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Correlation and path analysis study in diverse onion (*Allium cepa* L.) genotypes

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ABSTRACT : The association study resulted that the advantages of upgrading onion genotypes through simultaneous selection for equatorial diameter, followed by polar diameter, number of leaves plant^{-1} at 90 DAT, neck thickness, plant height at 90 DAT and TSS. Path co-efficient analysis revealed that polar diameter had highest positive direct effect followed by plant height at 60 DAT, TSS, plant height at 90 DAT, number of leaves plant^{-1} at 90 DAT and polar: equatorial diameter were the most important traits contributing towards bulb yield plant^{-1}. Direct selection of equatorial diameter, neck thickness, days to maturity, number of leaves plant^{-1} at 30 and 60 DAT and plant height at 30 DAT should be avoided instead of indirect selection. The highest production was observed in genotype OSR-1344 and Agrifound Light Red. Low incidence percentage of Stemphylium blight was found in genotype ON14-06 incidence percentage of thrips was found in genotype ON14-15. Considerable variability was observed among the genotypes for foliage character, bulb shape, bulb colour and bolting tendency. Foliage colour in green onion and shape and colour of onion bulb are most important characteristics to help customers in choosing cultivars in the market.

KEY WORDS : Onion, Character association, Path analysis, Yield

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Onion (*Allium cepa* L.) 2n=16 is an important bulb crop, belongs to the family Alliaceae and locally known as Pyaj. It is cultivated for food, medicines, religious purpose, spices and condiments since early times. Onion has strong flavoured due to presence of sulphur containing compound in very small quantity (about 0.005%) in the form of volatile oil allyl propyl disulphide ($C_6H_{12}O_2$) responsible for distinctive smell and pungency acts as gastric, stimulant and promotes digestion. Onion has many medicinal values and used for preparation of various Homeopathic, Unani and Ayurvedic medicines. India ranks first in area and second in production. Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Bihar, Andhra Pradesh, Rajasthan, Haryana and Tamil Nadu are the major onion growing states. The total area under production of onion in India during 2012-2013 was 1051.5 thousand ha with 16813.0 thousand MT production and 16.0 MT/ha productivity. However, in M.P. the total area was 111.73 thousand ha with total production 2691.00 thousand MT and productivity 24.1 MT/ha (Anonymous, 2013).

The genetic variability and its components are the genetic fractions of observed variability that provides measures of transmissibility of the variation and response to selection. The knowledge of pattern of inheritance of various characters are important consideration while, determining the most approximate breeding procedures applicable to any particular crop. The breeder's choice of the material for any improvement work consequently depends on the amount of genetic variability present.

The phenotype is often not the true indicator of its genotype, due to the masking effect of environment over genotype. Attempts have been made to determine the magnitude of heritable and non-heritable components and genetic parameters such as genotypic and phenotypic co-efficient of variation, heritability and genetic advance as percentage of mean in quantitative characters of onion. The previous workers who studied on the same objects *i.e*. Yaso (2007); Hosamani *et al*. (2010) and Adsul *et al*. (2010); Singh *et al*. (2010) and Jain *et al*. (2015). The estimates of correlation co-efficient analysis are more useful in the estimation of inter-relationship among the yield contributing components. Estimation of path co-efficient analysis gives the indication of the nature and extent of direct and indirect effect on genotypes of their own yield contributing components. These corroborate the earlier study of Hosamani *et al*. (2010) and Awale *et al*. (2011) for equatorial diameter Awale *et al*. (2011) and Saini and Maurya (2014) for polar diameter, Hosamani *et al*. (2010); Saini and Maurya (2014) for neck thickness, Hayder *et al*. (2007); Awale *et al*. (2011) and Saini and Maurya (2014) for plant height, Dhotre *et al*. (2010) for TSS. Hence, the present investigation was carried out to generate information in respect of some genetic parameter related to fruit yield and its attributing traits and identify better performing genotypes of onion in this location.

RESEARCH METHODS

The present investigation on correlation and path analysis in diverse onion (*Allium cepa* L.) of genotypes was conducted at Horticulture Complex, Department of Horticulture, College of Agriculture, J.N.K.V.V., Jabalpur (M.P.) under All India Network Research Project on Onion and Garlic (AINRPOG) during *Rabi* season 2014-2015. The experimental materials for the present investigation was comprised of 31 genotypes of onion were transplanted on plot size 3.0 x 2.0 m in Randomized Complete Block Design with three replications, to estimate the genetic variability, association and path analysis. The row and plant spacing was maintained at 15x10 cm, observations were recorded on the basis of five random competitive plants selected from each genotype separately for quantitative and qualitative parameters were evaluated as per standard procedure. The main objectives were in investigation estimate the genetic variability, correlation and path co-efficients analysis between yield and its attributing characters to identify better performing genotypes in onion.

