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Character association and their direct and indirect effects on bulb yield in onion (*Allium cepa* L.)

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Abstract

An experiment was conducted to evaluate 75 diverse genotypes of onion during *rabi* season for correlation and path analysis for bulb yield and its contributing characters. The genotypic correlation coefficient values were higher than the corresponding phenotypic correlation coefficients in almost all the trait pairs. Path coefficient analysis revealed that the characters *viz.*, neck thickness of bulb and number of leaves per plant exhibited moderate and positive direct effect on bulb yield.

Keywords: Bulb yield, correlation, onion, path analysis

Introduction

Onion (*Allium cepa* L.) is one of the important spice and vegetable crops grown in temperate, sub-tropical and tropical climate throughout the world. It is cultivated year round but the maximum during *rabi* season in our country.

India ranks second in the world in area and production after China and third in export after Netherland and Spain. India is producing 194.01 lakh tonnes of onion from an area of 12.03 lakh hectares with an average productivity of 16.13 t/ha (Anon., 2017a) [2]. In Gujarat, it is grown an about 0.51 lakh hectares with an average production of 13.6934 lakh tones and productivity of 26.54 t/ha (Anon., 2017b) [3].

Correlation, which is the primary tool of breeding programme only provides the amount of association of characters, while path coefficient analysis measures the direct influence of one variable upon another and facilitates the separation of correlation coefficients into components of direct and indirect effects (Dewey and Lu, 1959) [7]. Therefore, it is essential to identify the component characters through which yield can be improved. Thus, correlation in conjunction with path analysis would provide a better picture of cause and effect relationship between character pairs. Keeping this in view, the present study was carried out to formulate the selection strategies for improvement of pod yield in groundnut.

Materials and Methods

Seventy five genotypes of onion were selected out of large collection of germplasm maintained at the Vegetable Research Station, Junagadh Agricultural University, Junagadh in Randomized Block Design (RBD) with two replications during *rabi* 2018. Plot size was 0.45 m × 2.0 m length with spacing of 15 cm × 10 cm. The genotypes were randomly allotted to the plots in each replication. All the recommended agronomical practices along with necessary plant protection measures were followed timely for the successful raising of the crop. The observations were recorded on five randomly selected onion plants (except days to maturity, which was recorded on plot basis) in each entry and in each replication for 12 characters *viz.*, plant height (cm), number of leaves per plant, bolting (%), days to maturity, double onion bulb (%), bulb weight (g), neck thickness of bulb (cm), pseudo stem length (cm), bulb equatorial diameter (cm), bulb polar diameter (cm), TSS of bulb (%) and bulb yield (kg) and their mean values were used for statistical analysis.

The phenotypic and genotypic correlation coefficients of all the pairs of characters were worked out as per Al-Jibouri *et al.* (1958) [1]. The path coefficient analysis was carried-out as per the method suggested by Dewey and Lu (1959) [7].

Results and Discussion

The analysis of variance revealed that mean squares due to genotypes were significant for all the traits.

The values of genotypic correlations were higher than their corresponding phenotypic correlations in the present investigation for most of the characters (Table 1). This indicated that there was high degree of association between two variables at genotypic level, its phenotypic expression was deflated by the influence of environment. It also indicated that there was an inherent relationship between the characters studied, which is in agreement with the conclusions of Ghetia (1990) [8], Sutaria (1992) [18], Hosamani *et al.* (2010) [10] and Chattopadhyay *et al.* (2013) [5].

The bulb weight had positive and highly significant correlation with bulb equatorial diameter at genotypic level. The association of bulb yield per plot was positive and highly significant with number of leaves per plant and neck thickness of bulb at both genotypic and phenotypic levels. Whereas, bulb polar diameter found significantly and positively correlated with bulb yield per plot at genotypic level. These traits were important bulb yield determining characters and the weightage should be given to these traits at the time of selection. Positive association of bulb weight with bulb equatorial diameter was reported by Srivastav *et al.* (2017) [17].

