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Genetic variability, character association and path analysis studies in *Kharif* onion (*Allium cepa* var. *cepa* L.)

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ABSTRACT

Genetic variability, character association and path coefficients were studied in red onion involving 14 genotypes. High heritability with moderate to high GCV and genetic advance were recorded for double/split bulb per cent, fresh bulb weight and bulb yield as well as storage losses due to rotting, sprouting and total loss denoting their possibility of improvement with simple selection. Number of rings per bulb, TSS and dry matter content exhibited high heritability coupled with high expected genetic advance. Bulb yield exhibited positive and significant association with fresh bulb weight, equatorial diameter, TSS and number of rings per bulb and neck thickness was significantly correlated with rotting and total storage loss. Fresh bulb weight, equatorial diameter and bulb shape index exerted positive and direct effect and polar diameter and double/split bulb per cent showed negative direct effect on bulb yield. It was proposed to emphasize more on such characters to improve bulb yield.

Key words : *Kharif*, Onion, Variability, Heritability, Genetic advance, Character association, Path coefficient

Onion (*Allium cepa* var. *cepa* L.) is one of the most important vegetable crops grown in India. Karnataka is emerging as one of the major state contributing to a considerable extent to the county's production. Although many varieties have been released, the systematic crop improvement is lacking in onion when compared to other commercial vegetable crops. The present investigation was an attempt towards the improvement in onion to assess the nature and magnitude of genetic variability present in onion genotypes. Further, the extent of trait heritability in association with genetic advance was estimated. The inter-relationship among the characters was studied and correlation coefficients were partitioned into direct and indirect effects and their contribution towards bulb yield was studied.

MATERIALS AND METHODS

The present study was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *Kharif* 2008. Totally, 14 red onion genotypes were included for the study which comprised of improved and popular varieties as well as local races from different parts of Karnataka. Randomized Block Design with 3 replications was employed for the layout of experiment and the seeds were hand dibbled at 15 cm x 7 cm spacing in 2m x 2m plots. Five randomly selected plants in each block were used to record plant height and number of leaves (at 90 days after sowing), neck thickness (measured at harvest) and bulb characters. The data on days to maturity and double/split bulb per cent were computed on plot basis and bulb yield was converted to 'per ha' based on plot yield. Observations on shelf life were recorded at 3 months after storage on PLW, rotting, sprouting and total loss on weight basis and converted to percentage. The data subjected to analysis of variance, variability pattern, association among the attributes and path coefficient analysis.

RESULTS AND DISCUSSION

Analysis of variance revealed significant variation among the genotypes for all the 17 traits indicating wide variability in the collection. The estimates of mean, range and genetic parameters are given in Table 1. The range was maximum (31.32-93.86 g) for fresh bulb weight followed by double/split bulb per cent (12.67-53.75 %) and total loss (35.95-69.89 %) and minimum (0.86-1.25 %) for bulb shape index and neck thickness (9.50-13.40 mm). The genotypic and phenotypic coefficient of variations were computed based on the estimates of genotypic and phenotypic variances (Burton and Devane, 1953). High GCV values were lower than the respective PCV values for all the characters denoting environmental factors influencing their expression to certain extent. High GCV recorded for double/split bulbs (35.50) followed by fresh bulb weight (31.32) and loss due to rotting (25.69). Number of rings per bulb, bulb yield and loss due to rotting also exhibited high GCV and PCV. Total loss, TSS, dry matter content in bulbs, physiological loss in weight, number of leaves per plant, neck thickness showed moderate GCV and PCV. The rest of the characters

Table 1 : Estimation of mean, range and genetic variability parameters for seventeen quantitative characters in onion

Sr. No.	Characters	Mean	Range		GV	PV	GCV	PCV	H^2	GA	GAM
			Min.	Max.							
1.	Plant height (cm)	46.87	40.37	52.17	9.12	14.10	6.46	8.33	61.34	4.87	10.42
2.	Number of leaves	9.67	5.93	12.73	1.27	2.28	11.46	15.28	55.82	1.73	17.64
3.	Neck thickness (mm)	10.95	9.50	13.4	1.40	2.43	10.80	14.24	57.58	1.85	16.89
4.	Days to maturity	140.80	128.3	148.3	25.00	48.73	3.55	4.95	51.30	7.37	5.24
5.	Fresh bulb weight (g)	65.22	31.32	93.86	417.45	451.92	31.32	32.58	92.37	40.45	62.02
6.	Polar diameter of bulb (mm)	42.44	37.07	46.43	13.00	16.08	8.49	9.38	80.88	6.68	15.74
7.	Equatorial diameter of bulb (mm)	44.50	39.00	48.13	4.61	8.79	4.82	6.69	52.31	3.19	7.19
8.	Bulb shape index	0.95	0.86	1.25	0.007	0.008	9.20	9.63	91.21	17.29	18.09
9.	Number of rings per bulb	7.60	5.21	10.61	2.48	3.81	20.70	25.81	65.10	2.61	34.42
10.	Total soluble solids (%)	13.92	10.40	18.7	4.28	5.27	14.87	16.45	82.28	3.86	27.80
11.	Dry matter content in bulb (%)	15.56	12.37	19.39	4.21	5.55	13.19	15.14	75.94	3.68	23.68
12.	Doubles/splits (%)	32.71	12.67	53.75	134.88	164.3	35.50	39.18	82.08	21.67	66.25
13	Bulb yield (t/ha)	15.94	10.74	21.12	12.77	13.82	22.42	23.34	92.53	7.08	44.43
14.	PLW (%)	19.70	15.61	24.40	4.58	4.70	10.86	11.00	97.51	4.35	22.10
15.	Loss due to rotting (%)	17.77	10.81	26.57	20.43	22.93	25.69	25.76	97.10	9.20	51.79
16.	Loss due to sprouting (%)	13.30	7.90	18.97	9.39	9.92	23.04	23.68	94.65	6.14	46.18
17.	Total loss (%)	50.75	35.95	69.89	71.33	76.37	16.64	17.21	93.03	16.81	33.13

