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Genetic variability, heritability and genetic advance studies in onion (*Allium cepa* L.)

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ABSTRACT

Sixteen onion genotypes were evaluated for nine quantitative characters. Difference between GCV and PCV were found minimum for plant height, polar diameter, equatorial diameter, total yield, whereas, difference between GCV and PCV was observed high for the other traits like, bolting percentage, double bulb percentage, split bulb percentage, neck thickness, number of leaves. The narrow difference between GCV and PCV indicated that these characters were least influenced by the environment. On the other hand, the wide difference between GCV and PCV designated that environment had major role for phenotypic expression of these traits. High heritability accompanied with high genetic advance was noticed for all characters except found for boliting per cent, number of leaves, split bulb percentage, neck thickness, showed low heritability with low genetic advance indicating that simple selection may be effective to fix and improve such traits. As a result, selection of these this character was not to be effective. But, on the contrary, moderate to high heritability concomitant with high genetic advance reflected for the characters like plant height, polar diameter, equatorial diameter, total yield.

Keywords **:** Genetic advance, GCV, heritability, onion, PCV, variability

Onion (*Allium cepa* L.), crop is one of the most important vegetable and commercial crop. It belongs to the family Alliaceae, originated in central Asia. India is the second largest producer of onion in the world, next to China. India produces 19299 thousand MT onion from 1217 thousand hectares of area and productivity is 16.0 MT (NHB data base 2013-14). There has been a steady increase in area and production of onions in the last decade. In 1991-92, India exported 416 000 t of onion valued at Rs 1630.6 million which accounted for about 75 per cent of the total foreign exchange earnings for fresh vegetables. Besides the traditional rabi crop (winter season), the *kharif* crop (summer) is now being grown successfully in the north and eastern parts of the country which has revolutionized onion production and marketing in India. Several important cultivars such as Pusa Red, Pusa Ratnar, Arka Niketan, Punjab Selection, Hisar-2, N-2-4-1 and Udaipur 1-102 have been developed for the *rabi* season, whereas N-53, Arka Kalyan and Agrifound Dark Red are grown in the *kharif* and late *kharif* (rengda) seasons (Pandita 1994). Haldar *et. al.,* (2005) promising *kharif* onion cultivars or breeding lines developed at different Agricultural Universities and National Research Centre for Onion and Garlic, Pune have been evaluated under different temperature regimes by three plantings in field condition under tropical-humid conditions to assemble the basic information on the possibility of growing onion under early *rabi* condition in the Gangetic plain of West Bengal. Growing early-*rabi* onion with planting of seedlings in the first week of October employing the varieties like, Baswant 780, Agrifound Dark Red, Arka Pragati and Phule Safed and harvesting the bulbs during last week of February appeared to be the best.

Onion is one of the most variable species of plants having great differences in size, shape, color, firmness, percentage of dry matter, pungency, and sweetness of the bulb as well as that of the scape. In spite of the wide range of variability particularly for different bulb characters, yield and maturity in this crop, comparatively little improvement work has been done in this crop particularly in West Bengal. Therefore this experiment has been conducted to study genetic parameters for important economic traits and assess the magnitude of genetic variability, heritability, interrelationships among themselves for collection of varieties. To improve the yield through selection of better varieties, knowledge of the nature of association of bulb yield with yield contributing characters.

MATERIALS AND METHODS

Sixteen onion genotypes namely Arka Niketan, Arka Kalyan, Arka Bindu, Arka Bheem, Agri found Dark Red, Agri found Rose, Bhima Super, N-53, Indam Red Stone, Indam Hydrid-4, Indam Marshall, Indam gulab, Light red, Red diamond, Kohinoor-9, Fursungi were planted in a randomized block design (RBD) with three replications. Spacing was maintained 15cm between the rows and 10cm between the plants. Plot size was maintained 1m in length and 1m in breadth. The location of experimental field was at Kalyani C block Farm, BCKV, Nadia, West Bengal, during *Kharif* season 2015 and the soil in the research station is sandy loam in texture, fine, mixed with good water holding capacity.

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Table 1: Genetic variability parameters of sixteen genotypes evaluated in *Kharif*

Characters	Mean ± SE	Co-efficient of variation (%)		Heritability (Broad sense)	Genetic advance	Genetic advance as % of mean
		GCV	PCV			
Plant height (cm)	54.08±1.75	10.82	12.18	78.89	10.71	19.80
No of leaves	7.39±0.41	6.85	11.78	33.77	0.61	8.20
Bolting (%)	3.32±2.67	50.45	148.43	11.55	1.17	35.32
Double bulb (%)	3.79±1.38	117.46	133.27	77.68	8.09	213.26
Split Bulb (%)	0.49±0.72	174.9	305.57	32.76	1.03	206.22
Neck thickness(mm)	3.71±0.42	14.34	24.31	34.80	0.65	17.42
Polar diameter(mm)	41.82±1.22	12.55	13.53	86.10	10.03	23.99
Equatorial diameter (mm)	51.57±2.00	13.86	15.4	81.05	13.26	25.71
Total yield (q ha^{-1})	141.53±8.71	57.47	58.67	95.96	143.44	115.97

Nine morphological characters including yield and yield attributing traits were estimated. Agro-physiological characters such as plant height (cm), number of leaves $plant^{-1}$, bolting per cent, double bulb per cent, split bulb per cent, neck thickness(mm), polar diameter(mm), equatorial diameter(mm), total yield (q ha^{-1}) were recorded.