When two or more variables are included in the correlation studies, it becomes difficult to determine, which characters enhance the yield. The technique of path coefficient analysis overcomes this situation, which partitions the forces of association and examines the relative contribution of direct and indirect effects of the independent variables on the dependent variables. Path coefficient was carried out to

estimate the direct and indirect effects in respect to plant height, number of leaves per plant, bolting, days to maturity, double onion bulb, bulb weight, neck thickness of bulb, pseudo stem length, bulb equatorial diameter, bulb polar diameter, per plot and TSS of bulb. Direct and indirect effects of bulb yield contributing characters in onion are presented in Table 2. The results revealed that the highest direct positive effect on bulb yield was showed by neck thickness of bulb followed by number of leaves per plant. These characters turned out to be the major components of bulb yield. Similar results were observed earlier by Ghetia (1990) [8], Mohanty (2001) [12], Gurjar and Singhania (2006) [9], Meena *et al.* (2007) [11], Dewangan and Sahu (2014) [6], Sachin *et al.* (2015) [16] and Rajya Lakshmi (2015) [15].

Plant height expressed positive and low direct effect with bulb yield per plot. Sutaria (1992) [18] reported negative direct effect of plant height on yield. Number of leaves per plant had direct effect on bulb yield was positive and moderate. Mohanty (2002) [13] showed that number of leaves per plant produced high positive direct effect on yield. The character bulb weight had negative and negligible direct effect on bulb yield. The direct effect of TSS of bulb on bulb yield was positive and low. Same results found in past by other researchers like, Ghetia (1990) [8], Sutaria (1992) [18], Hosamani *et al.* (2010) [10], Dewangan and Sahu (2014) [6], Chattoo *et al.* (2015) [4] and Raghuwanshi *et al.* (2016) [14]. The residual effect at phenotypic level was 0.8860, which is high in magnitude.

Table 1: Phenotypic (P) and genotypic (G) correlation coefficients among 12 characters in onion

Traits	Cor.	Plant height (cm)	No. of leaves per plant	Bolting (%)	Days to maturity	Double onion bulb (%)	Bulb weight (g)	Neck thickness of bulb (cm)	Pseudo stem length (cm)	Bulb equatorial diameter (cm)	Bulb polar diameter (cm)	TSS of bulb (%)	Bulb yield per plot (kg)
Plant height (cm)	r _g	1.0000	0.2682*	-0.0748	0.5120**	-0.0355	-0.0145	-0.0969	-0.0522	-0.0214	0.1180	-0.0940	0.1256
	r _p	1.0000	0.0972	-0.0270	0.1225	-0.0393	0.0280	-0.0134	0.0044	0.1839	0.0246	-0.1097	0.1297
No. of leaves per plant	r _g		1.0000	-0.1985	0.1799	-0.0965	0.2233	0.5522**	-0.0765	0.1846	0.1632	-0.1572	0.5106**
	r _p		1.0000	-0.1558	0.1981	-0.0705	0.1993	0.2531*	-0.0843	0.2175	0.1162	-0.1293	0.2435*
Bolting (%)	r _g			1.0000	-0.2214	-0.0057	-0.1807	-0.1742	0.0278	-0.1528	0.1340	-0.1835	-0.2361*
	r _p			1.0000	-0.1458	-0.0068	-0.1481	-0.1250	0.0039	-0.0741	0.0867	-0.1372	-0.1606
Days to maturity	r _g				1.0000	-0.1728	0.5988**	0.6264**	-0.0963	-0.0412	0.1730	0.0948	0.1869
	r _p				1.0000	-0.1334	0.2978**	0.3079**	-0.0775	0.0682	0.0742	0.0653	0.0412
Double onion bulb (%)	r _g					1.0000	-0.3775**	-0.1075	0.0608	-0.0438	0.4615**	-0.0153	0.1694
	r _p					1.0000	-0.2238	-0.0753	0.0582	-0.0027	0.2786*	0.0008	0.1677
Bulb weight (g)	r _g						1.0000	0.1340	-0.0535	0.3261**	-0.2711*	0.1333	0.1083
	r _p						1.0000	0.0425	0.0118	0.2157	-0.0967	0.0449	-0.0314
Neck thickness of bulb (cm)	r _g							1.0000	-0.3627**	0.0732	0.4262**	-0.1434	0.3976**
	r _p							1.0000	-0.2349*	0.0806	0.2665*	-0.0991	0.2687*
Pseudo stem length (cm)	r _g								1.0000	0.1504	0.0161	-0.1777	0.1072
	r _p								1.0000	0.0065	-0.1024	-0.1137	0.0005
Bulb equatorial diameter (cm)	r _g									1.0000	0.0131	0.0427	0.1773
	r _p									1.0000	0.0356	-0.0174	0.0407
Bulb polar diameter (cm)	r _g										1.0000	0.0888	0.2471*
	r _p										1.0000	0.0103	0.1102
TSS of bulb (%)	r _g											1.0000	0.2087
	r _p											1.0000	0.1114
Bulb yield per plot (kg)	r _g												1.0000
	r _p												1.0000