The correlation co-efficients were calculated in all possible combinations taking all the characters into consideration at genotypic, phenotypic and environmental levels by using the formula as proposed by Miller *et al.* (1958) and the phenotypic correlations were tested for their significance by using "t" test. Path co-efficient analysis was worked out to show the cause and effect relationship between yield and various yield components and to partition the total correlation co-efficient into direct and indirect effects. This procedure was developed by Wright (1921) and as per consent used by Li (1956) and followed by Dewey and Lu (1959).

RESEARCH FINDINGS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Correlation co-efficient analysis:

The magnitude of genotypic correlation was higher than the phenotypic correlation for all the traits that indicated inherent association between various characters (Table 1). The findings are in agreement to Hosamani *et al.* (2010). Bulb yield plant^{-1} recorded highly significant and positive correlation with equatorial diameter, followed by polar diameter, number of leaves plant^{-1} at 90 DAT, neck thickness, plant height at 90 DAT and TSS indicating that these characters are the primary yield determinants in onion and can be improved through direct selection. These findings corroborate the earlier findings of Hosamani *et al.* (2010); Dhotre *et al.* (2010); Awale *et al.* (2011) and Saini and Maurya (2014) for equatorial diameter, Awale *et al.* (2011) and Saini and Maurya (2014) for polar diameter, Hosamani *et al.* (2010); Dhotre *et al.* (2010) and Saini and Maurya (2014) for neck thickness, Hayder *et al.* (2007); Awale *et al.* (2011); Saini and Maurya (2014) for plant height, Dhotre *et al.* (2010) for TSS and Panigrahi *et al.* (2014) in Potato.

Plant height at 30 DAT showed significant and positive correlation with plant height at 60 DAT, number of leaves plant^{-1} at 60 DAT, and number of leaves plant^{-1} at 30 DAT. Plant height at 60 DAT showed highly significant and positive with number of leaves plant^{-1} at 60 DAT, number of leaves plant^{-1} at 30 DAT, plant height at 90 DAT, neck thickness, number of leaves plant^{-1} at 90 DAT and equatorial diameter. Plant height at 90 DAT expressed a highly significant and positive correlation co-efficient with equatorial diameter, neck thickness,

Table 1 : Estimates of genotypic and phenotypic correlation co-efficients among yield and its contributing traits in onion

	Characters		Plant height (cm) 60DAT	Plant height (cm) 90DAT	Leaves plant at 30 DAT	Leaves plant at 60 DAT	Leaves plant^{-1} at 90 DAT	Polar diameter (cm)	Equatorial diameter (cm)	Polar: Equatorial	Neck thickness (cm)	TSS (^{0}Brix)	Days to maturity	Bulb yield plant^{-1}
			X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
X_1	Plant height (cm) 30	G	0.644	0.012	0.668	0.693	0.249	-0.198	0.048	-0.509	0.220	0.264	0.241	-0.041
	DAT	P	0.710**	0.089	0.278**	0.320**	0.124	-0.057	-0.011	-0.080	0.150	0.085	0.143	-0.072
X_2	Plant height (cm) 60	G	1	0.652	0.771	0.624	0.556	0.214	0.571	-0.770	0.670	-0.136	0.180	0.304
	DAT	P	1	0.385**	0.408**	0.512**	0.271**	0.150	0.265*	-0.129	0.324**	-0.062	0.080	-0.015
X_3	Plant height (cm) 90	G		1	0.750	0.706	0.522	0.748	0.804	-0.096	0.952	-0.376	0.085	0.575
	DAT	P		1	0.329**	0.442**	0.374**	0.482**	0.535**	-0.016	0.504**	-0.157	0.080	0.270**
X_4	Leaves plant^{-1} at 30	G			1	0.901	0.270	0.012	0.303	-0.601	0.466	-0.187	-0.082	0.147
	DAT	P			1	0.657**	0.178	-0.027	0.237*	-0.363**	0.419**	-0.102	-0.056	0.127
X_5	Leaves plant^{-1} at 60	G				1	0.108	0.075	0.224	-0.279	0.621	-0.341	-0.104	0.014
	DAT	P				1	0.107	0.080	0.195	-0.163	0.455**	-0.228*	-0.089	-0.012
X_6	Leaves plant^{-1} at 90	G					1	0.672	0.744	-0.112	0.476	0.119	0.249	0.799
	DAT	P					1	0.539**	0.635**	-0.094	0.349**	0.072	0.209*	0.607**
X_7	Polar diameter (cm)	G						1	0.896	0.396	0.600	-0.049	0.390	0.844
		P						1	0.750**	0.308**	0.504**	-0.061	0.353**	0.651**
X_8	Equatorial diameter	G							1	-0.248	0.710	-0.013	0.272	0.875
	(cm)	P							1	-0.167	0.534**	-0.007	0.264*	0.689**
X_9	Polar: Equatorial	G								1	-0.149	-0.093	0.288	0.103
	diameter (cm)	P								1	-0.046	-0.052	0.164	-0.120
X_{10}	Neck thickness (cm)	G									1	-0.112	-0.084	0.597
		P									1	-0.043	-0.060	0.405**
X_{11}	TSS (Brix)	G										1	-0.073	0.341
		P										1	-0.061	0.244*
X_{12}	Days to maturity	G											1	0.207

