Genetic variability and character association for yield and its component traits in kharif Onion genotypes

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ABSTRACT: A study was conducted involving 33 genotypes of kharif onion to discern the yield characters and component traits in relation to genetic variability and path coefficient analysis. The estimates of means due to genotypes were highly significant for all the characters, indicating the presence of genetic diversity in the existing material. The variation was highest for marketable bulb yield followed by average weight of marketable bulb. Genotype BSKO-1256 performed best in terms of yield and gave marketable yield of 296.90 q/ha followed by ASKO-1231 having 291.90 q/ha. Further, high heritability coupled with high genetic advance was observed in marketable yield followed by dry weight of bulb and average weight of marketable bulb. The association analysis revealed that onion genotypes can be improved by simultaneous selection of traits like plant height, collar thickness, polar diameter, equatorial diameter, fresh weight of bulb and TSS. Path coefficient showed these characters had positive direct effect on average weight of marketable bulb yield and hence purposeful selection based on these traits would help in improvement of kharif onion genotypes. It was concluded that genotype BSKO-1256 and ASKO-1231 could be utilized for onion crop improvement. The characters association and path analysis showed that selection of genotypes could be based on performance in terms of morphological characters involved in the improvement of marketable bulb yield.

Key words: Correlation, genotypes, kharif onion, path analysis, variability

Onion (*Allium cepa* L.) belongs to the family Amyrillidaceae, is an important bulb vegetable crop cultivated in more than hundred countries. It is a high value crop and its market price fluctuates as per supply and availability. Onion is an important crop as it earns a major portion of foreign exchange for the country. It is consumed as vegetable as well as a spice. Green leaves, immature bulbs and mature bulbs are preferred by consumers for kitchen purpose. Moreover, onion has many medicinal values and used for preparation of various Homeopathic, Unani and Ayurvedic medicines. Onion contains 25 active compounds that appear to inhibit the growth of cancerous cells wherein alliin being the main constituent. Onion has been found to contain organo-sulfur compounds that help combat cardiovascular disease, diabetes, cataracts and cancer, inhibit strokes, lower blood pressure and cholesterol level and stimulate the immune system. The potassium salts and the flavonoides quercetin present in onion perform an anti-inflammatory action. The essential oil present in onion acts as an expectorant, antiseptic, antifungal, anticoagulant, anthelmintic, balsamic, rubifacient and has analgesic and diuretic properties and reduce high-blood pressure. About 70% of the total onion production in India is confined to *rabi* season crop and remaining 30% is associated with *kharif* season crop. The area of onion production in Madhya Pradesh is 57.3 thousand hectares and annual total production is 952.3 thousand tons with productivity of about 16.6 tons per hectare. Rainy season onion cultivation is new preface in central India mainly for fresh bulbs. Due to increase in demand of onion, varietal improvement programs are necessary and to know the pattern of inheritance of various characters during *kharif* season. Keeping in view of the above, the present study was conducted to gather information of various genotypes and to study the relationships among the different traits of onion to discern the direct and indirect effect of these traits on bulb yield during rainy season.

MATERIALS AND METHODS

An experiment was conducted at Horticulture complex, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh. A total of 33 genotypes of *kharif* onion were laid out in Randomized Complete Block Design with 3 replications having 3m x 2m plot. Onion seedlings were transplanted as late *kharif* during