*, ** Significant @ 5% and 1% levels, respectively

Table 2: Phenotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on bulb yield in onion

Traits	Plant height (cm)	No. of leaves Per plant	Bolting (%)	Days to maturity	Double onion bulb (%)	Bulb weight (g)	Neck thickness of bulb (cm)	Pseudo stem length (cm)	Bulb equatorial diameter (cm)	Bulb polar diameter (cm)	TSS of bulb (%)	Phenotypic correlation with bulb yield per plot
Plant height (cm)	0.1586	0.0220	0.0020	-0.0110	-0.0076	-0.0010	-0.0040	0.0004	-0.0090	0.0007	-0.0213	0.1297
Number of leaves per plant	0.0154	0.2258	0.0118	-0.0178	-0.0137	-0.0073	0.0759	-0.0077	-0.0107	-0.0032	-0.0251	0.2435*
Bolting (%)	-0.0043	-0.0352	-0.0758	0.0131	-0.0013	0.0054	-0.0375	0.0004	0.0036	-0.0024	-0.0267	-0.1606
Days to maturity	0.0194	0.0447	0.0111	-0.0898	-0.0258	-0.0109	0.0923	-0.0071	-0.0033	-0.0020	0.0127	0.0412

Double onion bulb (%)	-0.0062	-0.0159	0.0005	0.0120	0.1938	0.0082	-0.0226	0.0053	0.0001	-0.0076	0.0002	0.1677
Bulb weight (g)	0.0044	0.0450	0.0112	-0.0267	-0.0434	-0.0366	0.0128	0.0011	-0.0106	0.0026	0.0087	-0.0314
Neck thickness of bulb (cm)	-0.0021	0.057	0.0095	-0.0276	-0.0146	-0.0016	0.2999	-0.0215	-0.0040	-0.0073	-0.0193	0.2687*
Pseudo stem length (cm)	0.0007	-0.0190	-0.0003	0.0070	0.0113	-0.0004	-0.0705	0.0914	-0.0003	0.0028	-0.0221	0.0005
Bulb equatorial diameter (cm)	0.0292	0.0491	0.0056	-0.0061	-0.0005	-0.0079	0.0242	0.0006	-0.0491	-0.0010	-0.0034	0.0407
Bulb polar diameter (cm)	-0.0039	0.0262	-0.0066	-0.0067	0.0540	0.0035	0.0799	-0.0094	-0.0017	-0.0273	0.0020	0.1102
TSS of bulb (%)	-0.0174	-0.0292	0.0104	-0.0059	0.0001	-0.0016	-0.0297	-0.0104	0.0009	-0.0003	0.1944	0.1114

*, ** Significant @ 5% and 1% levels, respectively

Residual effect = 0.8860

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