RESULTS AND DISCUSSION

The extent of variability with respect to various characters in different genotypes measured in terms of range, general mean, genotypic coefficient of variation, phenotypic coefficient of variation along with the amount of heritability (h^{-2}) and expected genetic advance as percent of mean (Table 1). The characters showing wide range of variation provide ample scope for efficient selection. The Genotypic coefficient of variation was less than that of phenotypic coefficient of variation, for all characters (Table 1), indicating the effect of environment on their genetic expression. The results on genetic variability of nine different characters of sixteen genotypes evaluated during *Kharif* season, 2015 indicated wide variability. Heritability estimate were observed to be highest for total yield (95.96) followed by polar diameter (86.10), whereas the lowest heritability in bolting percentage (11.55).

Robinson (1966) categorized estimates of heritability as low (5-10%), medium (10-30%) and high (30 and above). Following this classification, the heritability estimates obtained were high for all the characters indicating the low environmental effects. Similar results were reported by Dehdari, *et al.* (2001) and Mehta *et al.* (2005). Low differences between PCV and GCV for maximum traits were observed which indicates towards true genetic variability. GCV and PCV were highest for the characters split bulb percentage and double bulb percentage. Further traits such as polar diameter and plant height recorded high heritability and high genetic advance. (Singh *et. al.*, 2011) were carried out to study the genetic variability in late *Kharif* germplasm of onion at Nashik, Maharashtra (India) and their data indicated that the highest gross yield (41.17 t ha^{-1}) and marketable yield (39.13 t ha^{-1}) was recorded in line 744 and was *at par* with line 682 (39.07 t ha^{-1}) and (34.39 t ha^{-1}). A wide range of variability was observed for gross yield (19.65 to 41.17 t ha^{-1}), marketable yield (10.05 to 39.13 t ha^{-1}), bulb size index (20.40 to 35.90 cm^2), bolters (0.00 to 40.83%), doubles (0.00 to 47.50%), 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%) and marketable yield (29.34 and 29.90%). Highest heritability was noted in doubles, gross yield, bulb diameter, plant height and bolters. 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%) and marketable yield (54.53%) and rest of others characters showed medium to low genetic advance. Gross yield, marketable yield, doubles, bolters 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. 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. Mohanty 2001) studied genetic variability, interrelationship and path coefficients in 12 onion cultivars in a field experiment conducted in Orissa, India during the *kharif* season of 1997. High heritability with moderate to high genotypic coefficient of variation and genetic gain were recorded for weight of bulb, neck thickness, bulb yield and number of leaves per plant which could be improved by simple selection. Bulb yield manifested positive and significant phenotypic and genotypic correlation with plant height

and diameter and weight of bulb. Other characters also exerted positive, indirect effects via these traits on bulb yield suggesting that emphasis be given on such characters while exercising selection for amenability in bulb yield of onion.

Ram *et al.* (2011) were studied Genetic variability and correlation in onion during *rabi* seasons involving 16 genotypes showing wider variations for all traits. Results revealed that the genotype Pusa Madhvi, AOSDRB-0919 and AOSDRB-0913 performed better in terms of yield and yield contributing traits and these lines may be use for breeding program. The highest phenotypic and genotypic coefficient of variations were noted for yield plot^{-1} (16.96–15.81%), yield ha^{-1} (14.86–14.07%), bulb size (12.34–11.65%), plant height (12.00–11.57%) and bulb weight (14.27–11.57%). The high heritability and genetic advance were recorded in yield plot^{-1} (86.9 and 0.60%), yield ha^{-1} (89.6 and 7.30%), plant height (93.0 and 11.38%), bulb size (89.2 and 6.16%), and bulb weight (65.7 and 18.80%), suggesting the major role of genetic constitution in the expression of the character. Yield ha^{-1} had positive and highly significant correlation with yield plot^{-1}, TSS and bulb size both at phenotypic and genotypic level, respectively.

In general the characters that show high heritability with high genetic advance are controlled by additive gene action (Panse 1957) and selection is always effective for that trait. Genetic advance (in percent of mean) is a more reliable index for understanding the characters because its estimate is derived by involvement of deviation and intensity of selection. The present result shows the prevalence of greater genetic variability among the genotypes which offers good opportunities for crop improvement of Kharif onion through selection.

It is established that genetic variability is a basic pre requisite for plant breeding programme on which selection acts to evolve superior genotype. Thus the higher the amount of variation present for the various characters in the chosen materials, greater is the scope for its improvement through selection. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were computed to access the existing variability in the characters. The PCV were higher than GCV for all the characters indicating each and every characters were influenced by environmental factors up to some extent. The greater difference between GCV and PCV were observed for the characters Split Bulb percentage and Double bulb percentage indicating that these characters were influenced by environmental factors to greater extent. The very little difference between GCV and PCV were indicated that there was very little environmental influence and these characters cannot improve by providing favorable environment. The above findings are broadly in agreement with the earlier reports (Burton, 1952).

It was concluded from the present study that the 16 onion germplasms were found minimum GCV and PCV for plant height (cm), polar diameter, equatorial diameter, total yield (q ha^{-1}) whereas, high for the other traits like, bolting percentage, double bulb percentage, split bulb percentage, neck thickness(mm), number of leaves. The narrow difference between GCV and PCV indicated that these characters were least influenced by the environment. High heritability accompanied with high genetic advance was noticed for all characters except found for boliting per cent, number of leaves, split bulb percentage, neck thickness (mm), showed low heritability with low genetic advance indicating that simple selection may be effective to fix and improve such traits. As a result, selection of these this character was not to be effective. But, on the contrary, moderate to high heritability concomitant with high genetic advance reflected for the characters like plant height, polar diameter, equatorial diameter, total yield.

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