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Character Association and Path Analysis in Coloured Potato (*Solanum tuberosum* L.)

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A B S T R A C T

A field experiment was conducted in the Research Farm of All India Coordinated Research Project on Potato, OUAT, Bhubaneswar, Odisha, India to study the association among morphological traits in twenty one potato genotypes including coloured ones. The experiment was laid out in Randomized block design with four replications. It was observed that tuber yield plant^{-1} had significantly positive correlation with plant height, shoots plant^{-1}, compound leaf length, leaf breadth, Compound leaf area, compound leaves plant^{-1}, average tuber weight and tubers plant^{-1} at both phenotypic and genotypic level. Similarly, shoots per plant at 45 days exhibited maximum direct positive effect on tuber yield followed by average single tuber weight, plant height at 60 days, compound leaf breadth and number of tubers per plant. This indicates that selection for these traits will be rewarding because they have more direct contribution towards tuber yield.

Introduction

Potato (*Solanum tuberosum* L.), a member of the family Solanaceae, is one of the major cultivated food crops in the world. It ranks fourth after rice, wheat and corn (FAO STAT, 2017). In the east Indian state of Odisha, potato is cultivated over an area of 25.03 thousand hectares with production of 2.94 lakh tonnes and productivity of 12.04 metric tonnes per hectare (HAPIS, Odisha. 2017). Potato production in Odisha accounts 3.3 % of the total vegetable production and 3.78% of the total area under vegetable production of Odisha.

One of the most important phenotypic traits of potato is the skin colour. Most of the commercial potatoes bred till today are of white or yellow colour. Few varieties have different colours due to anthocyanin pigmentation. Lot of variability is seen

among the coloured potato genotypes. Coloured potatoes may have purple, red, pink, yellow or blue coloured skin. The skin colour of potato tuber results from differences in accumulation of anthocyanin pigments (Jong *et al*., 2003). Colorations originate from the accumulation of different classes of pigments, that is, carotenoids and anthocyanins (Brown, 2006; Brown *et al*., 2007).

Carotenoids impart white, yellow or saffron yellow colour to the skin and flesh (Brown, 2006; Brown, 2008). Colour of the skin and flesh has considerable effect on consumer acceptance (Crisosto *et al*., 2003). Coloured potatoes have better taste, appearance, protein content (Kita *et al.*, 2015) and are rich source of antioxidants (Brown *et al*., 2003 ; Brown, 2008; Jansen and Flamme, 2006) for which they draw the attention of researchers as well as consumers.

Traditionally red skinned potatoes have gained popularity in eastern India but now it is gaining momentum towards preference in north western and west central plains too which account for nearly 75% of potato production in India (Luthra *et al*., 2003).

Keeping in view the health benefit and marketability in India, some coloured varieties have been released by ICAR-CPRI, Shimla such as, Kufri Arun (Red), Kufri Lalima (Pink), Kufri Lalit (Light red), Kufri Kanchan (Pink), Kufri Neelakanth (Dark Purple), etc. The market price of coloured potatoes is often higher than normal varieties. Considering the potential of coloured skin potato, there is a need to evaluate varieties suitable for cultivation under different agro-ecological conditions.

However, limited studies have been conducted to correlate the contribution of easily marked morphological characters towards final tuber yield, particularly in coloured potato. Thus the present investigation was carried out to study the association of different morphological characters with tuber productivity.

Materials and Methods

The experiment was carried out at All India Co-ordinated Research Project on Potato, OUAT, Bhubaneswar, during *rabi*, 2018-19 with 21 potato genotypes including 15 coloured potato genotypes. The experiment was laid out in Randomized Block Design (RBD) with four replications. In each plot, a genotype was grown in five rows having twelve plants per row, spaced 60 cm between rows and 20 cm between plants. From randomly selected 5 plants per plot, observations were recorded for thirteen characters *viz*., plant height (cm) at 30days, 45 days and 60 days; shoots plant^{-1} at 30 days, 45 days and 60 days; leaf length (cm), leaf breadth (cm), number of compound leaves plant^{-1}, compound leaf area (cm^2), tubers plant^{-1}, average tuber weight (g) and tuber yield plant^{-1} (g) at 75 days. Genotypic and phenotypic correlation coefficients and path coefficient values were worked out following Singh and Chaudhary (1979).

Results and Discussion

In general, correlation studies are highly beneficial in selecting superior genotypes for any population improvement programme (Robinson, 1966). Interrelationship amongst quantitative characters both at genotypic and phenotypic levels helps in effective selection of a new genotype. The genotypic and phenotypic correlation coefficient values of component characters show their extent of positive or negative association with tuber yield (Table 1). The path matrix using genotypic correlation coefficient values exhibit the direct contribution of a component trait towards tuber yield (Table 2).

