0943	0.0948	0.1723	0.1116	0.1257	0.1119	0.0754	-0.0046	0.1024	0.0454	0.602**
DM	-0.0308	-0.0367	-0.0664	-0.0579	-0.0785	-0.1212	-0.0805	-0.0734	-0.0471	-0.0013	-0.0698	-0.0135	0.486**
NTPP	0.1546	0.3651	0.4024	0.3953	0.4161	0.3788	0.5704	0.4259	0.3739	-0.0393	0.4515	0.1338	0.790**
NEPT	-0.0555	-0.0908	-0.1087	-0.1275	-0.1235	-0.1152	-0.1420	-0.1902	-0.0642	0.0074	-0.1443	-0.0281	0.577**
TE(HR)	0.0074	0.0191	0.0170	0.0238	0.0194	0.0172	0.0291	0.0150	0.0444	-0.0179	0.0175	0.0104	0.723**
HI	-0.0615	0.0441	-0.0780	0.0953	0.0142	-0.0056	0.0368	0.0207	0.2148	-0.5337	-0.0996	-0.0808	-0.577**
NUE	0.0990	0.1341	0.1653	0.1505	0.1416	0.1373	0.1887	0.1809	0.0939	0.0445	0.2383	0.0835	0.535**
NRA	-0.0417	-0.0428	-0.0888	-0.0472	-0.0446	-0.0188	-0.0397	-0.0250	-0.0398	-0.0256	-0.0593	-0.1692	0.0488

Residual effect 0.247

Note: * and ** at 5% and 1% significant level respectively.

PE- Plant Emergence (%), PH-Plant Height at maturity (cm), NLPP-Number of leaves Plant^{-1}, NBPP- Number of branches plant^{-1}, NSPP-Number of shoots plant^{-1}, DMCS-Dry matter content of shoot (%), NTPP-Number of tubers plant^{-1}, NEPT- Number of eyes tuber^{-1}, TTY-Total tuber yield (Kg plot^{-1}), TE(HR)-Tuberization efficiency (Tuber: haulm ratio), HI- Harvest index (%), nitrogen use efficiency(%) and Nitrate reductase activity (µ mol/hour/g fresh weight).

Conclusion

Total tuber yield plot^{-1} exhibited significantly highly positive correlation association at genotypic and phenotypic level with plant height at maturity, number of leaves plant^{-1}, number of branch plant^{-1}, number of shoots plant^{-1}, dry matter content of shoot, number of tubers plant^{-1}, number of eye tuber^{-1} and Tuberization efficiency showed a positively significance association at genotypic and phenotypic level. Characters are useful indirect selection to enhance the development of total tuber yield in potato. The direct positively high effect on number of leaves plant^{-1}, number of branch plant^{-1}, number of shoots plant^{-1}, number of tubers plant^{-1} and Tuberization efficiency reported positive direct effects on total tuber yield. It means that direct selection of these traits would be beneficial for future research work. It is the most important direct influencing yield contributing characters. Thus, the selection pressure on these traits may lead to overall increase in the tuber yield.

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