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Short communication

Studies on genetic variability and heritability in bulb onion (*Allium cepa* L.) in North-Western plains of India

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ABSTRACT

A study on genetic variability, heritability and genetic advance was carried out in bulb onion for 13 traits using 43 accessions. The range of variation was highest for bolting (0 to 51.30%), followed by days to maturity (110 to 155 days) and bulb weight (44 to 87.03g). Values for phenotypic coefficient of variation were higher than corresponding genotypic coefficient of variation for all the characters studied. Higher heritability estimates were obtained for plant height, leaf length, days to maturity, number of scales per bulb, polar diameter, equatorial diameter and TSS. Bolting, bulb weight, neck-to-bulb ratio and the lachrymatory factor showed moderate heritability, while, lowest values were observed for leaf girth and number of leaves per plant. Genetic advance varied from 0.06 to 21.82 for leaf girth and bolting, respectively.

Key words: Bulb onion, variance, PCV, GCV, heritability, genetic advance

Bulb onion is one of the important vegetable crops of India and is commonly used for salad and culinary purposes. India is the second largest producer, with 151.18 lakh tonnes produced from 10.64 lakh hectare area (Anon., 2011a). It can be grown throughout the country. Maharashtra, Karnataka, Andhra Pradesh and Gujarat are the major onion growing states. However, onion in Punjab is grown on less than one percent of area (8.14 thousand hectare), but its production share is two percent (1.74 lakh tonnes) owing to high (21.5 t/ha) productivity (Anon., 2011b). To meet the growing and diverse needs of various stakeholders, right from production to the consumption-chain of bulb onion crop, development of improved varieties with a stable performance always remained a challenge to onion breeders. Knowledge of the type and magnitude of variation in available germplasm is a pre-requisite for successful breeding to achieve desired goals. Performance of different bulb onion cultivars is much affected by climactic conditions. Reports on estimated genetic variability and other genetic parameters under Punjab conditions were published in the 80s and 90s. Upon the advent of 21st century, huge differences in climatic conditions and genotypic variability have been observed. Further, onion is photo-thermosensitive for bulb development, and, there is a need to evaluate the existing bulb onion germplasm under conditions prevailing in Punjab. Therefore, the present work was undertaken to estimate genetic variability and heritability in bulb onion to help plan an efficient breeding programme.

Seeds of 43 genotypes were sown in a nursery in the first week of November (2009-10 and 2010-11) and transplanted in the first week of January (2010-11 and 2011-12) at a spacing of 15cm between rows and 7.5cm between plants. The experiment was laid out in Randomized Block Design, with three replications. Recommended cultural practices were followed as per the package of practices for cultivating a healthy onion crop. Data were recorded on leaf girth (cm), leaf length (cm), number of leaves per plant, plant height (cm), bolting (%), number of scales per bulb, number of days to 75% maturity, bulb weight (g), polar bulb diameter (cm), equatorial bulb diameter (cm), neck to bulb ratio (cm), lachrymatory factor (mg/100g) and total soluble solids (TSS, ^{o}Brix) as per descriptors of National Bureau of Plant Genetic Resources, New Delhi (Anon., 2000). Genotypic and phenotypic coefficients of variation, heritability in the broad sense, and expected genetic advance were calculated as per Burton and Devane (1953) and Johnson *et al* (1955) using the computer software CPCS (Singh and Cheema, 1985).

Analysis of variance for all characters recorded displayed significant variation among varieties (Table 1).

The range was highest for bolting (0.0 to 51.30%), followed by days to 75% maturity (110.0 to 155), bulb weight (44.00 to 87.03g) and lachrymatory factor (9.26 to 22.66 mg/100g) (Table 2). Phenotypic coefficient of variation (PCV) ranged from 7.89 (neck-to-bulb ratio) to 120.45 (bolting %) indicating a wide variability among the genotypes tested. PCV was high for bolting (120.45) and lachrymatory factor (20.24), moderate for bulb weight (18.77), leaf length (16.07), number of leaves per plant (14.97), TSS (14.09), plant height (13.76), number of scales per bulb (10.63), polar diameter (10.58) and days to 75% maturity (10.21), while, it was low for leaf girth (9.70), equatorial diameter (9.06) and neck-to-bulb ratio (7.89). GCV value was high for bolting (104.94), while, it was moderate for bulb weight (16.46), lachrymatory factor (16.53), leaf length (14.90), TSS (12.77) and plant height (12.54). Low GCV was observed in days to 75% maturity (9.78), number of scales per bulb (9.77), polar diameter (9.70), equatorial diameter (8.67), number of leaves per plant (8.37), neck-to-bulb ratio (6.31) and leaf girth (6.28). Values for PCV were found higher than for corresponding GCV, but, with narrow differences except for bolting (Table 3). Similar trend was earlier observed in diverse bulb onion genotypes by Melke and Ravishankar (2006) and by Pramoda and Gangaprasad (2007). The studies reflected presence of greater phenotypic variability among accessions and the responsiveness of attributes to selection for achieving improvement. Golani *et al* (2006) obtained moderate PCV and low GCV for bulb weight. A narrow difference in bulb weight and bulb diameter was observed by Rashid *et al* (2008) and Mohanty (2001). Sultana *et al* (2007) obtained very high PCV (104.47) and GCV (103.77) values for bulb weight. Very high values (>200) for PCV and GCV were observed for number of leaves at flowering, plant height, number of flowers per scape and fresh bulb weight, by Rashid *et al* (2008).

