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Genetic variability in late *kharif* (*Rangada*) onion (*Allium cepa* L.)

R.K. Singh*, S.R. Bhonde and R.P. Gupta

*National Horticultural Research and Development Foundation, Chitegaon Phata, Post-Darna Sangavi, Taluqa-Niphad, Nashik, 422 003, Maharashtra, India. *E-mail: singhrknbpgr@yahoo.com.*

Abstract

An investigation was carried out to study the genetic variability in late *kharif* germplasm of onion at Nashik, Maharashtra (India). The mean data indicated that the highest gross yield (41.17 t/ha) and marketable yield (39.13 t/ha) was recorded in line 744 and was at par with line 682 (39.07 t/ha) and (34.39 t/ha). A wide range of variability was observed for gross yield (19.65 to 41.17 t/ha), marketable yield (10.05 to 39.13 t/ha), bulb size index (20.40 to 35.90 cm^2), bolters (0.00 to 40.83%), doubles (0.00 to 47.50 %), thrips/plant (8.75 to 25.80) and plant height (54.95 to 71.80 cm). A higher magnitude of coefficient of variation was recorded for bolters (112.78 -112.65%), followed by doubles (86.35–86.16%), thrips/plant (37.55-37.36) and marketable yield (29.34 and 29.90 %). Highest heritability was noted in doubles, gross yield, bulb diameter, plant height, bolters and thrips/plant. The genetic advance as percent of mean ranged from 3.93 to 231.73. High genetic advance noted in bolters (231.73 %), doubles (177.12 %), thrips/plant (76.56%) and marketable yield (54.53%) and rest of others characters showed medium to low genetic advance. Gross yield, marketable yield, doubles, bolters, thrips/plant and bulb size index indicated higher estimates of genetic advance as percent of mean coupled with high heritability, suggesting the involvement of additive genetic variance for these traits. Marketable yield was significantly and positively correlated with plant height, neck thickness, bulb diameter, bulb size index, weight of 20 bulbs, and gross yield and negatively correlated with bolters, doubles and days for bulb initiation at genotypic and phenotypic levels. Plant height, leaves/plant, bulb diameter, bulb size index, weight of 20 bulbs and days for bulbs initiation. The study revealed that a wide range of variability for important characters exists in germplasm offering a good scope for developing improved onion varieties suitable for cultivation in Maharashtra.

Key words: *Allium cepa*, correlation, late *kharif*, heritability, onion, variability

Introduction

India is second largest producer of onion in the world after China. It is cultivated throughout the country during *kharif*, late *kharif* and *rabi* seasons. The main onion growing states in India are Maharashtra, Gujarat, Karnataka, Tamilnadu, Orissa, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Bihar and Punjab. About 66.83 million tons of onions are produced in the world from 3.73 million hectares area. India, being major onion producing country, produces 8.18 million tons from 0.80 million hectare land. Both mature and immature bulbs are used in various ways (Singh *et. al.*, 2004) and has many medicinal properties. An intermediate crop of onion between *kharif* and *rabi* is also taken in Maharashtra locally known as *rangada*. It is unique cultivation for this state with vast acreage and surplus onion production in this particular season. However, being off-season cultivation, the crop growth is totally different than *kharif* and *rabi* cultivation (Patil *et al*., 2000b). It is predominantly a *rabi* season crop and most onion cultivars are sensitive to photoperiod and thus their range of adoption is limited (Gupta and Singh, 2010). Work conducted on selection of suitable variety for late *kharif* onion is very scanty (Bhonde *et al.*,1990). Because of its high export potential it comes under cash crop. Non availability of required germplasms and no stability in desirable traits bring research gap in onion improvement programme. Lack of high yielding variety of onion in the country creates shortage during off season arrival period. To meet out the domestic requirement and also to fulfill the export demands, selection of suitable genotypes for late *kharif* season is required. Therefore, the present investigation was conducted to evaluate the variability in late *kharif* season onion for identifying genotypes suitable for late *kharif* season in Maharashtra.