showed low genotypic and phenotypic coefficient of variations.

Close disparity between GCV and PCV indicated the high heritability for the particular character which was observed in bulb yield (92.53 %), fresh bulb weight (92.37 %), bulb shape index (91.21) and plant height, polar diameter, number of rings per bulb, TSS, dry matter content, double/split bulb per cent and all the storage characters. Remaining characters showed moderate heritability denoting higher difference between GCV and PCV which indicate high influence of environment.

High estimates of genetic advance over mean (GAM) were observed for double/split bulb per cent, fresh bulb weight, bulb yield, number of rings per bulb, TSS, dry matter content, whereas, days to maturity and equatorial diameter exhibited low GAM. Rest of the characters exhibited moderate GAM. High values of heritability associated with high GAM were manifested by fresh bulb weight, bulb yield, double/split bulb per cent, number of rings per bulb and TSS which can be attributed to additive gene action regulating their inheritance and the phenotypic selection for their improvement could be achieved by simple selection methods (Panse, 1957). High estimates of heritability coupled with low to moderate GAM were expressed by plant height, bulb shape index and polar diameter indicating non-additive gene effect and the simple phenotypic selection will not be rewarding for the improvement (Ananthan and Balakrishnamoorthy, 2007).

The inter-relationship among the character was estimated according to Panse and Sukhatme (1967) and the correlation coefficients for 17 characters are given in Table 2. Bulb yield exhibited positive and significant association with fresh bulb weight, equatorial diameter, number of rings per bulb and TSS. Even though, double/split bulb per cent had weak but negative association with bulb yield indicating negligible influence on yield, it has significance with respect to reducing marketability of the bulbs. Hence, it is suggested to handle carefully during breeding programmes. Among the inter-character associations, TSS marked

Table 2 : Inter character associations among seventeen characters in onion

	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_{13}	X_{14}	X_{15}	X_{16}	X_{17}
X_1	1.000	0.245	0.425	0.219	0.332	0.045	0.224	-0.117	0.160	0.158	0.082	-0.071	0.420	0.177	0.041	0.239	0.298
X_2		1.000	0.380	0.258	0.329	-0.008	0.350	-0.304	0.288	0.214	0.220	-0.194	0.142	0.483	0.472	0.466	0.336
X_3			1.000	-0.136	0.259	0.028	0.159	-0.108	0.102	0.206	0.252	-0.103	0.387	0.574*	0.463	0.588*	0.308
X_4				1.000	0.353	0.292	0.354	0.014	0.305	0.345	0.224	-0.072	-0.075	-0.197	-0.178	-0.190	0.302
X_5					1.000	0.474	0.600*	0.018	0.652**	0.596*	0.360	-0.316	0.237	0.048	-0.271	0.002	0.877**
X_6						1.000	0.439	0.713	0.397	0.253	0.243	-0.324	-0.260	-0.091	-0.330	-0.248	0.494
X_7							1.000	-0.314	0.438	0.465	0.439	-0.052	0.260	0.239	-0.033	0.195	0.569*
X_8								1.000	0.056	-0.104	-0.101	-0.282	-0.477	-0.300	-0.344	-0.430	0.064
X_9									1.000	0.407	0.100	-0.211	0.100	-0.079	-0.251	-0.100	0.659**
X_{10}										1.000	0.627*	0.279	0.231	-0.047	-0.128	0.002	0.560*
X_{11}											1.000	0.210	0.111	0.266	0.142	0.225	0.397
X_{12}												1.000	0.147	-0.271	-0.072	-0.121	-0.294
X_{13}													1.000	0.383	0.280	0.615*	0.154
X_{14}														1.000	0.829**	0.940**	0.056
X_{15}															1.000	0.880**	-0.300
X_{16}																1.000	-0.030
X_{17}																	1.000