last week of August 2012 in spacing of 15 cm row to row and 10 cm plant to plant. All recommended cultural practices for onion were adopted to conduct the experiment. The observations on plant height (cm), number of leaves per plant, collar thickness (cm), neck thickness (cm), equatorial diameter of bulb (cm), polar diameter of bulb (cm), average weight of marketable bulb (g), fresh weight of bulb (g), dry weight of bulbs (%), marketable yield (q/ha), total soluble solids (TSS) and days to harvest were recorded. The data obtained in respect to all the characters were subjected to statistical analysis as described by Panse and Sukhatme (1963) to find out overall total variability present in the materials under study. Heritability and genetic advance were calculated by using the methods suggested by Hanson *et al.* (1956) and Johnson *et al.* (1955), respectively. Correlation coefficients and path coefficient analysis were worked out to show the cause and effect relationship between yield and various yield components and to partition the total correlation coefficient into direct and indirect effects as suggested by Miller *et al.* (1958) and Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance due to genotypes was highly significant for all the characters, indicating the presence of genetic diversity in the studied material. The data presented in Table 1 exhibited the existence of variability as plant height ranged from 50.13 cm for ASKO-1210 to 62.06 cm for CSKO-1269 with mean as 55.24 cm. Number of leaves per plant was lowest (9.86) in ASKO-1210 and highest (13.36) in ASKO-1227 with a mean value of 11.39. Collar thickness varied from 1.15 cm to 1.56 cm with an average value of 1.32 cm. The genotype ASKO-1227 was recorded with maximum collar thickness (1.56 cm) while minimum collar thickness was recorded (1.15 cm) in genotype BSKO-1259. Neck thickness varied from 0.66 cm for ASKO-1271 to 0.83 cm for CSKO-1233. The equatorial and polar diameter showed minimum value as 3.34 cm and 3.96 cm, respectively, for ASKO-1201. However, maximum equatorial (5.31cm) and polar diameter (5.49cm) were recorded for genotypes ASKO-1231 and CSKO-1233. The total bulb yield ranged from 201.63 q/ha for ASKO-1222 to 332.2 q/ha for ASKO-1231, however, marketable yield varied between 115.67 q/ha for ASKO-1271 and 296.90 q/ha for BSKO-1256. The average weight of marketable bulb was lowest in ASKO-1238 (33.76 g) and highest in CSKO-1266 (49.00 g). The maximum percentage of marketable bulbs (87.7%) was

Table 1: Genetic parameters of various characters in onion

Characters	Grand mean	Range		Coefficients of variations		Heritability	Genetic advance	Genetic advance
		Min.	Max.	Phenotypic	Genotypic	(%)		% of mean
Plant height (cm)	55.24	50.13	62.06	7.36	6.55	79.17	6.63	12.01
Leaves per plant	11.39	9.86	13.36	9.43	7.06	56.25	1.24	10.90
Collar thickness (cm)	1.32	1.15	1.56	7.66	5.90	59.25	0.12	9.35
Neck thickness (cm)	0.76	0.66	0.83	8.10	2.79	11.87	0.01	1.98
Polar diameter (cm)	4.78	3.96	5.49	9.48	7.72	66.33	0.62	12.95
Equatorial diameter (cm)	4.48	3.34	5.31	11.65	9.39	65.06	0.70	15.61
TSS (%)	12.73	10.56	15.0	14.52	13.40	85.15	3.67	25.47
Days to harvest	123.82	120.83	129.0	2.21	1.95	77.78	4.39	3.54
Fresh weight of bulb (g)	37.20	30.56	43.43	9.94	8.96	81.31	6.19	16.65
Dry weight of bulbs (%)	14.31	9.93	18.93	16.37	15.14	85.60	4.13	28.86
Marketable yield q/ha	188.83	115.67	296.9	26.37	22.49	72.70	74.59	39.50
Average weight of marketable bulb (g)	41.82	33.76	49.0	10.13	9.54	88.56	7.73	18.49

obtained from ASKO-1231. The TSS ranged from 10.56% for ASKO-1201 to 15.0% for CSKO-1233. Onion genotypes were harvested from 120.8 days to 129 days with an average of 123.8 days. The existence of variability was due to the diverse genotypes which were quite similar to the reports of Mohanty (2001), Khar *et al.* (2006) and Singh *et al*. (2010).