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : Path co-efficients showing direct and indirect effects of different characters on bulb yield per plant (g) in onion

Characters		Plant height (cm) 30DAT	Plant height (cm) 60DAT	Plant height (cm) 90DAT	Leaves /plant at 30 DAT	Leaves /plant at 60 DAT	Leaves /plant at 90 DAT	Polar diameter (cm)	Equatorial diameter (cm)	Polar: Equatorial	Neck thickness (cm)	TSS (Brix)	Days to maturity	Bulb yield plant^{-1}
Plant height (cm)	G	-0.043	0.416	0.003	-0.051	-0.033	0.008	-0.256	-0.019	-0.004	-0.104	0.126	-0.083	-0.041
30DAT	P	0.101	-0.212	-0.008	0.043	-0.020	0.028	-0.033	-0.002	0.017	0.003	0.018	-0.008	-0.072
Plant height (cm)	G	-0.028	0.646	0.157	-0.059	-0.030	0.017	0.277	-0.225	-0.006	-0.318	-0.065	-0.062	0.304
60DAT	P	0.072	-0.298	-0.033	0.064	-0.032	0.062	0.088	0.047	0.028	0.006	-0.013	-0.005	-0.015
Plant height (cm)	G	-0.001	0.421	0.241	-0.058	-0.034	0.016	0.967	-0.317	-0.001	-0.452	-0.179	-0.029	0.575
90DAT	P	0.009	-0.115	-0.085	0.051	-0.028	0.085	0.282	0.095	0.003	0.010	-0.033	-0.005	0.270**
Leaves plant^{-1} at	G	-0.029	0.498	0.180	-0.077	-0.043	0.008	0.016	-0.120	-0.005	-0.221	-0.089	0.028	0.147
30 DAT	P	0.028	-0.122	-0.028	0.156	-0.041	0.041	-0.016	0.042	0.077	0.008	-0.022	0.003	0.127
Leaves plant^{-1} at	G	-0.030	0.403	0.170	-0.069	-0.048	0.003	0.097	-0.088	-0.002	-0.295	-0.163	0.036	0.014
60 DAT	P	0.032	-0.153	-0.038	0.102	-0.062	0.024	0.047	0.034	0.035	0.009	-0.048	0.005	-0.012
Leaves plant^{-1} at	G	-0.011	0.359	0.126	-0.021	-0.005	0.031	0.869	-0.293	-0.001	-0.226	0.057	-0.085	0.799
90 DAT	P	0.013	-0.081	-0.032	0.028	-0.007	0.228	0.316	0.112	0.020	0.007	0.015	-0.012	0.607**
Polar diameter	G	0.009	0.138	0.180	-0.001	-0.004	0.021	1.293	-0.353	0.003	-0.285	-0.023	-0.134	0.844
(cm)	P	-0.006	-0.045	-0.041	-0.004	-0.005	0.123	0.585	0.132	-0.066	0.010	-0.013	-0.020	0.651**
Equatorial	G	-0.002	0.369	0.193	-0.023	-0.011	0.023	1.159	-0.394	-0.002	-0.337	-0.006	-0.093	0.875
diameter (cm)	P	-0.001	-0.079	-0.046	0.037	-0.012	0.145	0.439	0.177	0.036	0.010	-0.001	-0.015	0.689**
Polar: Equatorial	G	0.022	-0.498	-0.023	0.046	0.013	-0.003	0.512	0.098	0.008	0.071	-0.044	-0.099	0.103
dia.	P	-0.008	0.038	0.001	-0.057	0.010	-0.021	0.180	-0.030	-0.213	-0.001	-0.011	-0.009	-0.120
Neck thickness	G	-0.010	0.433	0.229	-0.036	-0.030	0.015	0.776	-0.280	-0.001	-0.474	-0.053	0.029	0.597
(cm)	P	0.015	-0.097	-0.043	0.065	-0.028	0.080	0.295	0.094	0.010	0.019	-0.009	0.003	0.405**
TSS (Brix)	G	-0.011	-0.088	-0.090	0.014	0.016	0.004	-0.063	0.005	-0.001	0.053	0.477	0.025	0.341
	P	0.009	0.018	0.013	-0.016	0.014	0.016	-0.036	-0.001	0.011	-0.001	0.212	0.004	0.244*
Days to maturity	G	-0.010	0.116	0.020	0.006	0.005	0.008	0.504	-0.107	0.002	0.040	-0.035	-0.343	0.207

