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

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Abstract
The present investigation was carried-out to assess the genetic variability, heritability, genetic advance. For this purpose, twenty four genotypes of onion laid out in Randomized Block Design (RBD) with three replications during the *Rabi* seasons 2017-18 at Vegetable Research Farm, Department of Horticulture, SHUATS, and Allahabad. The allocations of the treatments of the individual plots were using random number in each replication. Equatorial diameter of bulb (mm) and polar diameter of bulb (mm), recorded high estimates of GCV and PCV, heritability and genetic advance as per cent of mean. Therefore, these characters can be added in selection programme.

Keywords: Onion (*Allium cepa* L.), GCV, PCV, heritability, variability, genetic advance

Introduction
Onion belongs to the family *Alliaceae*, *genus Allium* and species *cepa* L. with basic chromosome number x = 8 (2n = 16). The genus *Allium* is large genus containing 450 species, which are biennial and perennial, and all of them are bulbous. Cultivated onion is herbaceous annual for the bulb production and biennial for seed production. The flowers are bisexual which are protoandraus and cross-pollinated. The inflorescence stalk with only internodes, which elongates in the life cycle of the plant. The edible portion is a modified stem, botanically known as “Truncated bulb” which develops underground, and consists of vegetative stem axis and the storage leaf bases of the outer leaves.

Onion is rich source of minerals, vitamins, protein, carbohydrates, ascorbic acid. Onion bulb is rich in minerals like phosphorus, calcium and carbohydrates. It also contains protein and vitamin C. In India onion is grown in three crop seasons, namely *kharif* (harvested in October-November), late *kharif* (January February) and *Rabi* (April – May). *Rabi* season crop is the largest accounting for about 60 percent of annual production with *kharif* and late *kharif* accounting for about 20 percent each.

The genetic variability and its components are the genetic fractions of observed variability that provides measures of transmissibility of the variation and response to selection. The knowledge of pattern of inheritance of various characters are important consideration while, determining the most approximate breeding procedures applicable to any particular crop. The breeder’s choice of the material for any improvement work consequently depends on the amount of genetic variability present.Therefore present field investigation was carried out with a view to study the genetic variability, heritability and genetic advance in onion by assessing onion genotypes.

Materials and Methods
The experiment material comprised of twenty four genotypes of onion laid out in Randomized Block Design (RBD) with three replications during the *Rabi* seasons 2017-18. The allocations of the treatments of the individual plots were using random number in each replication. The observations recorded on 5 randomly selected plants from each genotypes in each replication were recorded for 24 characters *viz.* plant height (cm) at 30, 60, 90 DAT, length of leaves (cm) at 30, 60 90 DAT, number of leaves plants^{-1} at 30, 60, 90 DAT, collar height (cm) at 30, 60, 90 DAT, neck thickness (cm) at 90 DAT, equatorial diameter of bulb (mm), polar diameter of bulb (mm), fresh weight of bulb plants^{-1} (g), dry weight of bulb plants^{-1} (g), fresh bulb yield plot^{-1} (kg), dry bulb yield plot^{-1} (kg), fresh bulb yield ha^{-1} (qt.), dry bulb yield ha^{-1} (qt.), number of scales blub^{-1}, total soluble solids (TSS ^{0} Brix), vitamin –C (mg/100 g).

The data were subjected to statistical analysis to estimate the genetic variability, heritability, genetic advance, genetic advance as per cent of mean.

Results and Discussion

The simple measure of variability like mean, phenotypic and genotypic coefficients of variation (PCV and GCV), heritability in broad sense and genetic advance as percent of mean are presented in Table.1. All the 24 characters under study exhibited high variability as evident from the estimates of mean, coefficients of variation, heritability and genetic advance

The analysis of variance revealed highly significant differences among all the onion genotypes for 24 characters at 5%, 1% and 0.1% level of significance, indicating the presence of sufficient variability among genotypes. Thus indicating the ample scope for selection of promising genotypes from the present gene pool.