Estimation of components of genetic parameters of variation for yield and its attributes exhibited a wide range of variation for the characters studied. Results indicated that the values of phenotypic coefficient of variations were higher in magnitude than that of genotypic coefficient of variation for all the characters indicating that the environment had a great role in influencing the expression of the characters. On perusal of Table 1, the phenotypic (PCV) and genotypic (GCV) coefficient of variation varied from 2.2 to 26.37% and 1.95 to 22.49%, respectively. The high PCV and GCV were recorded for marketable yield and dry weight of the bulbs. The high values showed greater phenotypic and genotypic variabilities among the genotypes and responsiveness of the attributes for making further improvement by selection. The results were close conformity to the findings of Gurjar and Singhania (2006) and Singh *et al.* (2010). However, these coefficient of variations exhibited low for characters like days to harvest (2.21%), plant height (7.3%), collar thickness (7.66%), neck thickness (8.10%), number of leaves per plant (9.43%) and polar diameter (9.48%), indicating the potential of heterosis breeding for their amelioration. Whereas these were moderate for characters like TSS (14.52%) and average weight of marketable bulbs (10.13%). The present findings were similar to those of Gurjar and Singhania (2006) and Morsy *et al.* (2011). The highest heritability in broad sense obtained for average weight of marketable bulbs (88.56%), TSS (85.15%), dry weight of bulbs (85.6%), plant height (79.17%), days to harvest (77.8%) and marketable yield (72.7%) indicated that these characters were least influenced by environmental modification. However, medium heritability was observed in polar diameter (66.3%), equatorial diameter (65.06%), collar thickness (59.25%) and number of leaves per plant (56.25%). The lowest heritability was recorded in neck thickness (11.87%). The results were close proximate to those of Mohanty (2001), Hayder *et al.* (2007) and Yaso (2007). The genetic advance as percentage of mean was recorded highest for marketable yield (39.50%), dry weight of bulbs (28.86%) and TSS (25.47%). Whereas average weight of marketable bulbs (18.49%), equatorial diameter (15.6%), polar diameter (12.95%), plant height (12.01%), number of leaves per plant (10.9%) and collar thickness (9.35%) exhibited moderate value and days to harvest (3.54%) and neck thickness (1.98%) showed the lowest estimates (Table 1). High heritability coupled with high genetic advance for traits like marketable yield followed by dry weight of bulbs, fresh weight of bulbs and TSS indicated higher response for selection of high yielding genotypes as these characters are governed by additive gene action. The results of the present study corroborated with the findings of Melke and Ravishankar (2006) and Yaso (2007).

As presented in Table 2, the plant height expressed high significant and positive association at genotypic level with neck thickness (0.08), polar diameter (0.24), TSS (0.42), days to harvest (0.44) fresh weight of bulb (0.56), dry weight of bulb (0.35), marketable yield (0.38) and average weight of marketable bulb (0.57). Number of leaves per plant exhibited positive and significant correlation with neck thickness (0.31), polar diameter (0.36), TSS (0.20), days to harvest (0.26), fresh weight of bulb (0.22) and average weight of marketable bulbs, however, significant negative correlation was also observed for collar thickness (-0.58) and dry weight of bulbs (-0.22). With increase in plant height and number of leaves, more photosynthesis occured and matter accumulated in bulbs for weight and size improvement. Collar thickness had positive and significant correlation with neck thickness, days to harvest and dry weight of bulb and only positive relationship with fresh weight of bulb, marketable yield and average weight of marketable bulb which compensated the negative relationship with polar diameter and equatorial diameter. Neck thickness showed positive and/or significant correlation with all the characters under study. Similar observations were also recorded by Trivedi *et al.* (2006).

Polar and equatorial diameter and size determinants of bulb had also positive and/or significant relationship with all the characters except collar thickness which indicated that when these two variables increase, weight of marketable bulb and marketable yield also increase simultaneously. TSS was positively correlated with all the characters except dry weight of bulbs and collar thickness. Similar trend were observed for days to harvest, fresh weight of bulb, dry weight of bulbs, marketable yield which showed significant and positive correlation with average weight of marketable bulbs/plant at genotypic and phenotypic level both.