Materials and methods

The present investigation was carried out at National Horticultural Research and Development Foundation, Nashik, Maharashtra, India during 2008-09 and 2009-10. Nashik (20° N latitude and 73° E longitudes) is located on altitude of 492.0 above MSL. The climate of Nashik is sub-tropical with minimum and maximum temperature and humidity ranging between 2.0 to 42.0°C and 48.0 to 80.0%, respectively with an annual rain fall around 881.0 mm. The trial was laid out in randomized block design with two replications. The soil was clay loam, medium in organic carbon (0.58%), available nitrogen (385.2 kg/ha), phosphorus (45.13kg/ha) and rich in available potash (291.2kg/ha). The study comprised 28 diverse lines (Table 1), selected from 200 germplasms evaluated at this centre along with four checks namely Agrifound Dark Red, B. Super, B-780 and Phule Suvarna. Eight week old seedlings of each lines were transplanted in flat beds during first week of November at the spacing of 15x10 cm in a plot of 3.6 x 1.8 m size. The recommended package of practices was uniformly followed during whole experiment period. Randomly selected plants from each plot were used to record the observations on plant height (cm), leaves/plant, neck thickness (cm), bulb diameter (cm), bulb size index (cm^2), weight of 20 bulbs (kg),

Table 1. List of accessions and their source

Accession	Source
359	NBPGR, New Delhi
372	IARI, New Delhi
377	IARI, New Delhi
382	NBPGR, New Delhi
388	NBPGR, New Delhi
406	Ludhiana, Punjab
409	NBPGR, New Delhi
411	NBPGR, New Delhi
425	NBPGR, New Delhi
449	Nashik, Maharashtra
579	Nashik, Maharashtra
597	Dindigul, Tamilnadu
630	Karnal, Haryana
654	Lasalgaon, Maharashtra
668	Dindigul, Tamilnadu
682	Pipalgaon, Nashik, Maharashtra
696	Ottur, Pune, Maharashtra
705	Pipalgaon, Nashik, Maharashtra
706	Pipalgaon, Nashik, Maharashtra
744	Ottur, Junnar, Pune, Maharashtra
745	Ottur, Junnar, Pune, Maharashtra
748	Mydukur, A. P.
751	Purandar, Pune, Maharashtra
752	Purandar, Pune, Maharashtra
753	Purandar, Pune, Maharashtra
779	Lasalgaon, Maharashtra
780	Lasalgaon, Maharashtra
782	Kurnool, A.P.
Agrifound Dark Red	NHRDF, Nashik, Maharashtra
Bheema Super	DOGR, Pune, Maharashtra
B-780	Rahuri, Maharashtra
Phule Suvarna	Rahuri, Maharashtra

days for bulb initiation, days for harvesting, bolters (%), doubles (%), thrips/plant, gross yield (t/ha) and marketable yield (t/ha). The data was analyzed to work out the variance components and coefficient of variation as per method suggested by Burton and de Vane (1953). Heritability in broad sense and expected genetic advance as percent of mean were estimated as suggested by Johnson *et al.* (1955) and correlations were worked out by the method of Al-Jibouri *et al.* (1958).

Results and discussion

The significant differences recorded for all the characters under study are presented in Table 2. Analysis of variance for thirteen characters indicated that there is considerable variation in respect to all the characters studied. Mean data indicated that the highest gross yield (41.17 t/ha) and marketable yield (39.13 t/ha) was recorded in line 744 which was at par with line 682 (39.07 t/ha and 34.39 t/ha, respectively.

A wide range of variability was observed for gross yield (19.65 t/ha to 41.17 t/ha), marketable yield (10.05 t/ha to 39.13 t/ha), bulb size index (20.40 to 35.90 cm^2), bolters (0.00 to 40.83%), doubles (0.00 to 47.50 %), thrips/plant (8.75 to 25.80) and plant height (54.95 to 71.80 cm). The spectrum of large variability for important characters offer a good scope for the improvement in late *kharif* onion to the breeder. Others traits showed moderate to low range of variations. It is clear from the mean data that above lines can be used in crop improvement programme for development in onion varieties. The extent of variability with respect to thirteen quantitative characters in different late *kharif* onion lines, measured in terms of range, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), environment coefficient of variation (ECV) along with amount of heritability (%), expected genetic advance and genetic advance as percent of mean are given in Table 3. The PCV was higher than the CGV in all characters. Medium PCV was observed for gross yield (17.80%), bulb size index (14.99%) and weight of 20 bulbs (11.61%). A similar trend in some of the important characters was also reported by Sidhu *et. al*. (1986) and Hydar *et. al.* (2007). All the above characters which showed high to medium coefficient of variation are of economic importance and there is an ample scope for improvement of these characters through selection.

