Research Article

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Genetic variability analysis in onion (*Allium cepa* L.) genotypes

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ABSTRACT

Genetic variability parameters *viz*., GCV, PCV, heritability, genetic gain, mean performance and range were assessed among twelve varieties of onion during *Kharif*, 2023 with adopting randomized block design and three replications. Results revealed that phenotypic coefficient of variation were higher than corresponding genotypic coefficient of variation for all the traits studied and magnitude of various variability parameters were significantly differ among the genotypes studied. Highest heritability (98.95%) has been reported in fresh weight of bulb, followed by dry weight of bulb (98.83%) and neck diameter (96.64%). Bhima Dark Red was best performing variety on the basis of yield per ha, followed by Bhima Super and Bhima Red yielding 298.24, 279.64 and 266.84 q/ha, respectively.

Introduction

Onion (*Allium cepa* L.) is the second most widely cultivated vegetable crop belonging to *Alliaceae* family. In India, it occupies an area of 1.64 million hectare with the production of 26.83 million tonnes and productivity is 16.36 tonnes per ha (Anonymous, 2021). It has predominantly expansion as a food source and value addition for a range of meals, it can be eaten raw (salads) or cooked as well as in processed form *e.g.,* flakes.

The availability of sufficient genetic variability is of immense importance in a crop improvement programme as high variability is required for effective selection. Therefore, it is essential for a plant breeder to assess the variability parameters mean performance, range, phenotypic coefficient of variation, genotypic coefficient of variation, heritability, genetic advance and genetic gain, as these parameters give the information regarding the availability of genetic variability for different characters in available germplasm. Hence, study of genetic variability of bulb yield and its contributing traits among different genotypes provides a strong basis for selection of desirable genotypes for augmentation of yield and other yield attributing characters (Amerullah *et al*., 2021).

Material and Methods

The present study was conducted at open field of Hi-tech Unit, Department of Horticulture, Rajasthan College of Agriculture, and Udaipur from June, 2023 to February, 2024 located at 24°34' 50.0556" N latitude and 73° 42' 19.8648" E longitude. Twelve onion varieties *viz.,* Bhima Super, Bhima Raj, Bhima Safed, Bhima Dark Red, Bhima Shubhra, Bhima Red, N-241, Bhima Light Red, Agrifound Light Red, Baswant-780 and Desi Tejas were planted with row-to-row distance of 30 cm and plant-to-plant distance of 10 cm in

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Randomized Block Design (RBD) with three replications. All the recommended cultural practices for raising healthy crop and plant protection measures were followed as per POP of Zone IV a (Kaushik and Ameta, 2014). Observations were recorded from five randomly selected plants in each plot for various quantitative characters and the data were subjected to statistical analyses. Suitable methodology was followed for recording various traits *i.e.* days to emergence was recorded by counting days from sowing to germination, plant height (cm) was measured from base of plant to top of longest leaf with the help of measuring scale and average was worked out, number of leaves per plant was counted in five randomly selected and tagged plant at maturity, leaf length (cm) was measured from joint of the leaf lamina to the tip of the leaf at maturity with the help of measuring scale, leaf width (mm) was measured from broad part of the leaf at maturity with the help of measuring scale, days to maturity was recorded by counting days from the day of planting seedlings till the bulbs reached to maturity, neck thickness (mm) was measured with the help of vernier caliper from below the joint of leaf lamina, bulb length (cm) was recorded by measuring the length between two polar ends of the bulb with the help of vernier caliper at harvest, bulb diameter (cm) was recorded from the point of maximum width of the bulb across the polar length, fresh weight of bulb (g) was recorded by selecting five randomly tagged plant from each treatment and replication and weighed after harvest with the help of digital electronic balance and expressed in grams and average was worked out, similarly dry weight of bulb (g) was recorded after curing and bulb yield (q/ha) was recorded by weighing all the bulbs of each experimental plot and derived yield per ha in quintals. The phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h^2), genetic advance (GA) and the expected genetic gain (GG) for different characters were analyzed as per procedure suggested by Burton and Devane (1953) and Johnson *et al* (1955), respectively.

Result and Discussion

Analysis of variance for twelve characters indicated that there is considerable variation in respect to all the traits, the results of mean, range, GCV, PCV, heritability, genetic advance and genetic gain for various characters of 12 genotypes of onion (Table 1) clearly showed higher magnitude of genetic variability in material studied.