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

X_1 – Plant height; X_2 – Number of leaves; X_3 – Neck thickness; X_4 – Days to maturity; X_5 – Polar diameter
X_6 – Equatorial diameter; X_7 – Bulb shape index; X_8 – Fresh bulb weight; X_9 – Number of rings per bulb; X_{10} – Total soluble solids
X_{11} – Bulb dry matter content; X_{12} – Doubles/split bulbs; X_{13} – Physiological loss in weight; X_{14} – Loss due to rotting; X_{15} – Loss due to sprouting
X_{16} – Total loss; X_{17} – Bulb yield

significant association with dry matter content (Patil, 1997). The positive and significant association of equatorial diameter, TSS and number of rings per bulb with bulb yield could be attributed to their significant association with fresh bulb weight which is a chief yield attributing characters. Similarly, significant association between equatorial diameter and fresh bulb weight (Haydar *et al.*, 2007). Neck thickness exhibited positive and significant association with loss due to rotting and total loss (Patil, 1997). The total loss exhibited the positive and significant association with its components, physiological loss in weight, loss due to rotting and loss due to sprouting (Satodiya and Singh, 1997).

Path coefficient analysis was carried out as suggested by Dewey and Lu (1959) excluding the storage attributes. The estimates of direct and indirect effects are presented in Table 3. With bulb yield, significantly associated characters, fresh bulb weight, equatorial diameter and TSS exhibited positive direct effects. Similarly, Aliyu *et al.* (2007) reported positive direct effects by number of leaves per plant, bulb weight and equatorial diameter. Even though, bulb shape index showed highest direct positive effect on yield due to high indirect contribution via polar diameter but, the negative indirect effects via, equatorial diameter, double/split bulb per cent and number of leaves lower the effect and resulted in weak association of bulb shape index with bulb yield. Polar diameter exhibited high negative direct effect on yield. These features clearly signify the influence of bulb dimensions bulb yield.

An overview of character association and path analysis indicated that, the selections considering fresh bulb weight, equatorial diameter, polar diameter, bulb shape index, TSS and double/split bulb per cent will be more useful for the breeder to increase the bulb yield as well as higher marketable bulbs as these characters influence the yield directly or indirectly via other characters.

Table 3 : Direct and indirect effects of different characters on bulb yield in onion

	Correlation with yield	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	0.298	-0.0218	-0.0053	-0.0093	-0.0048	-0.0072	-0.0010	-0.0049	0.0025	-0.0035	-0.0034	-0.0018	0.0015
X_2	0.336	0.0058	0.0238	0.0090	0.0061	0.0078	-0.0002	0.0083	-0.0072	0.0069	0.0051	0.0052	-0.0046
X_3	0.308	0.0396	0.0354	0.0932	-0.0127	0.0242	0.0026	0.0148	-0.0101	0.0095	0.0192	0.0235	-0.0096
X_4	0.302	-0.0007	-0.0008	0.0004	-0.0033	-0.0012	-0.0010	-0.0012	0.0000	-0.0010	-0.0011	-0.0007	0.0002
X_5	0.877	0.2121	0.2102	0.1654	0.2255	0.6388	0.3028	0.3833	0.0115	0.4165	0.3807	0.2300	-0.2019
X_6	0.494	-0.0574	0.0120	-0.0357	-0.3725	-0.6047	-1.2758	-0.5601	-0.9096	-0.5065	-0.3228	-0.3100	0.4134
X_7	0.569	0.2148	0.3356	0.1525	0.3394	0.5753	0.4209	0.9588	-0.3011	0.4200	0.4459	0.4209	-0.0499
X_8	0.064	-0.1475	-0.3831	-0.1361	0.0176	0.0227	0.8986	-0.3958	1.2604	0.0706	-0.1311	-0.1273	-0.3554
X_9	0.659	0.0337	0.0606	0.0215	0.0642	0.1379	0.0836	0.0922	0.0118	0.2106	0.0857	0.0211	-0.0444
X_{10}	0.560	0.0020	0.0028	0.0027	0.0045	0.0077	0.0033	0.0060	-0.0013	0.0053	0.0130	0.0081	0.0036
X_{11}	0.397	0.0118	0.0317	0.0364	0.0323	0.0519	0.0351	0.0633	-0.0146	0.0144	0.0904	0.1443	0.0303
X_{12}	-0.294	0.0055	0.0150	0.0080	0.0056	0.0244	0.0250	0.0040	0.0218	0.0163	-0.0216	-0.0162	-0.0773

Residual effect = 0.4342 (Underlined values indicate direct effects)

X_1 – Plant height X_2 – Number of leaves X_3 – Neck thickness X_4 – Days to maturity X_5 – Polar diameter
X_6 – Equatorial diameter X_7 – Bulb shape index X_8 – Fresh bulb weight X_9 – Number of rings per bulb

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