Residual effect Genotypic– 0.0954 and Phenotypic –0.2888 polar diameter, number of leaves plant^{-1} at 60 DAT, number of leaves plant^{-1} at 90 DAT, number of leaves plant^{-1} at 30 DAT and bulb yield plant^{-1}. These findings corroborated the earlier findings of Awale *et al.* (2011) and Saini and Maurya (2014) bulb yield plant^{-1}. Number of leaves plant^{-1} at 30 DAT expressed significant and positive correlation with number of leaves plant^{-1} at 60 DAT, neck thickness and equatorial diameter while, it was found significant and negative correlation with polar: equatorial. Number of leaves plant^{-1} at 60 DAT expressed significantly and positively associated with neck thickness, while, it was found significant and negative association with TSS. Finding closely relate with the findings of Dhall and Brar (2013).

Association of polar diameter was recorded significant and positive with equatorial diameter, bulb yield plant^{-1}, neck thickness, days to maturity and polar: equatorial. The findings are in agreement to Hosamani *et al.* (2010); Awale *et al.* (2011); Dhall and Brar (2013) and Saini and Maurya (2014). Equatorial diameter was recorded highly significant and positive with bulb yield plant^{-1}, neck thickness and days to maturity. The findings corroborate the earlier findings Hosamani *et al.* (2010); Dhotre *et al.* (2010); Awale *et al.* (2011) and Saini and Maurya (2014). TSS was recorded highly significant and positive association with bulb yield plant^{-1}. The findings are in agreement to Hosamani *et al.* (2010); Dhotre *et al.* (2010); Barad *et al.* (2012) and Dewangan and Sahu (2014).

Path co-efficient analysis :

Path co-efficient analysis (Table 2) of different characters contributing towards bulb yield plant^{1} showed that polar diameter had the highest positive direct effect followed by plant height at 60, 90 DAT, TSS, number of leaves plant^{-1} at 90 DAT and polar: equatorial. The results are in propinquity with Aliya *et al.* (2007); Dhotre *et al.* (2010) and Hosamani *et al.* (2010) for polar diameter, Hosamani *et al.* (2010) and Sharma *et al.* (2015) for plant height, Hosamani *et al.* (2010) for TSS, Barad *et al.* (2012), for bulb weight, polar: equatorial and Sharma *et al.* (2015) for number of leaves plant^{-1}.The characters polar diameter, plant height at 60 DAT, TSS, plant height at 90 DAT, number of leaves plant^{-1} at 90 DAT and polar: equatorial had correlation co-efficient values at par with their direct effect on bulb yield plant^{-1}. This indicates true relationships with bulb yield plant^{-1} and direct selection for these traits would result in higher breeding efficiency for improving yield. Thus, these traits might be reckoned as the most important component traits of bulb yield plant^{-1}.Whereas, equatorial diameter had the highest negative direct effect on bulb yield plant^{1} followed by neck thickness, days to maturity, number of leaves plant^{-1} at 30 DAT, number of leaves plant^{-1} at 60 DAT and plant height at 30 DAT. The results are in propinquity with Dhall and Brar (2013) and Panigrahi *et al.* (2014) in potato and Sharma *et al.* (2015). But equatorial diameter, neck thickness, days to maturity, number of leaves plant^{-1} at 30 DAT, number of leaves plant^{-1} at 60 DAT and plant height at 30 DAT was positively correlated to it. This indicated that the indirect effect was the cause of correlation and the indirect causal factors are to be considered simultaneously for selection.

Conclusion :

It is concluded that the highest production was recorded in OSR-1344 and Agrifound Light Red. While, ON14-06 and ON14-15 are well performing genotypes for biotic resistance. The correlation and path analysis could make the selection easier and evaluated the traits found could help to establish adequate selection strategies in onion.

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