J. Hortl. Sci.
Vol. 10(2):237-241, 2015

Short communication

Studies on genetic variability, correlation and path analysis of yield and yield components in onion

R. Rajya Lakshmi
Horticultural Research Station
Venkataramannagudem, West Godavari Dist. -534101, India
Email: rajlaxmi_vzm@rediffmail.com

ABSTRACT

Evaluation of 11 varieties of onion, viz., N-2-4-1, B-780, AFLR, AFDR, AW, C-355, Pusa Red, L-28, Arka Kalyan, Phule Samarth and Local revealed that PCV was greater than GCV for all the traits. High values for heritability, coupled with moderate-to-high GCV and genetic gain, were noticed for neck thickness, weight and diameter of the bulb and bulb yield, which can be improved by simple selection. Moderate-to-high estimates for heritability accompanied by low GCV / genetic gain were observed for plant height and number of leaves, which warrant heterosis breeding for amelioration. Genotypic correlation coefficients were higher than the corresponding phenotypic ones for most of the characters, reflecting a predominant role of the heritable factors. Yield showed positive association with plant height, neck thickness, weight, length, equatorial diameter of the bulb, both at the phenotypic and genotypic levels. Path coefficient analysis revealed a positive direct effect with regard to plant height, neck thickness, weight, length and diameter of the bulb. Hence, these are the main characters contributing to yield potential of the onion plant. Therefore, it is suggested to lay emphasis on these traits while imposing selection for bulb yield in the onion crop.

Key words: Correlation, genetic advance, heritability, onion, variability

Onion ranks as the second highest crop in the world in terms of production, among vegetables. It is extensively used in human diet and has some medicinal properties. It is also exported from India to several countries. Onion cultivation in India is at a stage where a large number of varieties and hybrids have been developed, and are under use by the farmer. Onion production, productivity and prices fluctuate greatly. Low keeping-quality of recently bred varieties / hybrids and their susceptibility to diseases are a major threat to onion cultivation. However, onion production, in general, is very low and unstable. Systematic efforts are lacking on genetic improvement of this crop. The phenotype of an individual is determined by its genotype and the environment in which it grows, or is stored, and genotypes may respond differently to various environments. Effectiveness of selection as a breeding method depends on the magnitude of genetic variability, association between various characters, and, their direct and indirect effects on yield and heritability. The relative magnitude of these parameters helps us decide upon a breeding programme for achieving maximum advance in the minimum amount of time with available resources.

Yield is a complex trait influenced by several genetic factors that interact with the environment. Success in any breeding programme for yield improvement depends on the existing genetic variability in the base population, and on the efficiency of selection. For successful selection, it is necessary to study the nature of association of the trait in question with other relevant traits, as also the genetic variability available for the same. Path coefficient provides a better index for selection than mere correlation coefficient, as, it separates the correlation coefficients of yield and yield components into direct and indirect effects. Therefore, the present study was undertaken with an objective of evaluating the nature and magnitude of variability, character-association among various traits, heritability, and expected genetic gain in onion. Information on such aspects can be of great help in formulating an appropriate breeding strategy for genetic upgradation of this important commercial vegetable crop.

The experiment was laid out in Randomized Block Design, with three replications, during *rabi* season of 2006-07, 07-08 and 08-09 at Agricultural Research Station, Seethampeta. Eleven cultivars of onion, viz., N-2-4-1, B-

780, AFLR, AFDR, AW, C-355, Pusa Red, L-28, Arka Kalyan, Phule Samarth and Local, collected from various sources, were tested. Eight-week old, healthy seedlings of each variety were transplanted on flat beds at a spacing of 15cm x 10cm in a plot size of 3.6m x 3.0m. Recommended package of practices was adopted to raise the crop successfully. Observations were recorded on plant height, number of leaves/plant, neck thickness, polar bulb diameter, equatorial bulb diameter, bulb weight and total soluble solids, from five randomly-selected plants in each plot. Bulb yield was accounted for on per plot basis. Analysis of Variance (ANOVA) was carried out as per to Cochran and Cox (1950). Genotypic Coefficient of Variation (GCV) and Phenotypic Coefficient Variation (PCV) was estimated using the formula of Burton and Dewane (1952). Heritability in the broad sense (h2) and expected genetic advance (GA) were worked out according to Allard (1960). Analysis of covariance for all the combinations of traits was made and used for estimating correlations. Phenotypic and genotypic correlation was worked out as per Falconer (1964). Path coefficient of various traits under study was calculated as per Dewey and Lu (1959).

