Journal of Crop and Weed, 13(1) : 103-106 (2017)

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

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Received: 05-12-2016 ; Revised: 15-03-2017 ; Accepted : 25-03-2017

ABSTRACT

Ten genotypes were evaluated as a part of the experiment indicated significant differences among genotypes for all traits. Pooled mean performances showed that Agrifound Dark Red had highest plant height (51.42 cm), average bulb weight (75.06 g), total bulb yield (306.42 q ha^{-1}) and marketable bulb yield (295.09 q ha^{-1}). High GCV was recorded for Plant height, number of leaves, polar diameter, equatorial diameter, neck thickness, average marketable bulb weight, marketable yield, days to maturity, total soluble solids, pyruvic acid and phenol content in bulbs. High heritability was observed for most of the characters. Total bulb yield was positively and significantly correlated with plant height (0.802), number of leaves (0.630), polar diameter (0.572), equatorial diameter (0.919) and average bulb weight (0.974). Superior genotypes like Agrifound Dark Red (313.49 q ha^{-1} and 299.35 q ha^{-1}) and Gota (287.43 q ha^{-1} and 275.93 q ha^{-1}) exhibited high total yield in both the locations Kalyani and Bankura of West Bengal, India.

***Keywords* :** GCV, heritability, kharif onion, PCV, pyruvic acid, variability

Onion (*Allium cepa* L.) is one of the most important commercial vegetable grown in India and is believed to have originated in Central Asia. The pungency in onion is due to the presence of a volatile compound known as allyl-propyl disulphide. In Eastern India specially, West Bengal, Odissa and Bihar onion is mostly grown during *rabi* season and the bulb is made available from April onwards and states depends on other states which produce *kharif* and late *kharif* onion for supplying of bulbs during October to March. This situation may be improved to some extent if the possibilities and potentialities of *kharif* onion cultivation are exploited in these new areas for *kharif* onion. *Kharif* onion has potentialities in Eastern parts of India particularly in the alluvial, red and laterite zone if proper care is taken mainly during seedling stage. Onion cultivation in *kharif* is generally not practiced mainly because of weather vagaries and unawareness of the farmers about its production technology and lack of promising varieties for Eastern India. June to November is the critical period in whole country, where there is no fresh harvest onion (Tripathi & Lawande 2003). Hence, it is necessary to study the performance of *kharif* onion genotypes sown under different environmental condition along with its stability. The present investigation therefore, is carried out to study genetic parameters for important economic traits and assess the magnitude of yield, genetic variability, heritability in West Bengal condition.

MATERIALS AND METHODS

The investigation was carried out at "C" Block Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal in the research field of All India Coordinated Research Project on Vegetable Crops, situated at 23.5^0 N latitude and 89^0 E longitude at a MSL of 9.75m. The soil texture of the farm is sandy loam with neutral pH and the other location Dalpur, Chatna, Bankura of West Bengal. It is situated between 23° 23' north latitude and 87° 07' east longitude. The soil texture of the farm was sandy to sandy loam under red and laterite zone, having slightly acidic in reaction, during *kharif* seasons of 2011 to 2012. Laboratory experiments were done in the Department of Vegetable Crops laboratory, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur. Ten open pollinated varieties/landraces were taken for the experiment (Table 1). The experiment was laid out in Randomized Block Design and replicated thrice. Plants were spaced 15 cm between row to row and 10 cm between plants to plant. Recommended Fertilizer Dose: 120: 50: 100: 40 @ N: P_2O_5: K_2O: S, kg ha^{-1}. Farm Yard Manure (FYM): 20 tons ha^{-1}. Observations on growth parameters were taken from randomly selected ten plants per replication at 90 days after transplanting. Bulb characters and yield were recorded from randomly selected ten bulbs after harvest. The mean values obtained from the ten competitive plants selected at random from each genotype in each replication for different horticultural traits were subjected to statistical analysis as suggested by Panse and Sukhatme (1984) .

RESULTS AND DISCUSSION

The data obtained from these experiments were subjected to various statistical analyses for elucidating

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the valid information. Analysis of variance indicated significant differences among genotypes for all traits. These differences indicated the presence of variability and opportunity for improvement. Sufficient genetic variability for many traits had also been reported by (Mohanty and Prusti 2001; Pavlovic *et al.* 2003; Hosamani *et al.* 2010; Ibrahim *et al.* 2013) for bulb yield in onion. Among ten genotypes over two locations (Kalyani and Bankura) and two year (2011 and 2012), the genotype Agrifound Dark Red was tallest followed by Baswant-780 and Gota (Table 2). Maximum numbers of leaves were found in the genotype Gota. Desirable minimum neck thickness was found in Arka Pragati followed by Arka Kalyan and Bhima Red. Highest average bulb weight, total yield and marketable yield was found in the variety Agrifound Dark Red followed by Gota and Baswant 780. In case of days to maturity N-53 requires minimum number of days to mature while Arka Niketan required maximum number of days to maturity. Highest total soluble solids (TSS) was found in the variety Arka Niketan followed by Arka Kalyan and Agrifound Dark Red. Agrifound Dark Red had highest pyruvic acid content among ten genotype studied. Dry matter content was highest in Arka Kalyan while Baswant 780 had lowest. Higher total sugar was observed in Agrifound Dark Red followed by Arka Pragati and Arka Kalyan. Highest phenol content was observed in Gota followed by Agrifound Dark Red and Arka Kalyan. These values are based on the performance of variety over two year and four locations.