Plant height at 30 days showed significant positive correlation with shoots plant^{-1} and compound leaf length at both phenotypic and genotypic levels. Plant height at 30 days exhibited positive correlation with yield which corroborates the findings of Sattar *et al.,* (2007), Panigrahi *et al.,* (2017) and Khayatnezhad *et al.,* (2011).

Plant height at 30 days exhibited significant positive correlation with the same character at 45 and 60 days as well as shoots per plant which highlights the importance of early vigour on crop growth and productivity. Significant correlation of plant height only at 30 days with tuber yield might be due to proper partitioning of photosynthates after vigorous growth at early stage. Channelization of photosynthates towards tuber development might be responsible for slow shoot growth at later stages.

Shoots plant^{-1} was found to be significantly and positively associated with the tuber yield plant^{-1}. This result is in agreement with the findings of Panigrahi *et al.,* (2017). This character has also significant positive association with height of the plant at 30 and 45 days, compound leaf length, leaf breadth, number of compound leaves per plant and tubers per plant.

Compound leaf length had positive correlation with plant height at 30 days, shoots per plant, compound leaf area, leaf number, tubers per plant and average single tuber weight but negatively correlated with compound leaf breadth. This character exhibited significant and positive correlation with yield per plant both at phenotypic and genotypic levels.

Compound leaf breadth had positive correlation with plant height at 30 days, shoots per plant but negatively correlated with compound leaf length, compound leaf area, leaf number, tubers per plant and average single tuber weight. This character exhibited significant and positive correlation with yield per plant both at phenotypic and genotypic levels.

Compound leaf area had positive correlation with plant height at 30 days, compound leaf length but negative correlation with shoots per plant, leaf breadth and tubers per plant. This character exhibited significant positive correlation with yield per plant both at phenotypic and genotypic levels.

Number of tubers plant^{-1} was found to be positively associated with tuber yield plant^{-1}. This result is in agreement with the findings of Sattar *et al.,* (2007), Luthra *et al.,* (2018) and Khayatnezhad *et al.,* (2011). Further, the number of tubers per plant had significant positive correlation with plant height, shoots per plant, compound leaf length, leaf breadth and tubers per plant but negative correlation with compound leaf area and average single tuber weight.

Number of leaves per plant was found to be significantly and positively associated with tuber yield plant^{-1}. This result is in agreement with the findings of sattar *et al.,* (2007). Further the number of compound leaves per plant had significant positive correlation with plant height, shoots per plant, compound leaf length, leaf breadth and tubers per plant but negative correlation with compound leaf area.

Average weight of single tuber had positive correlation with plant height at 30 days, shoots per plant, compound leaf length and leaf breadth but negative correlation with tubers per plant. This character exhibited highest significant positive correlation with yield per plant both at phenotypic and genotypic levels. This result was in agreement with the findings of Khayatnezhad *et al.,* (2011).

Table.1 Correlation coefficient among yield attributing morphological characters of 21 genotypes

		PH 30d	PH 45d	PH 60d	SP 30d	SP 45d	SP	CLL	CLB	CLA	NCL	TPP	ASTW
PH 45d	r_g	0.580**											
	r_P	0.607**											
PH 60d	r_g	0.495**	0.845**										
	r_P	0.519**	0.904**										
SP 30d	r_g	0.344**	0.036^{NS}	-0.081^{NS}									
	r_P	0.370**	0.039^{NS}	-0.091^{NS}									
SP 45d	r_g	0.438**	0.026^{NS}	-0.082^{NS}	0.954**								
	r_P	0.456**	0.036^{NS}	-0.077^{NS}	0.968**								
SP 60d	r_g	0.454**	0.065^{NS}	-0.047^{NS}	0.921**	0.958**							
	r_P	0.483**	0.078^{NS}	-0.035^{NS}	0.948**	0.982**							
CLL	r_g	0.259*	0.134^{NS}	0.169^{NS}	0.337**	0.384**	0.357*						
	r_P	0.307**	0.189^{NS}	0.199^{NS}	0.400**	0.449**	0.416*						
CLB	r_g	0.104^{NS}	0.083^{NS}	-0.003^{NS}	0.209^{NS}	0.189^{N}	0.169	-					
	r_P	0.190^{NS}	0.152^{NS}	-0.035^{NS}	0.268*	0.245*	0.236*	-					
CLA	r_g	0.188^{NS}	0.011^{NS}	0.283**	-0.117^{NS}	-	-	0.153	-				
	r_P	0.209^{NS}	0.016^{NS}	0.303**	-0.127^{NS}	-	-	0.174	-				
NCL	r_g	0.131^{NS}	0.225*	0.173^{NS}	0.424**	0.408**	0.448*	0.323*	0.31	-			
	r_P	0.165^{NS}	0.277*	0.218*	0.471**	0.453**	0.493*	0.387*	0.43	-0.230*			
TPP	r_g	0.165^{NS}	0.318**	0.195^{NS}	0.296**	0.255*	0.217*	0.155	0.22	-	0.477**		
	r_P	0.178^{NS}	0.404**	0.251*	0.404**	0.324**	0.287*	0.230*	0.38	-	0.633**		
ASTW	r_g	0.161^{NS}	-	-0.096^{NS}	0.095^{NS}	0.182^{N}	0.164	-	0.16	0.435**	0.006^{N}	-	
	r_P	0.202^{NS}	-	-0.108^{NS}	0.090^{NS}	0.220*	0.192	0.037	0.31	0.538**	-	-0.225*	
TYPP	r_g	0.205^{NS}	0.091^{NS}	0.039^{NS}	0.273*	0.311**	0.265*	0.122	0.34	0.373**	0.362**	0.310**	0.735**
	r_P	0.240*	0.091^{NS}	0.054^{NS}	0.317**	0.373**	0.325*	0.211	0.50	0.431**	0.440**	0.470**	0.751**

