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Studies on association between yield attributing traits in potato (*Solanum tuberosum* L.)

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Abstract
Understanding the direction and magnitude of correlation between tuber yield and its attributing traits in potato (*Solanum tuberosum* L.) is a prerequisite for identification of such characters whose selection would prove beneficial in any breeding program. The present experiment was carried out in order to study correlation among twenty five potato genotypes which were evaluated for thirteen quantitative traits in randomised block design during *rabi* season of 2015-16. Significant and positive correlation of total tuber yield, both at genotypic and phenotypic levels was recorded with number of tubers plant^{-1} (0.863 and 0.325), number of leaves plant^{-1} (0.744 and 0.354, respectively), dry weight of tubers plant^{-1} (0.659 and 0.522, respectively), number of compound leaves plant^{-1} (0.615 and0.463) and harvest index percentage (0.457 and 0.361, respectively). Thus, direct selection for above traits will be helpful in improving total tuber yield of potato affect the growth, development and ultimately tuber yield.

Keywords: potato, correlation, yield determinants, tuber yield

Introduction
Potato (*Solanum tuberosum* L.) belonging to the family *Solanaceae*, is one of the most important food crops of India as well as of many countries of the world. It produces more calories and protein per unit area with minimum time and water than most of the major food crops. It is cultivated worldwide under various environmental conditions. Tuber yield is a complex character associated with many interrelated components. Study of correlation between different quantitative characters provides an idea of association that could be effectively utilized in selecting a better plant type in potato breeding programme. It has been reported that simple correlation coefficients are useful to study the interrelationships between tuber yield and other characters and information about the correlation of agronomic and morphological characters with yields is helpful in the identification of the components of this complex character. Therefore present study was carried out in order to find the characters that influenced the yield.

Materials and Methods
The present experiment was conducted at Indira Gandhi Krishi Viswavidayalaya (IGKV), Raipur during *rabi* season of 2015-16 in order to evaluate the performance of twenty five genotypes of potato for various yield and its component traits under field condition with three replications of each genotype. Each plot measuring 2.4 x 2.4 meter had four rows spaced at 60 cm apart with intrarow spacing of 20 cm. The potato tubers were planted during second week of November, 2015. The recommended dose of fertilizer *i.e.* nitrogen 150 Kg, phosphorus 100 Kg and potassium 100 Kg per hectare was applied. Half quantity of nitrogen was applied at the time of planting of tubers and remaining was applied before earthing up at 45 DAP. The crop was visited regularly throughout the growing season and intercultural operations viz., weeding, irrigation and plant protection measures were performed when necessary.
For each character under study, data were recorded on five randomly taken plants from each plot and expressed on plant basis. The mean of five plants was used for statistical analysis. Observation on important characters *viz*., plant emergence percentage, plant height, number of shoots per plant, number of compound leaves per plant, plant canopy cover per cent number of tuber per plant, fresh weight of tubers per plant, dry weight of tuber per plant, harvest index per cent, marketable tuber yield per plot and total tuber yield per plot were recorded. To estimate the association between two variables, correlation coefficient at phenotypic and genotypic levels, was worked out in all possible combination. The phenotypic and genotypic correlations between all possible characters were calculated according to Miller *et al*. (1958) [7].

Result and Discussion

Yield, being a complex quantitative trait, is dependent on a number of component characters; therefore, knowledge of association of different components, together with their relative contributions, has immense value in selection. In general, the genotypic correlations were observed to be higher than the corresponding phenotypic which might be due to modifying or masking effect of environment in the expression of these characters under study as explained by Nandpuri *et al.*, (1973). Johnson *et al.* (1955) also reported that higher genotypic correlation than phenotypic correlation indicated an inherent association between various characters.

Fresh weight of tuber plant^{-1} had highly significant and positive correlation with total tuber yield both at genotypic (0.998) and phenotypic (0.849) levels indicating that increase in fresh weight of tuber plant^{-1} will simultaneously increase the total tuber yield. Similar result have been reported by Singh *et al.* (2015) [10], Darabad *et al.* (2014) [3] and Lamboro *et al.* (2014) [5].

Total tuber yield exhibited the positive and significant association, both at genotypic and phenotypic levels with number of tubers plant^{-1} (0.863 and 0.325), number of leaves plant^{-1} (0.744 and 0.354, respectively), dry weight of tubers plant^{-1} (0.659 and 0.522, respectively), number of compound leaves plant^{-1} (0.615 and 0.463) and harvest index percentage (0.457 and 0.361, respectively) indicating that the plant types possessing more number of tuber, compound leaves and leaves per plant will also show better performance in terms of total tuber yield. The association of number of tubers plant^{-1} with total tuber yield was also reported by Singh *et al.* (2015), [10] Ummyiah *et al.* (2013) [12] and Patel *et al.* (2002) [9] and correlation of number of leaves with tuber yield was reported by Ara *et al.* (2009) [1] and Singh (2008) [11]. The finding of correlation of tuber yield with dry weight of tubers plant^{-1} is supported by the findings of Nasiruddin *et al.* (2014) [8] and Khayatnezhad *et al.* (2011) [4], whereas correlation of tuber yield with harvest index per cent was also reported by Chandrakar *et al.* (2007) [2] and Luthra (2001) [6].