Table 2: Estimates of genotypic and phenotypic correlation coefficients

Characters		Plant height (cm)	Leaves per plant	Collar thickness (cm)	Neck thickness (cm)	Polar diameter (cm)	Equatorial diameter (cm)	TSS (%)	Days to harvest	Fresh weight of bulb (g)	Dry weight of bulbs (%)	Marketable yield (q/ha)	Average weight of marketable bulb (g)
Plant height (cm)	G		0.089	-0.08	0.085**	0.240**	0.177	0.428**	0.445**	0.566**	0.356**	0.389**	0.572**
	P		0.097	-0.046	0.280**	0.145	0.130	0.328**	0.370**	0.421**	0.272**	0.318**	0.469**
Leaves per plant	G			-0.589**	0.371**	0.362**	0.094	0.203*	0.267**	0.224*	-0.227*	0.175	0.298**
	P			-0.366**	0.216*	0.282**	0.133	0.154	0.110	0.151	-0.166	0.186	0.220*
Collar thickness(cm)	G				0.398*	-0.381	-0.088	-0.29**	0.220*	0.167	0.602**	0.031	0.129
	P				0.065	-0.199*	-0.042	-0.225	0.202	0.119	0.398**	0.028	0.075
Neck thickness(cm)	G					0.527**	0.130	0.325**	0.446**	0.671**	0.233*	0.330**	0.733**
	P					0.228*	0.199*	0.109	0.364**	0.255*	0.042	0.178	0.213*
Polar diameter cm)	G						0.448**	0.574*	0.164	0.373**	0.142	0.540**	0.507**
	P						0.443**	0.364**	0.107	0.248*	0.094	0.318**	0.384**
Equatorial diameter(cm)	G							0.329**	0.047	0.486**	0.309**	0.625*	0.474**
	P							0.224*	0.015	0.363**	0.191	0.370*	0353**
TSS (%)	G								0.276**	0.452**	-0.07	0.141	0.475**
	P								0.254*	0.372**	-0.047	0.156	0.406**
Days to harvest	G									0.370**	0.276**	0.145	0.475**
	P									0.318**	0.251*	0.156	0.406**
Fresh weight of bulb (g)	G										0.482**	0.807**	0.981**
	P										0.423**	0.644**	0.916**
Dry weight of bulbs (%)	G											0.510**	0.487**
	P											0.397**	0.459**
Marketable yield (q/ha)	G												0.807**
	P												0.669**
Average weight of marketable bulb (g)	G												
	P												

Table 3: Estimates of genotypic and phenotypic path coefficients showing direct and indirect effect on average weight of marketable bulb