Mean square estimates were significant for all the traits, indicating sufficient diversity among varieties. The range of variation encountered and the genetic parameters estimated are presented in Table 1. The range was highest for bulb yield (165.9-241.4 q/ha), followed by bulb weight (18.33-54.63g) and plant height (29.86-40.83cm); and, this was medium-to-low for number of leaves per plant (7.1-10.9), TSS (17.48-21.14°B), length of bulb (2.18-5.4cm), equatorial diameter of bulb (1.38-4.07cm) and neck thickness (0.32-1.67cm).

Substantial difference within phenotypic (PCV) and genotypic coefficient of variation (GCV) was observed for all the attributes. High PCV and GCV were noticed for neck thickness (26.04, 28.13%), bulb yield (22.4, 24.86%), bulb weight (22.1, 24.21%) and equatorial diameter of bulb (20.83, 22.12%), while, these were moderate for length of bulb (18.19, 20.12%) and number of leaves per plant (9.35, 12.81%). This explains the high phenotypic and genotypic variability among accessions, and responsiveness of the traits for planning further improvement by selection. PCV was higher than the corresponding GCV for all the traits studied, which could be due to an interaction of the varieties with their environment (to some degree) suggesting that environmental factors influence expression of these characters. A high degree of disparity between PCV and GCV for number of leaves per plant and length of bulb depicted the susceptibility of these traits to environment fluctuations. A close correspondence between PCV and GCV for the rest of the traits implied their relative resistance to environmental variation. These results are in conformity with findings of Mohanty and Prusti (2001).

Estimates for heritability indicate the effectiveness with which selection can be expected, for exploiting the existing genetic variability (Burton and Dewane, 1952). In the present investigation, this ranged from 26.91% for TSS, to 89.54% for equatorial diameter of the bulb. A high heritability was observed for equatorial diameter of the bulb, neck thickness, weight of the bulb, bulb yield and polar bulb diameter. However, for plant height and number of leaves per plant, moderate heritability was observed. High heritability in the broad sense indicated that a large proportion of phenotypic variance was attributable to genotypic variance, and that the differences observed for these characters among genotypes were real; and, traits were less influenced by the environment, and, selection based on phenotypic performance for these traits would prove

Table 1. Range, mean, variance, coefficients of variation, heritability and genetic advance for bulb yield and other traits in onion

Trait	Mean	Range (Min – Max)	Genetic variance	Phenotypic variance	Genetic coefficient of variation	Phenotypic coefficient of variation	Heritability (%)	Genetic advance	Genetic advance as % of mean
Plant height (cm)	36.50	29.86 - 40.83	9.75	12.80	8.55	9.80	76.15	5.61	15.38
No. of leaves	9.68	7.10 - 10.90	0.82	1.54	9.35	12.81	53.00	1.36	14.06
Neck thickness (cm)	1.33	0.32 - 1.67	0.12	0.14	26.04	28.13	83.52	0.66	49.67
Equatorial bulb diameter (cm)	3.56	1.38 - 4.07	0.55	0.62	20.83	22.12	89.54	1.43	40.41
Bulb weight (g)	42.85	18.33 - 54.63	89.72	107.63	22.10	24.21	83.36	17.81	41.57
Polar bulb diameter (cm)	4.50	2.18 - 5.40	0.67	0.82	18.19	20.12	81.52	1.52	33.87
TSS (°B)	18.91	17.48 - 21.14	0.48	1.80	3.66	7.09	26.91	0.73	3.89
Yield q/ha	175.0	165.9 - 241.4	15.49	18.93	22.4	24.86	81.84	7.33	41.9