High magnitude of genotypic as well as phenotypic coefficient of variation were recorded for traits *viz*., leaf width (22.07% and 22.62%), neck diameter (23.00% and 23.39%), fresh weight of bulb (34.95% and 35.13%), dry weight of bulb (35.16% and 35.37%) and bulb yield (23.41% and 24.80%). Similar results were reported by Dwivedi *et al*. (2017) for neck thickness, Amerullah *et al*. (2021) for fresh weight of bulb and Hosamani *et al*. (2010) for bulb yield while working with onion, further, phenotypic coefficient of variation were higher than corresponding genotypic coefficient of variation for all the traits studied, indicating influence of environment on expression of traits in various genotypes. The earlier findings of Chattopadhyay *et al*. (2013), Khosa and Dhatt (2013), Lakshmi (2015), Dwivedi *et al*. (2017), Dangi *et al*. (2018), Manjunath and Hiremath (2022), Prakash *et al*. (2022) and Yogita *et al*. (2023) were in same line as they also reported high PCV then corresponding GCV while working on onion.

The majority of the traits had high heritability and it was recorded highest for fresh weight of bulb (98.95%), dry weight of bulb (98.83%), neck diameter (96.64%), days to maturity (96.43%), leaf width (95.20%), bulb diameter (92.74%), bulb yield (89.08%) and number of leaves per plant (83.08%). However, moderate heritability was observed for bulb length (58.28%), leaf length (44.48%), days to emergence (44.16%) and plant height at maturity (30.30%). The highest heritability was recorded for fresh weight of bulb which was cent percent followed by dry weight of bulb, neck diameter, days to maturity, leaf width, bulb diameter, bulb yield and number of leaves per plant were showed high heritability (>60 per cent). High heritability have also been reported by Amerullah *et al*. (2021) for fresh weight of bulb, Hosamani *et al*. (2010) for bulb yield, whereas Parmar *et al*. (2018) observed high heritability for neck diameter, similarly, Khosa and Dhatt (2013), Dangi *et al*. (2018), Singh *et al*. (2011) and Bharti *et al*. (2011) reported high heritability for days to maturity, leaf width, bulb diameter and bulb weight, respectively, while working with onion. The moderate heritability (30-60 per cent) were observed for bulb length, leaf length, days to emergence and plant height at maturity. These findings are in close conformity of Parmar *et al*. (2018) as they reported moderate heritability for bulb length and plant height of onion. High heritability coupled with high genetic advance (89.08% and 103.40%) was recorded for bulb yield q/ ha, (98.95% and 86.06%) for fresh weight of bulb and (98.83% and 78.14%) for dry weight of bulb.

The highest genetic advance as percent of mean (genetic gain) was recorded for the dry weight of bulb (72.01%), fresh weight of bulb (71.61%), neck diameter (46.57%), bulb yield (45.51%), leaf width (44.36%), bulb diameter (37.03%) and number of leaves per plant (22.38%). Genetic gain is an important parameter of genetic variability as it shows potentialities of the improvement for particular trait in breeding programme. Seven characters out of twelve showed higher genetic gain *i.e*. more than 20 per cent (Johnson *et al.,* 1955), these characters are dry weight of bulb, fresh weight of bulb, neck diameter, bulb yield, leaf width, bulb diameter and number of leaves per plant, further heritability for above traits was also high, indicated that these characters are governed by additive gene action and thus direct selection of these traits could be effective in crop improvement programme, hence

these traits can be keep on priority for selection. Higher genetic gain accompanied with high heritability has also been reported by Parmar *et al.* (2018) for bulb yield, weight of bulb, number of leaves per plant and neck thickness of bulb, similarly Prakash *et al.* (2023) seen same trend for fresh bulb weight, dry bulb weight and bulb yield while working with onion. The findings of Srivastav *et al.* (2017), Dangi *et al.* (2018), Solanki *et al.* (2015) and Dwivedi *et al.* (2017) was in conformity with the results of present investigation as they also reported high genetic advance as per cent of mean along with high heritability for the various traits of onion.

Mean performance (Table 2 & 3) for various traits in genotypes showed that the highest bulb yield (298.24 q/ha) and fresh weight of bulb (183.92 g) was recorded for genotype Bhima Dark Red which was at par with genotype Bhima Super (279.64 q/ha and 176.10 g, respectively). Further, mean values for most of traits were higher and in desirable direction for Bhima Dark Red and Bhima Super varieties. A wide range of bulb yield (105.91-298.24 q/ha), fresh weight of bulb (66.02-183.92 g), dry weight of bulb (59.64-164.75 g), days to maturity (105-127 days), leaf length (43.45-55.49 cm) and plant height at maturity (49.48-59.08 cm) were observed for various genotypes.