Fresh weight of tubers plant^{-1} had highly significant and positive correlation both at genotypic and phenotypic level with number of tubers plant^{-1} (0.801 and 0.451, respectively), number of leaves plant^{-1} (0.787 and 0.446, respectively), number of compound leaves plant^{-1} (0.624 and 0.547, respectively), whereas, dry weight of shoots plant^{-1} was positively correlated with fresh weight of tubers plant^{-1} (0.813) at genotypic level only. The above findings suggests that the plant types having more number of tubers, leaves and shoots plant^{-1} and higher fresh weight of shoots plant^{-1} is expected to posses high fresh weight of tubers plant^{-1}. Plant height had highly significant but negative correlation with fresh weight of tubers plant^{-1} at genotypic (-0.439) and phenotypic (-0.303) level.

Number of tubers plant^{-1} had highly significant and positive association both at genotypic and phenotypic levels with number of leaves plant^{-1} (0.921 and 0.341, respectively), number of compound leaves plant^{-1} (0.737 and 0.407, respectively) and number of shoots plant^{-1} (0.438 and 0.303, respectively). Plant canopy cover percentage also had positive association with number of tubers plant^{-1} (0.404 and 0.295, respectively). The above findings indicate that showed that any positive increase in such characters will suffice the boast in tuber yield. Similar finding were reported by Darabad *et al.* (2014) [3], Nasiruddin *et al.* (2014) [8] and Patel *et al.* (2002) [9] for plant canopy cover percentage and number of shoots plant^{-1}.

Harvest index per cent exhibited significant and positive correlation both at genotypic and phenotypic levels with number of leaves plant^{-1}, dry weight of tubers plant^{-1}, whereas, it was significantly but negatively associated with fresh weight of shoots plant^{-1}. Dry weight of tubers plant^{-1} had significant and positive correlation both at genotypic and phenotypic levels with number of tubers plant^{-1} and fresh weight of tubers plant^{-1}. Plant canopy cover percentage had positive and highly significant correlation for the characters namely number of shoots plant^{-1}, number of leaves plant^{-1} and plant height at genotypic level.

Conclusion

Correlation coefficient analysis measures the magnitude of relationship between various plant characters and determines the component character on which selection can be based for improvement in potato tuber yield. Therefore, present study indicated that fresh weight of tuber plant^{-1}, number of tubers plant^{-1}, number of leaves plant^{-1}, dry weight of tubers plant^{-1}, number of compound leaves plant^{-1} and harvest index percentage were the main components contributing to tuber yield and therefore, should be given high priority in the selection programme.

Table 1: Phenotypic (PCV) and genotypic (GCV) coefficient of correlation for tuber yield and its attributing trait in potato.

Characters		Plant Emergence %	Plant height (cm)	Number of shoots plant^{-1}	Number of leaves plant^{-1}	Number of compound leaves plant^{-1}	Plant canopy cover %	Fresh weight of shoots (gm)	Dry weight of shoots (gm)	Number of tubers plant^{-1}	Fresh weight of tubers (gm)	Dry weight of tubers (gm)	Harvest Index %	Total tuber yield (Kg plot^{-1})
Plant Emergence%	P	1.000	-0.017	-0.190	-0.022	-0.088	-0.076	-0.261*	-0.101	0.062	0.101	0.146	0.252*	0.099
	G	1.000	-0.120	-0.480**	-0.113	-0.162	0.086	-0.467**	-0.226*	0.321**	0.199	0.170	0.531**	0.140
Plant height (cm)	P			0.115	-0.261*	-0.040	0.060	0.049	0.111	-0.335**	-0.303**	-0.199	-0.288*	-0.290*
	G			0.542**	-0.566**	-0.022	0.255*	0.054	0.296**	-0.381**	-0.439**	-0.302**	-0.532**	-0.432**
Number of shoots plant^{-1}	P				0.214	0.407**	0.137	0.015	0.102	0.303**	0.269*	0.358**	0.161	0.219
	G				0.575**	0.803**	0.755**	0.309**	0.114	0.438**	0.394**	0.629**	-0.009	0.421**
Number of leaves plant^{-1}	P					0.477**	0.118	0.033	-0.061	0.341**	0.446**	0.438**	0.275*	0.354**
	G					0.999**	0.468**	-0.043	-0.122	0.921**	0.787**	0.899**	0.735**	0.744**
Number of compound leaves plant^{-1}	P						0.255*	0.239*	0.224*	0.407**	0.547**	0.434**	0.085	0.463**
	G						0.426**	0.329**	0.249*	0.737**	0.624**	0.520**	0.080	0.615**
Plant canopy cover %	P							-0.001	-0.243*	0.295**	0.085	0.129	0.048	0.082
	G							-0.092	-0.499**	0.404**	0.131	0.402**	0.200	0.182
Fresh weight of shoots plant^{-1} (gm)	P								0.364**	-0.017	0.266*	0.022	-0.642**	0.278*
	G								0.612**	0.147	0.342**	-0.040	-0.635**	0.409**
Dry weight of shoots plant^{-1} (gm)	P									-0.011	0.159	-0.044	-0.246*	0.176
	G									0.257*	0.246*	-0.098	-0.339**	0.251*
Number of tubers plant^{-1}	P										0.451**	0.454**	0.393**	0.325**
	G										0.801**	0.969**	0.469**	0.863**
Fresh weight of tubers plant^{-1} (gm)	P											0.592**	0.469**	0.849**
	G											0.687**	0.446**	0.998**
Dry weight of tubers plant^{-1} (gm)	P												0.458**	0.522**
	G												0.623**	0.659**
Harvest Index%	P													0.361**
	G													0.457**
Total tuber yield (Kg plot$^{-1)}$	P													1.000
	G													1.000*

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