effective. Earlier workers have also obtained similar results, viz., high heritability for bulb yield (Singh *et al*, 1995), weight of the bulb (Mohanty and Prusti, 2001; Mahin *et al*, 2011), neck thickness and diameter of the bulb (Gurjar and Singhania, 2006; Hossain *et al*, 2008). Our study revealed a moderate heritability for number of leaves and plant height. These results are in consonance with Gurjar and Singhania (2006) and Mohanty (2001).

Heritability is not an absolute parameter, as, heritability can be high even when genetic variance is low. However, the expected genetic gain can be high only if genetic variance is high (Allard, 1960). Burton advocated that GCV, along with heritability estimates, can furnish a better picture of the amount of progress expected by phenotypic selection. Heritability estimates, in conjunction with genetic gain, are more effective and dependable in anticipating improvement through selection (Johnson *et al*, 1955). Expected genetic gain was high for neck thickness, bulb yield, bulb weight and equatorial diameter of the bulb; moderate for polar bulb diameter, and low for TSS, number of leaves and plant height. Similarly, Patil *et al* (1986) and Gurjar and Singhania (2006) reported high genetic gain for bulb yield and low genetic gain for TSS, which is in agreement with our study.

High values for heritability, coupled with moderate to high GCV and genetic gain, were noticed for neck thickness, weight and diameter of the bulb, and bulb yield. This may be attributed to additive gene action controlling inheritance of these traits. Phenotypic selection for their amelioration can be achieved by simple methods like mass selection or bulk method, after performing hybridization in the early generations (Panse, 1957). Moderate-to-high estimates for heritability, accompanied by low GCV and genetic gain, were observed for plant height and number of leaves. It can be inferred that these traits were conditioned by non-additive gene action and high genotype-environment interaction. The heritability is expressed due to a favourable influence of the environment rather than the genotype, and, simple selection would be rewarding. However, the genotypes can be improved by developing hybrid varieties or by isolation of transgressive segregates in heterosis breeding programmes. These results support the reports of Gowda *et al* (1988), Gurjar and Singhania (2006) and Mahin *et al* (2011).

Estimates for phenotypic and genotypic correlation coefficient (Table 2) imply that genotypic correlation was of a higher magnitude than the corresponding phenotypic correlation for most of the character combinations, thereby establishing a strong inherent relationship among the attributes studied. The yield showed a positive association with plant height, neck thickness, and weight, length, equatorial diameter of the bulb, both at the phenotypic and the genotypic level (Hossain *et al*, 2008; Marey *et al*, 2012).

Table 2. Phenotypic (P) and genotypic (G) correlation coefficients among various trais in onion

		No. of leaves	Neck thickness (cm)	Bulb weight (g)	Polar bulb diameter (cm)	Equatorial bulb diameter (cm)	TSS (ºB)	Yield (t/ha)
Plant height (cm)	P	0.5974	0.7774**	0.7399**	0.7518**	0.7530**	-0.3466	0.3980
	G	0.7674**	0.8117**	0.8761**	0.8222**	0.8283**	-0.6715*	0.4253
No. of leaves	P		0.7162*	0.6804*	0.6553*	0.7470**	-0.4960	0.0121
	G		0.8777**	0.8877**	0.8896**	1.0160**	-1.0975**	-0.0546
Neck thickness (cm)	P			0.7774**	0.8298**	0.8549**	-0.4416	0.1079
	G			0.8542**	0.9457**	0.9693**	-0.9267**	0.1445
Bulb weight (g)	P				0.8076**	0.8302**	-0.6307*	0.4339
	G				0.9310**	1.0037**	-1.0263**	0.4849
Polar bulb diameter (cm)	P					0.8689**	-0.5065	0.2822
	G					0.9566**	-0.8470**	0.2864
Equatorial Bulb diameter (cm)	P						-0.5323	0.2309
	G						-1.1355**	0.2238
TSS (ºB)	P							-0.2838
	G							-0.3709