The estimation of genotypic coefficient of variance and phenotypic coefficient variance for all the characters are presented in (Table 1). The genotypic coefficient variance value were categorized as low (0-10%), moderate (10-20%) and high (20% and above) given by Sivasubramanian and Madhavamenon (1973). Wide range of genotypic coefficient of variation (GCV) was observed for the characters ranging from plant height (cm) at 90 DAT (2.17) to equatorial diameter of bulb (mm) (21.20). Higher magnitude of genotypic coefficient of variance (GCV) was recorded for equatorial diameter of bulb (mm). Therefore, these characters can be added in selection programme.While moderate estimates were observed for collar height (cm) at 30 DAT, polar diameter of bulb (mm), fresh bulb yield plot^{-1} (kg), dry bulb yield plot^{-1} (kg), fresh bulb yield ha^{-1} (qt.), dry bulb yield ha^{-1} (qt.) and vitamin –C (mg/100 g). Low estimates of genotypic coefficient of variance was observed for plant height (cm) at 30, 60, 90 DAT, length of leaves (cm) at 30, 60, 90 DAT, number of leaves plants^{-1} 30, 60, 90 DAT, collar height (cm) at 60, 90 DAT, neck thickness (cm) at 90 DAT, fresh weight of bulb plants^{-1} (g), dry weight of bulb plants^{-1} (g), number of scales blub^{-1} and total soluble solids (TSS ^{0} Brix). Similar findings were also reported by Mohanty (2001) [3], Santra *et al*., (2017) [5] and Singh *et al*., (2017) [7].

The phenotypic coefficient variance value were categorized as low (0-10%), moderate (10-20%) and high (20% and above) given by Sivasubramanian and Madhavamenon (1973). Wide range of phenotypic coefficient of variation (PCV) was observed for the characters ranging from plant height (cm) at 90 DAT (3.33) to equatorial diameter of bulb (mm) (21.42). Higher magnitude of phenotypic coefficient of variance (PCV) was recorded for equatorial diameter of bulb (mm). Therefore, these characters can aid in selection programme. While moderate estimates were observed for collar height (cm) at 30 DAT, neck thickness (cm) at 90 DAT, polar diameter of bulb (mm), fresh weight of bulb plants^{-1} (g), dry weight of bulb plants^{-1} (g), dry bulb yield plot^{-1} (kg), fresh bulb yield plot^{-1} (kg), fresh bulb yield ha^{-1} (qt.), dry bulb yield ha^{-1} (qt.), number of scales blub^{-1}, and vitamin –C (mg/100 g). Low estimates of phenotypic coefficient of variance was observed for plant height (cm) at 30, 60, 90 DAT, length of leaves (cm) at 30, 60, 90 DAT, number of leaves plants^{-1} 30, 60, 90 DAT, collar height (cm) at 60, 90 DAT and total soluble solids (TSS ^{0} Brix). Selection on the basis of these characters will be more useful for the improvement of this crop towards attaining higher yield. Similar findings were also reported by Mohanty (2001) [3], Santra *et al*., (2017) [5] and Singh *et al*., (2017) [7].

The heritability estimate were found to be Wide range of heritability (%) in broad sense was observed for the characters ranging from collar height (cm) at 90 DAT (21) to equatorial diameter of bulb (mm) (98). High heritability (>60) was recorded for the characters *viz* equatorial diameter of bulb (mm), polar diameter of bulb (mm), total soluble solids (TSS ^{0} Brix) and vitamin –C (mg/100 g). These characters are therefore governed by additive gene effects. Selection on the basis of these characters will be more useful for the improvement of this crop towards attaining higher yield. Low heritability (<30%) for collar height (cm) at 90 DAT, length of leaves (cm) at 30, 60 DAT and number of leaves plants^{-1} 60, 90 DAT. Similar findings were also reported by Mohanty (2001) [3], Trivedi *et al*., (2006), Aditika *et al*., (2017) [1], Santra *et al*., (2017) [5] and Singh *et al*., (2017) [7].