Table 1. Range, mean, GCV, PCV, heritability, genetic advance and genetic gain in *kharif* onion

S.No.	Characters	Range	Mean	GCV	PCV	ECV	h^2	GA	GG
1	Days to emergence	4.80-6.07	5.58	6.60	9.94	7.43	44.16	0.50	9.04
2	Plant height at maturity (cm)	49.48-59.08	52.85	4.32	7.85	6.56	30.30	2.59	4.90
3	Number of leaves/ plant	8.20-11.53	9.61	11.92	13.08	5.38	83.08	2.15	22.38
4	Leaf length (cm)	43.45-55.49	48.33	6.28	9.42	7.02	44.48	4.17	8.63
5	Leaf width (mm)	4.75-11.38	8.74	22.07	22.62	4.95	95.20	3.88	44.36
6	Neck diameter (mm)	7.30-15.85	11.35	23.00	23.39	4.29	96.64	5.28	46.57
7	Bulb length (cm)	5.42-6.87	6.26	7.49	9.81	6.34	58.28	0.74	11.78
8	Bulb diameter (cm)	5.40-9.31	7.02	18.66	19.38	5.22	92.74	2.60	37.03
9	Days to maturity	105.43-127.27	116.45	6.02	6.13	1.16	96.43	14.19	12.18
10	Fresh weight of bulb (g)	66.02-183.92	120.17	34.95	35.13	3.60	98.95	86.06	71.61
11	Dry weight of bulb (g)	59.46-164.75	108.51	35.16	35.37	3.83	98.83	78.14	72.01
12	Bulb yield (q/ ha)	105.91-298.24	88.05	23.41	24.80	8.19	89.08	103.40	45.51

Table 2. Mean values for days to emergence and vegetative parameters of *kharif* onion

S. No.	Genotype	Days to emergence	Plant height at maturity (cm)	Number of leaves/ plant	Leaf length (cm)	Leaf width (mm)	Neck diameter (mm)
1	Bhima Super	6.07	57.98	11.13	53.88	10.82	14.52
2	Bhima Raj	5.80	51.54	9.20	47.59	9.02	11.28
3	Bhima Safed	5.87	51.25	8.70	46.90	8.28	10.62
4	Bhima Dark Red	5.67	59.08	11.53	55.49	11.38	15.85
5	Bhima Shubhra	6.03	49.48	8.20	43.45	4.75	7.30
6	Bhima Red	4.83	52.68	10.33	47.42	9.65	12.38
7	N-241	5.57	51.79	9.43	47.57	9.29	11.46
8	Bhima Light Red	5.60	50.88	8.67	46.38	8.07	9.78
9	N-53	5.73	53.17	10.53	49.89	9.67	12.86
10	Agrifound Light Red	4.80	50.27	8.40	44.34	6.09	7.80
11	Baswant-780	5.10	55.11	10.73	50.93	10.46	13.40
12	Desi Tejas	5.93	50.93	8.43	46.12	7.43	8.91
GM		5.58	52.85	9.61	48.33	8.74	11.35
SEm±		0.24	2.00	0.30	1.96	0.25	0.28
CD at 5%		0.70	5.87	0.88	5.74	0.73	0.82

CD at 1%	0.95	7.98	1.19	7.81	1.00	1.12
CV (%)	7.43	6.56	5.38	7.02	4.95	4.29

Table 3. Mean values for days to maturity, bulb traits and bulb yield of *kharif* onion

S. No.	Genotype	Bulb length (cm)	Bulb diameter (cm)	Days to maturity	Fresh weight of bulb (g)	Dry weight of bulb (g)	Bulb yield (q/ ha)
1	Bhima Super	5.42	8.66	118.47	176.10	157.73	279.64
2	Bhima Raj	6.35	6.50	122.33	110.52	97.42	243.01
3	Bhima Safed	6.87	6.34	105.43	93.15	84.03	212.46
4	Bhima Dark Red	6.56	9.31	121.67	183.92	164.75	298.24
5	Bhima Shubhra	6.29	5.44	120.57	66.02	59.46	105.91
6	Bhima Red	5.43	7.82	113.73	133.80	122.88	266.84
7	N-241	6.38	6.85	108.50	123.22	113.30	246.38
8	Bhima Light Red	6.83	6.09	110.23	86.18	78.41	214.22
9	N-53	6.54	7.52	122.70	151.45	137.09	257.99
10	Agrifound Light Red	6.51	5.40	118.60	71.97	63.22	161.87
11	Baswant-780	5.48	8.51	127.27	166.75	152.73	251.57
12	Desi Tejas	6.48	5.76	107.87	78.96	71.04	188.61
GM		6.26	7.02	116.45	120.17	108.51	227.23
SEm±		0.23	0.21	0.78	2.50	2.40	10.75
CD at 5%		0.67	0.62	2.29	7.33	7.03	31.52
CD at 1%		0.91	0.84	3.11	9.97	9.56	42.88
CV (%)		6.34	5.22	1.16	3.60	3.83	8.19

Conclusion

From the results of investigation, it is concluded that the Bhima Dark Red was found best performer for bulb yield per hectare followed by Bhima Super, Bhima Red and N-241. Further a wide range of variability were observed for most of traits in varieties in terms of GCV, PCV, heritability and genetic gain which could be utilized in breeding programmes to develop desirable genotypes of *kharif* onion.

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Conflict of Interest

The authors have no conflict of interest.

Data Sharing

All relevant data are within the manuscript.

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