*Significant at 5%; **Significant at 1%

Table 3. Path coefficients in onion

		Plant height (cm)	No. of leaves	Neck thickness (cm)	Bulb weight (g)	Polar bulb diameter (cm)	Equatorial bulb diameter (cm)	TSS (ºB)	Correlation with bulb yield
Plant height (cm)	P	(0.5755)	-0.2443	-0.5450	0.5170	0.0717	-0.0189	0.0420	0.3980
	G	(-0.4147)	-1.8000	0.4929	2.8565	-0.9097	0.3954	-0.1951	0.4253
No. of leaves	P	0.3438	(-0.4089)	-0.5020	0.4754	0.0625	-0.0188	0.0601	0.0121
	G	-0.3182	(-2.3455)	0.5329	2.8943	-0.9843	0.4850	-0.3188	-0.0546
Neck thickness (cm)	P	0.4474	-0.2928	(-0.7010)	0.5432	0.0791	-0.0215	0.0535	0.1079
	G	-0.3366	-2.0586	(0.6072)	2.7853	-1.0463	0.4627	-0.2692	0.1445
Bulb weight (g)	P	0.4259	-0.2782	-0.5450	(0.6987)	0.0778	-0.0208	0.0764	0.4339
	G	-0.3633	-2.0820	0.5187	(3.2606)	-1.0301	0.4791	-0.2982	0.4849
Polar bulb diameter (cm)	P	0.4327	-0.2679	-0.5816	0.5642	(0.0953)	-0.0218	0.0613	0.2822
	G	-0.3409	-2.0866	0.5742	3.0356	(-1.1064)	0.4567	-0.2461	0.2864
Equatorial bulb	P	0.4334	-0.3054	-0.5993	0.5801	0.0828	(-0.0251)	0.0645	0.2309
diameter (cm)	G	-0.3435	-2.3830	0.5886	3.2727	-1.0584	(0.4774)	-0.3299	0.2238
TSS	P	-0.1995	0.2028	0.3096	-0.4407	-0.0483	0.0134	(-0.1211)	-0.2838
(ºB)	G	0.2784	2.5742	-0.5627	-3.3464	0.9371	-0.5421	(0.2905)	-0.3709

P= Phenotypic; G=Genotypic (Values in parentheses are direct effects)

Inter-relationship between plant height, neck thickness, and weight, length, equatorial diameter of the bulb, was significant both at the phenotypic and the genotypic level. A negative correlation of bulb yield was observed with TSS. Earlier studies observed a positive association of bulb yield with plant height, neck thickness, and weight and equatorial diameter of the bulb (Raghu Ram and Singh, 2000; Mohanty and Prusti, 2001) and negative association with TSS (Gurjar and Singhania, 2006).

Path coefficient analysis was performed to assess direct and indirect effects of various traits on bulb yield (Table 3). Even though correlation analysis can quantify the degree of association between two characters, it does not provide reasons for such an association. A simple linear correlation coefficient is designed for detecting the presence of linear association between two variables; it cannot detect any other type of variable association. Thus, non-significant correlation coefficient values cannot be taken to imply absence of any functional relationship between two variables. Path coefficient analysis unravels this mystery by breaking the total correlation coefficient into components of direct and indirect effects.

Bulb-weight had the maximum direct positive effect on bulb-yield. Plant height and polar bulb diameter had a direct positive effect on bulb-yield at the phenotypic level. Neck thickness and equatorial diameter of the bulb showed direct positive effect on bulb-yield, at the genotypic level only. Very high and positive direct effect of bulb-weight even after counter-balance by its negative indirect effects via the number of leaves per plant, registered a strong positive direct effect on yield. On the other hand, number of leaves per plant displayed a negative direct effect on yield at both genotypic and phenotypic levels. Earlier workers have reported a direct positive effect of bulb-weight on bulb-yield (Mohanty and Prusti, 2001; Gurjar and Singhania, 2006)