High heritability values in broad sense are also helpful in selection if coupled with high phenotypic performance. Robinson (1966) categorized the estimates of heritability as low (5-10%), medium (10%-30%) and high (30 and above). Based on this classification, the present study revealed that all the traits have high heritability. It is noted in present investigation that the values of heritability ranged from 79.0 to 99.56% in broad sense. The highest heritability was noted in doubles, gross yield, bulb diameter, plant height, bolters and thrips/plant. The finding of the present study in respect of heritability are in accordance with the reports of Haydar *et al*. (2007), Mohanty (2001) and Ghetia *et al*. (2000) for yield and weight of bulb. The genetic advance as percent of mean ranged from 3.93 to 231.73. High genetic advance was noted in bolters (231.73 %), doubles (177.12 %), thrips/plant (76.56%) and marketable yield (54.53%) and rest of other characters showed medium to low genetic advance. Gross yield, marketable yield, doubles, bolters, thrips/plant and bulb size index indicated higher estimates of genetic advance as percent of mean coupled with high heritability, suggesting the involvement of additive genetic variance for these traits (Panse, 1957). These results are similar to Haydar *et al.* (2007), Mehta *et al.*(2005) and Singh *et al.* (2010b) in respect of bulb yield. Patil *et al.* (2000a) also reported high heritability and genetic advance for premature bolter and doubles.

High to moderate heritability associated with medium to low genetic advance as percent of mean was observed for number of leaves/plant, plant height, neck thickness, bulb diameter and weight of 20 bulbs, indicating that these traits are governed by non additive gene action and high genotypic environment interaction. The traits which showed high heritability with high genetic advance will be more amendable to improvement through mass selection, progeny selection or any other modified selection procedure aiming at exploiting the additive variance.

In the present experiment, the study on correlation among different traits revealed that, in general the genotypic correlation coefficients were slightly higher than the phenotypic correlation (Table 4). This indicated little role of environment in the expression of genetic relationship of the traits in the phenotypes. The marketable yield was significantly and positively correlated with plant height, neck thickness, bulb diameter, bulb size index, weight of 20 bulbs, and gross yield at both genotypic and phenotypic levels and negatively correlated with bolters, doubles and days for bulb initiation at both levels. Gross yield was positively and significantly correlated with neck thickness, bulb diameter, bulb size index and weight of 20 bulbs and negatively

Table 2. Performance of onion genotypes for late *kharif* season at Nashik in Maharashtra