r_g= genotypic correlation coefficient; rP= phenotypic correlation coefficient;
* Significant at 5% level; ** Significant at 1% level
NB: PH-Plant height (cm), SP- Shoots per plant, CLL-Compound leaf length (cm),
CLB-Compound leaf breadth (cm), CLA-Leaf area (m^2), NCL-No. of compound leaves $plant^{-1}$,
TPP- Tubers per plant, TYPP –Tuber yield per plant (g), ASTW-Average single tuber weight (g)

Table.2 Path matrix using genotypic correlation coefficient values

	PH 30d	PH 45d	PH 60d	SP 30d	SP 45d	SP 60d	CLL	CLB	CLA	NCL	TPP	ASTW
PH 45d	**-0.424**	-0.257	-0.220	-0.157	-0.193	-0.205	-0.130	-0.080	-0.089	-0.070	-0.075	-0.031
PH 60d	-0.122	**-0.202**	-0.182	-0.008	-0.007	-0.016	-0.038	-0.031	-0.003	-0.056	-0.081	0.026
SP 30d	0.466	0.813	**0.899**	-0.082	-0.070	-0.032	0.179	-0.032	0.272	0.196	0.226	-0.045
SP 45d	-1.089	-0.114	0.268	**-2.939**	-2.846	-2.785	-1.175	-0.788	0.372	-1.385	-1.187	-0.810
SP 60d	2.081	0.166	-0.354	4.422	**4.566**	4.481	2.050	1.119	-0.030	2.068	1.479	1.190
CLL	-0.631	-0.102	0.046	-1.238	-1.282	**-1.307**	-0.544	-0.309	0.097	-0.644	-0.375	-0.306
CLB	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002	**-0.004**	0.000	-0.001	-0.001	-0.001	-0.001
CLA	0.102	0.082	-0.019	0.145	0.132	0.127	-0.054	**0.539**	-0.088	0.232	0.207	0.089
NCL	-0.147	-0.011	-0.213	0.089	0.005	0.052	-0.122	0.115	**-0.706**	0.162	0.076	-0.274
TPP	-0.103	-0.173	-0.136	-0.294	-0.283	-0.308	-0.241	-0.269	0.143	**-0.624**	-0.395	-0.252
ASTW	0.019	0.044	0.027	0.044	0.035	0.031	0.025	0.042	-0.012	0.069	**0.108**	0.043
TYPP 75d	0.089	-0.154	-0.061	0.336	0.318	0.286	0.265	0.202	0.474	0.493	0.490	**1.220**

Residual effect= 0.05826

NB: PH-Plant height (cm), SP- Shoots per plant, CLL-Compound leaf length (cm), CLB-Compound leaf breadth (cm), CLA-Leaf area (m^2), NCL-No. of compound leaves $plant^{-1}$, TPP- Tubers per plant, TYPP –Tuber yield per plant (g), ASTW-Average single tuber weight (g)

Maximum direct positive effect was exhibited by the shoots per plant at 45 days (4.566) followed by average single tuber weight (1.220), plant height at 60 days (0.899) and compound leaf breadth (0.539). This indicates that these traits contribute directly towards tuber yield much more than other characters and selection for these traits will be rewarding. The traits like compound leaf length, number of compound leaves, plant height at 30 and 60 days and shoots per plant at 30 and 45 days exhibited negative direct effect on yield.

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