Keeping in view the estimates for correlation coefficients and direct / indirect contribution of component traits to bulb-yield, selection should be done on the basis of bulb-weight, as, it has a positive direct effect and a high indirect effect via several other traits. Results of our study indicate that plant height, neck thickness, and weight, polar and equatorial diameter of the bulb, have a positive correlation with bulb-yield. Path coefficient analysis revealed a positive direct effect of plant height, neck thickness, and weight, polar and equatorial diameter of the bulb. Therefore, these are the main traits, contributing to yield potential in the onion plant. Thus, these characters should serve as an ideal criterion for selecting for yield in a crop of onion. This study also revealed that the wealth of variability available in onion offers good prospects for improvement of this crop in the near future.

REFERENCES

Allard, R.W. 1960. Principles of Plant Breeding. John Wiley & Sons, Inc., New York, pp. 89-98

Burton, G.W. 1952. Qualitative inheritance in grasses. Procs. Sixth International Grassland Congress, Ames, Iowa, USA, pp. 273-283

Cochran, W.G. and Cox, G.M. 1950. Experimental design. John Wiley & Sons, Inc., New York, USA, pp. 617

Dewey, D.R. and Lu, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy J.,* **51**:515-518

Falconer, D.S. 1964. Introduction to quantitative genetics. Oliver and Boyd, Edinburgh, pp. 312-324

Gowda, R.V., Singh, T.H. and Somkumar, R.G. 1988. Genetic variability in onion. *PKV Res. J*., **22**:146-148

Gurjar, R.S.S. and Singhania, D.L. 2006. Genetic variability, correlation and path analysis of yield and yield components in onion. *Indian J. Hort.,* **63**:53-58

Hossain, M.S., Khalekuzzaman, M., Rashid, M.H. and Rahman, M.S. 2008. Variability and interrelationship among yield and yield contributing characters in onion (*Allium cepa* L.). *J. Bio-Sci*., **16**:85-88

Johnson, H.W., Robinson, M.F. and Comstock, R.E. 1955. Estimation of genetic and environmental variability in soybeans. *Agronomy J*., **47**:314-318

Marey, R.A., Abo Dahab, A.M.A. and Karam S.S. 2012. Phenotypic correlation and path coefficient analysis in some onion genotypes grown in upper Egypt. *J. Agril. Res. Kafer EI-Sheikh Univ*., **38**:154-156

Mahin, R., Alireza, M., Nasser, M., Habib, D., Samaneh, K. and Fahimeh, Y. 2011. Evaluation of genetic variability of six Iranian landraces of onion (*Allium cepa* L.) for seed yield and yield components. *Russian Agril. Sci*., **37**:385-391

Mohanty, B.K. 2001. Genetic variability, inter-relationship and path analysis in *kharif* onion. *Annl. Agril. Res.,* **22**:349-353

Mohanty, B.K and Prusti, A.M. 2001. Studies on variability, heritability, correlation and path coefficients in *kharif* onion**.** *The Orissa J. Hort*., **29**:75-78

Panse, V.G. 1957. Genetics of quantitative characters in relation to plant breeding. *Indian J. Genet*, **17**:318-328

Patil, J.D., Desale, G.Y. and Kale, P.N. 1986. Genetic variability studies in onion (*Allium cepa* L.). *J. Maharashtra Agril. Univ*., **11**:281-283

Raghu Ram, N. and Singh, N. 2000. Studies on genetic variability in onion**.** Nat'l. Symp. Onion-Garlic production and post harvest management - challenges and strategies. 19-21 November 2000, Nasik, Maharashtra, India, pp. 188

Singh, J., Pandey, U.C. and Rana, M.K. 1995. Stability parameters for desirable traits in onion (*Allium cepa* L.) cultivars. *Haryana J. Hortl. Sci.,* **24**:60-64

(MS Received 24 April 2014, Revised 11 May 2015, Accepted 29 June 2015)