Characters		Plant height (cm)	Leaves per plant	Collar thickness (cm)	Neck thickness (cm)	Polar diameter (cm)	Equatorial diameter (cm)	TSS (%)	Days to harvest	Fresh weight of bulb (g)	Dry weight of bulbs (%)	Marketable yield (q/ha)
Plant height (cm)	G	-0.089	-0.008	0.013	0.051	0.068	-0.0008	-0.097	0.032	0.698	0.030	-0.126
	P	0.075	0.006	-0.0006	-0.019	0.022	-0.006	0.012	0.010	0.318	0.022	0.026
Leaves per plant	G	-0.007	-0.095	0.105	0.019	0.103	-0.0004	-0.046	0.019	0.276	-0.019	-0.057
	P	0.0072	0.070	-0.005	-0.014	0.044	-0.006	0.005	0.003	0.114	-0.013	0.015
Collar thickness (cm)	G	0.006	0.056	-0.179	0.024	-0.109	0.0004	0.06	0.016	0.205	0.051	-0.010
	P	-0.003	-0.025	0.014	-0.004	-0.003	0.002	-0.008	0.005	0.089	0.033	0.002
Neck thickness (cm)	G	-0.075	-0.030	-0.071	0.060	0.151	-0.0006	-0.074	0.032	0.828	0.020	-0.107
	P	0.021	0.015	0.0009	-0.069	0.035	-0.010	0.004	0.004	0.092	0.003	0.015
Polar diameter (cm)	G	-0.021	-0.034	0.068	0.032	0.286	-0.0002	-0.130	0.012	0.460	0.012	-0.175
	P	0.010	0.019	-0.002	-0.015	0.156	-0.023	0.013	0.003	0.187	0.007	0.026
Equatorial diameter (cm)	G	-0.015	-0.008	0.015	0.007	0.128	-0.004	-0.075	0.003	0.600	0.026	-0.203
	P	0.009	0.009	-0.0006	-0.013	0.069	-0.051	0.008	0.0004	0.274	0.015	0.031
TSS (%)	G	-0.038	-0.019	0.052	0.019	0.164	-0.001	-0.228	0.020	0.558	-0.006	-0.045
	P	0.024	0.010	-0.033	-0.007	0.056	-0.011	0.038	0.007	0.281	-0.003	0.013
Days to harvest	G	-0.039	-0.025	-0.039	0.027	0.047	-0.0002	-0.063	0.073	0.456	0.023	-0.047
	P	0.027	0.007	0.002	-0.010	0.016	-0.0007	0.009	0.028	0.240	0.020	0.008
Fresh weight of bulb (g)	G	-0.050	-0.021	-0.029	0.040	0.107	-0.002	-0.103	0.027	1.235	0.041	-0.262
	P	0.031	0.010	0.001	-0.017	0.038	-0.018	0.014	0.091	0.756	0.035	0.054
Dry weight of bulbs (%)	G	-0.031	0.021	-0.107	0.014	0.040	-0.001	0.016	0.020	0.595	0.085	-0.166
	P	0.020	-0.011	0.005	-0.002	0.014	-0.009	-0.001	0.007	0.319	0.083	0.033
Marketable yield (q/ha)	G	-0.034	-0.016	-0.005	0.020	0.154	-0.003	-0.032	0.010	0.996	0.043	-0.325
	P	0.023	0.013	0.0004	-0.012	0.049	-0.019	0.005	0.002	0.487	0.033	0.084

Phenotypic residual value : 0.1084
Genotypic residual value : 0.0035

Dhotre *et al*. (2010) and Morsy *et al.* (2011) also obtained the similar results.

Path coefficient analysis (Table 3) of different characters contributing towards average weight of marketable bulb showed that high positive genotypic direct effect exerted through fresh weight of bulb, polar diameter, dry weight of bulb and neck thickness, whereas negative direct effect exerted through marketable yield, TSS, collar thickness, leaves per plant, plant height and equatorial diameter. Although, the positive direct effect compensated the negative direct effect and influenced the maximum average weight of marketable bulb. These results are in accordance with the findings reported by Mohanty (2001) and Gurgar and Singhania (2006). Plant height and number of leaves per plant had shown positive indirect effect via fresh weight of bulb, polar diameter, days to harvest and per cent dry weight of bulb at both genotypic and phenotypic level while the negative indirect effect was shown by equatorial diameter and marketable yield at genotypic level. However, the characters involved in the negative indirect effect showed positive correlation with plant height and number of leaves per plant thus resulting in the improvement of average weight of marketable bulb within the genotypes studied. Marketable bulb yield had shown positive indirect effect via polar diameter, fresh weight of bulb, days to harvest and dry weight of bulb at both genotypic and phenotypic level but the negative indirect effect was shown by plant height, number of leaves per plant, collar thickness, TSS and equatorial diameter at genotypic level. However, the characters showing negative indirect effect had shown positive correlation with average weight of marketable bulb which is in confirmation with the findings of Mohanty (2001) and Meena *et al*. (2007).

CONCLUSIONS

The various genotypes of *kharif* onion showed wide range of variability for all characters. The genotypes BSKO-1256 and ASKO-1231 could be utilized further for crop improvement. The high heritability coupled with high genetic advance was observed in marketable yield, dry weight of bulb and average weight of marketable bulb. The characters association and path analysis indicate that selection of genotypes could be made on performance basis for plant height, collar thickness, polar diameter, equatorial diameter, fresh weight of bulbs and TSS which were directly involved in the improvement of marketable bulb yield.

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