The estimation of genetic advance as percent mean for all the characters are presented in (Table 1). Wide range of genetic advance as percent mean was observed for the characters ranging from number of leaves plants^{-1} 90 DAT (2.80) to equatorial diameter of bulb (mm) (43.23). Genetic advance as per cent of mean was highest for equatorial diameter of bulb (mm) and polar diameter of bulb. Lowest genetic advance percent of mean was observed in plant height (cm) at 30, 60, 90 DAT, length of leaves (cm) at 30, 60, 90 DAT, number of leaves plants^{-1} 30, 60, 90 DAT, collar height (cm) at 60, 90 DAT, neck thickness (cm) at 90 DAT.

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 polar diameter and equatorial diameter. Similar findings were also reported by Mohapatra *et al*., (2017) [4].

Conclusion

Analysis of variance showed significant difference for all the characters under study, indicates that there was ample scope for selection of promising genotypes from present germplasm for yield improvement. Equatorial diameter of bulb (mm) and Polar diameter of bulb (mm), recorded high estimates of GCV and PCV, Heritability and Genetic Advance as per cent of mean. Selection on the basis of these characters will be more useful for the improvement of this crop towards attaining higher yield.

Table 1: Range, mean, variance, coefficient of variations, heritability, genetic advance and genetic advance as percent of mean for 24 characters of onion genotypes

S. No	Characters	Range		Mean	GV ($\sigma^2 g$)	PV ($\sigma^2 p$)	CV		h^2 (bs) (%)	GA 5%	GA as % of Mean 5%
		Min.	Max.				GCV (%)	PCV (%)			
1	Plant height (cm) at 30 DAT	30.81	37.27	34.33	2.32	4.50	4.44	6.18	52.00	2.26	6.57
2	Plant height (cm) at 60 DAT	56.76	68.70	62.30	7.37	17.77	4.36	6.77	41.00	3.60	5.78
3	Plant height (cm) at 90 DAT	72.02	80.13	77.02	2.79	6.59	2.17	3.33	42.00	2.24	2.91
4	Length of leaves (cm) at 30 DAT	26.88	34.01	30.91	1.79	6.69	4.33	8.37	27.00	1.43	4.61

5	Length of leaves (cm) at 60 DAT	52.01	62.99	56.80	5.17	19.93	4.00	7.86	26.00	2.39	4.20
6	Length of leaves (cm) at 90 DAT	61.61	69.16	66.69	2.35	6.04	2.30	3.68	39.00	1.97	2.96
7	No. of leaves plant^{-1} at 30 DAT	4.33	5.13	4.72	0.03	0.09	3.96	6.50	37.00	0.24	4.98
8	No. of leaves plant^{-1} at 60 DAT	6.53	7.67	7.12	0.04	0.17	2.88	5.76	25.00	0.21	2.98
9	No. of leaves plant^{-1} at 90 DAT	9.00	10.33	9.61	0.06	0.22	2.58	4.88	28.00	0.27	2.80
10	Collar height (cm) at 30 DAT	2.77	5.06	3.57	0.19	0.39	12.26	17.59	49.00	0.63	17.59
11	Collar height (cm) at 60 DAT	6.19	7.25	6.70	0.06	0.17	3.67	6.10	36.00	0.31	4.55
12	Collar height (cm) at 90 DAT	9.53	11.43	10.41	0.12	0.57	3.32	7.25	21.00	0.33	3.13
13	Neck thickness (cm) at 90 DAT	2.37	3.24	2.73	0.03	0.09	6.76	11.08	37.00	0.23	8.50
14	Equatorial diameter of bulb (mm)	57.98	133.60	81.87	301.41	307.69	21.20	21.42	98.00	35.40	43.23
15	Polar diameter of bulb (mm)	54.98	126.00	80.00	230.62	245.48	18.98	19.58	94.00	30.32	37.90
16	Fresh weight of bulb plant^{-1} (g)	109.13	156.40	129.71	146.77	289.54	9.34	13.12	51.00	17.77	13.70
17	Dry weight of bulb plant^{-1} (g)	97.13	139.20	115.44	116.26	229.35	9.34	13.12	51.00	15.81	13.70
18	Fresh bulb yield plot^{-1} (kg)	1.83	3.05	2.41	0.11	0.23	13.68	19.79	48.00	0.47	19.49
19	Dry bulb yield plot^{-1} (kg)	1.63	2.71	2.15	0.09	0.18	13.69	19.79	48.00	0.42	19.49
20	Fresh bulb yield ha^{-1} (qt.)	91.62	152.48	120.77	273.14	571.29	13.68	19.79	48.00	23.54	19.49
21	Dry bulb yield ha^{-1} (qt.)	81.54	135.71	107.49	216.36	452.53	13.68	19.79	48.00	20.95	19.49
22	Number of scales bulb^{-1}	6.20	9.00	7.35	0.39	0.75	8.46	11.78	52.00	0.92	12.53
23	Total soluble solids (TSS ^{0} Brix)	8.62	11.85	9.92	0.43	0.71	6.64	8.52	61.00	1.06	10.68
24	Vitamin –C (mg/100 g)	8.65	12.27	9.73	1.03	1.24	10.43	11.45	83.00	1.91	19.58