Genotype	Plant height (cm)	Leaves/ plant	Neck thickness (cm)	Bulb diameter (cm)	Bulb size index (cm^2)	20 Bulb weight (kg)	Bolters (%)	Doubles (%)	Days for bulb initiation	Days for harvesting	Thrips/ plant	Gross yield (t/ha)	Marketable yield (t/ha)	Colour of bulb
359	61.60	7.75	1.43	5.28	22.38	1.43	13.17	19.50	41.00	115.50	11.20	32.61	25.05	Red
372	58.60	7.90	1.63	5.43	23.26	1.28	0.00	0.00	42.50	115.50	8.92	33.36	23.36	L Red
377	59.05	7.80	1.53	5.83	26.71	1.63	6.91	4.27	41.50	115.50	10.35	31.49	28.85	L Red
382	67.50	7.50	1.68	5.37	22.60	1.28	0.00	0.00	42.00	115.00	12.17	25.05	21.68	Red
388	67.15	8.35	1.80	5.33	22.69	1.53	6.33	6.33	42.50	113.50	13.50	32.55	28.87	Red
406	67.70	7.75	1.59	5.33	21.00	1.40	21.61	11.06	40.50	116.50	15.90	31.27	25.25	Red
409	70.60	8.35	1.57	5.76	26.17	1.45	10.50	47.50	43.50	117.00	15.85	29.42	22.91	L Red
411	56.60	7.40	1.58	6.06	30.17	1.68	7.85	19.12	41.50	112.50	19.30	24.75	20.05	L Red
425	63.10	8.90	1.67	5.25	21.50	1.23	4.17	45.91	42.50	113.50	25.70	20.05	13.92	L Red
449	56.20	7.40	1.47	5.23	20.40	1.10	10.26	21.68	43.00	114.50	17.85	19.65	10.05	Red
579	64.90	9.70	1.73	5.65	24.36	1.68	10.00	14.50	41.50	114.50	25.80	28.87	18.87	Red
597	58.60	8.60	1.56	5.77	24.32	1.43	40.83	8.67	44.50	115.50	21.95	22.26	13.41	Red
630	60.10	7.70	1.39	5.27	21.95	1.43	6.13	30.63	45.00	111.50	13.85	24.25	17.15	L Red
654	67.50	7.90	1.82	5.82	27.68	1.68	0.00	27.14	43.50	111.50	16.80	36.15	28.48	L Red
668	54.95	8.50	1.45	5.80	28.41	1.53	5.43	28.29	40.50	118.50	14.50	31.97	23.80	Red
682	66.90	10.60	1.75	6.31	30.97	1.71	2.55	8.38	41.50	116.50	25.10	39.07	34.39	D Red
696	61.50	8.50	1.74	5.89	23.95	1.38	5.48	38.09	40.50	118.00	18.70	38.41	29.47	Red
705	67.80	8.80	1.67	6.01	27.55	1.51	1.19	20.79	43.00	116.50	19.60	34.38	24.40	L Red
706	67.30	8.35	1.57	5.86	26.76	1.61	4.56	10.59	41.50	116.00	12.90	35.21	28.94	D Red
744	71.00	8.40	1.87	6.45	35.90	1.66	0.63	0.34	38.50	110.50	8.95	41.17	39.13	D Red
745	65.60	8.55	1.73	5.88	28.38	1.61	2.53	10.75	38.00	111.50	16.20	38.93	33.90	Red
748	71.80	8.70	1.69	6.19	32.40	1.62	3.19	0.61	39.00	110.50	12.90	38.90	37.38	D Red
751	64.70	8.30	1.78	5.75	26.63	1.60	0.00	0.00	41.00	115.50	9.55	33.36	19.07	Red
752	59.70	7.80	1.79	6.28	30.96	1.71	0.00	16.06	42.50	116.50	19.95	36.87	26.40	Red
753	60.40	8.70	1.53	6.00	28.99	1.77	2.65	7.32	43.00	118.00	12.80	37.20	29.78	Red
779	55.70	7.90	1.43	5.86	25.45	1.48	4.00	8.00	41.50	116.50	9.10	29.09	20.95	L Red
780	56.60	8.50	1.59	6.37	32.44	1.71	2.25	19.50	42.00	116.50	9.25	39.56	33.81	D Red
782	63.50	8.70	1.53	5.53	20.92	1.15	14.14	14.64	43.00	118.50	7.70	29.69	18.89	Red
Agrifound Dark Red	60.30	8.65	1.30	5.77	24.59	1.33	7.10	6.31	41.50	118.50	8.95	30.86	26.17	D Red
Bheema Super	60.80	7.80	1.49	5.95	26.46	1.63	9.48	4.49	43.50	116.50	3.75	32.58	29.49	D Red
B-780	67.75	8.70	1.63	6.15	29.23	1.43	11.37	9.93	42.50	116.50	12.95	33.92	27.95	D Red
Phule Suvarna	59.90	8.75	1.57	6.23	25.97	1.52	12.58	11.09	44.50	115.50	13.90	35.60	30.72	D Red
LSD (P=0.05)	0.57	0.35	0.06	0.07	2.61	0.05	0.79	1.72	1.49	1.16	1.12	2.35	2.53	

Table 3. Range, mean, coefficient of variation, heritability and genetic advance for different traits in late *kharif* season onion

Character	Range	SEm	Grand Mean	Coefficients of variations			Heritability	Genetic advance	GA as % of mean
				PCV (%)	GCV (%)	ECV (%)			
Plant height	54.95-71.80	0.19	62.98	7.68	7.66	0.44	89.00	9.93	15.75
Leaves/plant	7.40-10.60	0.11	8.35	8.02	7.76	2.02	93.00	1.29	15.44
Neck thickness	1.39-1.87	1.97	1.60	8.65	8.48	1.73	85.00	0.27	16.87
Bulb diameter	5.23-6.45	2.51	5.79	6.15	6.12	0.61	99.00	0.72	12.43
Bulb size index	20.40-35.90	0.90	26.28	14.99	14.18	4.86	89.00	7.26	27.62
Weight of 20 bulbs	1.10-1.70	1.82	1.50	11.61	11.48	1.71	97.00	0.35	23.33
Bolters	0.00-40.83	0.27	7.09	112.78	112.65	5.42	99.00	16.43	231.73
Doubles	0.00-47.50	0.59	14.73	86.35	86.16	5.72	99.56	26.09	177.12
Days for bulb initiation	38.00-45.00	0.51	42.00	3.86	3.45	1.73	79.00	2.67	6.35
Days for harvesting	110.50-118.50	0.40	115.26	2.03	1.97	0.49	94.00	4.54	3.93
Thrips/plant	8.75-25.80	0.38	14.55	37.55	37.36	3.77	98.00	11.14	76.56
Gross yield	196.50-411.75	0.84	321.44	17.81	17.81	0.37	99.00	117.92	36.68
Marketable yield	100.50-391.33	8.76	253.95	29.34	29.90	4.87	96.00	138.50	54.53