Variability, heritability and genetic advance

The availability of sufficient variations was observed for bulb yield and its contributing characters in both the year and the locations studied (Table 3). PCV, GCV, heritability and genetic advance also revealed the existence of wide range of variability with respect to the characters among the genotypes. It is really encouraging from the point of research efforts aimed at improving yield. Similar results of variability were noticed by Mohanty & Prusti (2001); Pavlovic *et al.* (2003); Hosamani *et al.* (2010); Ibrahim *et al.* (2013). for bulb yield Equatorial diameter, neck thickness, average bulb weight, total yield, marketable yield, having high heritability with moderate genetic advance per cent over mean indicating additive gene action hence, immediate selection will be advantageous for the development of better variety for those characters. The high variability values for bulb yield among the genotypes suggest that there is lot of scope for selection of high yielding superior genotypes. Moderate values of genotypic coefficient of variation and phenotypic coefficient of variation were noticed for neck thickness, average bulb weight, total yield, marketable yield and days to maturity. Similar result was found in winter onion (*rabi*) by Vidyasagar *et al.* (1993); Balareddy (1999); Mohanty (2004) and (Yaso) 2007.

Table 1: Genotypes used and their sources

S. No.	Open pollinated	Sources
1	Bhima Super	DOGR, Rajgurunagar
2	Bhima Raj	DOGR, Rajgurunagar
3	Bhima Red	DOGR, Rajgurunagar
4	Arka Niketan	IIHR, Bangalore
5	Arka Kalyan	IIHR, Bangalore
6	Arka Pragati	IIHR, Bangalore
7	Baswant 780	Vijay Seeds
8	N-53	Jindal seeds
9	Agrifound Dark Red	NHRDF
10	Gota	Krishidhan

Most of the horticultural and quality traits *viz.*, plant height, number of leaves, polar diameter, equatorial diameter, neck thickness, average marketable bulb weight, total yield, marketable yield, days to maturity, total soluble solids, pyruvic acid and phenol content in bulbs exhibiting high heritability (>80 %) indicates that a large proportion of phenotypic variance is attributed to genotypic variance, and reliable selection procedure developed for these traits on the basis of phenotypic variation. Johnson *et al.* (1955) stressed that for estimating the real effects of selection, heritability alone is not sufficient and genetic advance along with heritability is more useful. The estimates of broad sense heritability ranged from 33.62 per cent (Dry matter) to 99.61 per cent (Total yield). High heritability indicated the major role of genetic constitution in expression of characters and that performance of characters are repeatable. These results agree with Pavlovic *et al.* (2003) for bulb yield, Hosamani *et al.* (2010) for dry matter content yield per hectare, total soluble solids and average bulb weight in onion. Yield contributing characters like polar diameter (90.24 %), equatorial diameter (98.07 %) and average bulb weight (99.07 %) were recorded higher heritability values. The results suggest that the yield components in onion are influenced by environmental conditions. High genetic advance as per cent mean was noticed for pyruvic acid and phenol while moderate value ware observed in case of equatorial diameter, neck thickness, average bulb weight, total yield and marketable yield. Phenotypic co-efficient of variation and genotypic co-efficient of variation for plant height and pyruvic acid ranged from 6.06 to 5.49 per cent and 19.79 to 19.19 per cent, respectively.

Genetic advance is the measure of improvement that can be achieved by practicing selection in a population.

Table 2 : Pooled mean performance of open pollinated genotypes (pooled over locations)