Genetic coefficient of variation does not indicate amount of heritable variation; hence, estimation of heritability needs to be made. In the present study, high heritability was observed for days to 75% maturity (0.917), equatorial diameter (0.915), leaf length (0.859), number of scales per bulb (0.845), polar diameter (0.842), plant height (0.829) and TSS (0.821). High values indicate that substantial improvement can be expected by laying emphasis on selection for these traits. Bulb weight (0.769), bolting (0.759), lachrymatory factor (0.667) and neck-to-bulb ratio (0.64) showed moderate heritability, while, leaf girth (0.419) and number of leaves per plant (0.312) exhibited low heritability (Table 4).

Table 1. Analysis of Variance for various traits studied in bulb onion (*Allium cepa* L.)

S. No.	Traits	Mean Sum of Squares	
		Treatment	Error
1	Leaf girth (cm)	0.0222104**	0.006978
2	No. of leaves per plant	1.5001390**	0.634568
3	Leaf length (cm)	144.42210**	7.474208
4	Plant height (cm)	152.53720**	9.768558
5	Bolting (%)	1062.0710**	101.6490
6	Days to 75% Maturity	553.38890**	16.27509
7	Bulb weight (g)	347.27060**	31.57870
8	No. of scales per bulb	1.1793810**	0.067891
9	Polar diameter (cm)	0.4634826**	0.027342
10	Equatorial diameter (cm)	0.5965305**	0.018017
11	Neck to bulb ratio (cm)	0.0568237*	0.008963
12	Lachrymatory factor (mg/100g)	29.168650**	4.164181
13	TSS (°Brix)	6.4470720**	0.436672

** Significant at 1% and * significant at 5%

Table 2. Performance of bulb onion genotypes for morphological and quality traits.

Trait	GM	Range	PCV	GCV	H_{bs}	GA
Leaf girth (cm)	1.13	0.83 - 1.30	9.70	6.28	0.419	0.06
No of leaves/plant	6.42	5.24 - 8.18	14.97	8.37	0.312	0.42
Leaf length (cm)	45.36	29.52 - 58.12	16.07	14.90	0.859	8.77
Plant height (cm)	55.02	37.09 - 70.26	13.76	12.54	0.829	8.80
Bolting (%)	17.05	0.00 - 51.30	120.45	104.94	0.759	21.82
Days to 75 % maturity	136.79	110 - 155	10.21	9.78	0.917	17.94
Bulb weight (g)	62.32	44.00 - 87.03	18.77	16.46	0.769	12.59
No. of scales/ bulb	6.23	5.27 - 7.80	10.63	9.77	0.845	0.78
Polar diameter (cm)	3.93	2.91 - 4.82	10.58	9.70	0.842	0.48
Equatorial diameter (cm)	5.07	4.06 - 6.06	9.06	8.67	0.915	0.59
Neck to bulb ratio (cm)	1.99	1.74 - 2.43	7.89	6.31	0.640	0.14
Lachrymatory factor (mg/100g)	17.47	9.26 - 22.66	20.24	16.53	0.667	3.30
TSS (°Brix)	11.08	9.12 - 14.27	14.09	12.77	0.821	1.79

GM- General mean, PCV- Phenotypic coefficient of variation, GCV- Genotypic coefficient of variation,
H_{bs}- Heritability in the broad sense, GA- Genetic advance.

This indicates poor response for improvement through direct selection for these traits. Literature shows higher heritability for TSS (Hosamani *et al*, 2010), polar diameter (Trivedi *et al*, 2006), plant height (Pramoda and Gangaprasad, 2007), bolting (Hossain *et al*, 2008 and Sultana *et al*, 2007) and days to maturity (Dhaduk *et al*, 2011), whereas, heritability is seen moderate for bulb weight (Hosamani *et al*, 2010) and low heritability for number of leaves per plant (Golani *et al*, 2006). Selection for traits with high heritability is influenced less by environmental factors, and selection based on phenotypic performance is reliable.

Genetic advance gives the actual picture, as, it measures genetic gain under selection. It is desirable to consider genetic advance and heritability simultaneously during selection, because, high heritability is not always coupled to high genetic improvement (Johnson, 1955). In the present study, estimates for genetic advance were higher (GA) for bolting (21.82), and moderate for days to 75% maturity (17.94) and bulb weight (12.59). Rest of the traits had low values for genetic advance, as indicated in Table 4. However, higher heritability was observed for polar diameter, equatorial diameter, TSS and number of scales per bulb, although genetic advance was low. Similar trend was reported by Trivedi *et al* (2006) and Mohanty (2001) while Singh *et al* (1995) found high genetic advance for bulb weight and bulb yield. However, Melke and Ravishankar (2006) reported higher heritability and genetic advance for traits like number of leaves per plant, TSS, biological yield per plant and plant height.

To conclude, it was found that heritability and genetic advance values were variable from trait to trait. Days to 75% maturity showed higher heritability and moderate genetic advance, while, moderate heritability and moderate genetic advance was seen for bulb weight. This suggests that substantial improvement in traits can be expected by practicing selection for specific traits. On other hand, low values for heritability and genetic advance in various traits indicated that direct selection may not be very effective. Selection can thus be made for improving multiple traits simultaneously, having a good heritability and genetic advance.

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