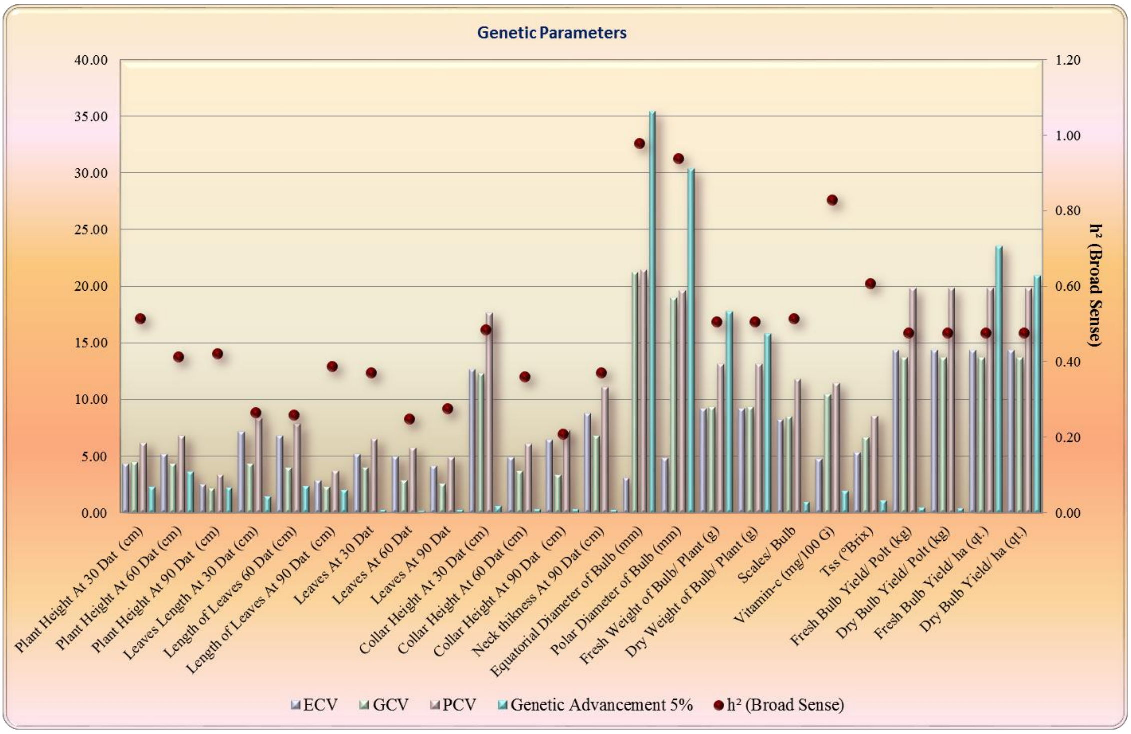

Fig 1: Range, mean, variance, coefficient of variations, heritability, genetic advance and genetic advance as percent of mean for 24 characters of onion genotypes

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