	PH (cm)	NOL	PD (mm)	ED (mm)	NT (mm)	ABW (g)	TY (q ha^{-1})	MY (q ha^{-1})	DTM	TSS (°brix)	PA (µmole g^{-1})	DM (g100 g^{-1})	TS (mg g^{-1})	Phenol (mg g^{-1})
BhimaSuper	45.09	9.11	46.17	51.14	13.35	55.62	223.24	213.64	116.00	11.36	1.49	8.29	13.18	0.63
Bhima Raj	48.71	9.74	50.32	52.75	11.18	57.75	224.38	211.59	123.92	10.54	1.62	7.56	12.57	0.46
Bhima Red	48.60	8.94	47.60	49.96	9.84	57.19	221.95	211.71	120.58	10.31	2.40	7.41	12.53	0.55
ArkaNiketan	46.86	10.36	48.20	54.57	9.86	60.48	235.23	213.72	138.25	12.04	2.55	7.72	13.45	0.65
ArkaKalyan	46.57	9.13	49.83	56.21	9.22	64.70	265.00	250.97	120.08	11.67	2.57	8.38	13.48	0.94
ArkaPragati	48.70	9.37	49.02	54.26	9.03	54.31	222.47	213.82	134.75	11.31	2.61	7.90	13.49	0.77
Baswant 780	49.84	9.84	53.76	60.26	11.52	66.38	276.74	264.68	115.25	9.90	2.11	7.15	11.61	0.87
N-53	42.06	9.21	41.57	43.66	10.40	47.68	183.16	173.43	113.50	11.30	2.61	8.20	12.33	0.92
ADR	51.42	10.23	47.18	59.09	10.07	75.06	306.42	295.09	120.58	11.66	2.81	7.74	13.71	1.06
Gota	49.84	10.51	49.21	62.11	10.45	74.61	281.68	270.82	124.17	10.17	2.65	7.47	12.72	1.09
Avg.	47.77	9.64	48.28	54.40	10.49	61.38	244.03	231.95	122.71	11.03	2.34	7.78	12.91	0.79
SEm(±)	**0.71**	**0.16**	**0.59**	**0.44**	**0.20**	**0.49**	**1.34**	**1.64**	**0.27**	**0.15**	**0.07**	**0.29**	**0.31**	**0.02**
LCD(0.05)	**2.11**	**0.46**	**1.76**	**1.32**	**0.59**	**1.48**	**4.01**	**4.90**	**0.80**	**0.44**	**0.20**	**0.87**	**0.92**	**0.04**

Table 3 : Genetic components of different growth parameters in Onion for open pollinated genotypes

Characters	GM	Range	GCV(%)	PCV(%)	h^2	GA (%)
Plant height(cm)	47.77	42.06-51.42	5.49	6.06	82.23	10.26
Number of leaves	9.64	8.94-10.51	5.71	6.35	80.76	10.56
Polar diameter(mm)	48.28	41.57-53.76	6.40	6.74	90.24	12.53
Equatorial diameter(mm)	54.40	43.66-62.11	9.99	10.08	98.07	20.37
Neck thickness(mm)	10.49	9.03-13.35	11.93	12.36	93.10	23.70
Average bulb weight(g)	61.38	47.68-75.06	14.35	14.42	99.07	29.43
Total yield(q/ha)	244.03	183.16-306.42	15.18	15.21	99.61	31.22
Marketable yield(q ha^{-1})	231.95	173.43-295.09	15.84	15.89	99.41	32.54
Days to maturity	122.71	113.50-138.25	6.60	6.61	99.60	13.58
Total soluble solids(°brix)	11.03	9.90-12.04	6.53	6.93	88.91	12.69
Pyruvic acid(µmole g-1)	2.34	1.49-2.81	19.19	19.79	94.07	38.34
Drymatter(g 100g-1)	7.78	7.15-8.38	3.64	7.48	33.62	13.64
Total sugar(mg g-1)	12.91	11.61-13.71	4.58	6.15	55.30	7.01
Phenol(mg g-1)	0.79	0.46-1.09	27.18	27.36	98.80	53.36

Therefore, heritability values computed in broad sense would be more meaningful and useful when accompanied by genetic gain. The magnitude of phenotypic coefficient of variation was higher as compared to that of genotypic coefficient of variation in all the traits studied. The high variability values for total yield among the genotypes suggest that there is lot of scope for selection of high yielding superior genotypes. The characters with moderate GCV and PCV values with high heritability and genetic advances over mean, indicating that it is controlled by additive gene action and less influenced by environment. Also, those traits can be improved through selection. But, yield is a complex character and is a function of several component characters and their interaction with environment. Direct selection based on yield alone will not be very effective in crop improvement programmes.

High expected genetic advance was observed for the pyruvic acid and phenol. The heritability values for all of these characters were high indicating additive gene effects. Similarly, for equatorial diameter, neck thickness, average bulb weight, total yield and marketable yield moderate genetic advances associated with high heritability ware found. In case of characters like plant height, numbers of leaves, polar diameter, days to maturity and total soluble solids having high heritability, were associated with low genetic advance. These features may be attributed to non-additive gene effect.

It may be concluded that superior genotypes like Agrifound Dark Red, Gota and Baswant 780 having potentiality to perform in both the locations Kalyani and Bankura of West Bengal, India for *kharif* season and can bring a new era of *kharif* onion cultivation in Eastern part of India specially in West Bengal.

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