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Table 4. Genotypic (r_g) and phenotypic (r_p) correlation coefficients for different traits in late *kharif* season onion

Character		Leaves /plant	Neck thickness	Bulb diameter	Bulb size index	Weight of 20 bulbs	Bolters (%)	Doubles (%)	Days for bulb initiation	Days for harvesting	Thrips/ plant	Gross yield	Marketable yield
Plant height	r_g	0.308	0.580**	0.095	0.190	0.124	-0.148	-0.090	-0.325	-0.340	0.093	0.338	0.403*
	r_p	0.297	0.564**	0.096	0.186	0.121	-0.147	-0.089	-0.291	-0.329	0.091	0.337	0.397*
Leaves/plant	r_g		0.280	0.369*	0.245	0.142	0.004	-0.148	0.173	0.442*	0.334	0.281	0.311
	r_p		0.261	0.252	0.233	0.140	0.006	-.0980	0.168	0.427*	0.324	0.259	0.303
Neck thickness	r_g			0.311	0.408*	0.367*	-0.332	-0.099	-0.367*	-0.426*	0.345*	0.438*	0.363*
	r_p			0.303	0.371*	0.368*	-0.326	-0.998	-0.317	-0.403*	0.341*	0.429*	0.351*
Bulb diameter	r_g				0.927**	0.692**	-0.226	-0.227	-0.213	0.014	-0.041	0.689**	0.683**
	r_p				0.893**	0.684**	-0.223	-0.226	-0.192	0.010	-0.041	0.686**	0.673**
Bulb size index	r_g					0.789**	-0.389*	-0.243	-0.416*	-0.222	-0.054	0.694**	0.723**
	r_p					0.741**	-0.362*	-0.230	-0.322	-0.217	0.055	0.658**	0.681**
Weight of 20 bulbs	r_g						-0.283	-0.232	-0.232	-0.197	0.531**	0.617**	0.614**
	r_p						-0.281	-0.229	-0.214	-0.202	0.525**	0.611**	0.599**
Bolters (%)	r_g							0.321	0.291	0.187	0.169	-0.430*	-0.389*
	r_p							0.311	0.263	0.181	0.165	-0.429*	-0.382*
Doubles (%)	r_g								0.264	0.775**	0.462*	-0.294	-0.343*
	r_p								0.229	0.756**	0.459*	-0.293	-0.336*
Days for bulb initiation	r_g									0.216	0.865**	-0.491*	-0.518**
	r_p									0.197	0.731**	-0.436*	-0.458*
Days for harvesting	r_g										-0.148	0.019	-0.141
	r_p										-0.136	0.018	-0.139
Thrips/plant	r_g											-0.255	-0.292
	r_p											-0.251	-0.287
Gross yield	r_g												0.916**
	r_p												0.901**

*, ** Significant at P=0.05 and P=0.01, respectively

correlated with bolters and days for bulb initiation at genotypic and phenotypic levels. Neck thickness was positively correlated with plant height at both genotypic and phenotypic levels. A positive correlation existed between bulb diameter and leaves/plant at genotypic level. Bulb size index was positively correlated with neck thickness and bulb diameter at both levels. Weight of 20 bulbs was positive and significantly correlated with neck thickness, bulb diameter and bulb size index at genotypic and phenotypic levels.

Bolters was negatively and significantly correlated with bulb size index. Days for bulb initiation was negatively and significantly correlated with neck thickness and bulb size index at genotypic level. Days for harvesting was positively correlated with leaves/plant and double and negatively correlated with neck thickness. In correlation studies it was noted that, the traits *viz*. plant height, number of leaves/plant, bulb diameter, bulb size index, weight of 20 bulbs, days for bulbs initiation, and yield were most important yield contributing traits and correlated to each other as reported earlier by Pal *et al.* (1988) and Singh *et al.* (2010a). Based on variability, heritability, genetic advance and correlation in existing germplasm, it may be concluded that selection for above traits is possible for developing onion varieties suitable for late *kharif* season.

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