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Studies on genetic variability and heritability in bulb onion (*Allium cepa* L.) in the South-Eastern plains of Bihar, India

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ABSTRACT

The study was conducted at Vegetable Research Farm, Department of Horticulture, Bihar Agricultural University, Sabour, Bhagalpur during Rabi season 2021-22 with the objective to study genetic variability in onion (*Allium cepa* L.) for yield and yield attributing traits. The experimental material consisted of 15 onion genotypes from different locations in India. Experimental trial was laid out in a RBD with three replications. Analysis of variance was done by the method suggested by Panse and Sukhatme (1967). The observations were recorded on five randomly selected plants of all genotypes for plant height, number of leaves, leaf length, leaf width, pseudostem length, neck thickness, polar diameter, equatorial diameter, and average bulb weight. Analysis of variance indicated significant differences among the genotypes for all the characters under study which implied a considerable amount of genetic variability in the genotypes included in the study. The highest average weight of onion bulb was recorded in genotype LC-1 (62.13g) which was statistically at par with LC-2 (58.53g), Patna Red (57.80g), Bhima Shakti (57.28 g) and Agrifound Light Red (56.87g). High PCV and GCV were recorded for pseudostem length and neck thickness. Moderate GCV and PCV were found in leaf width, average bulb weight, plant height, leaf length, equatorial diameter and bulb size index. High heritability along with high genetic advance as percentage of mean was exhibited by all the morphological traits. The genotypes LC-1, LC-2, Patna Red and Bhima Shakti were identified as promising ones for the yield and yield contributing traits.

***Key words**: Onion genotypes, Genetic variability*

Introduction

Onion (*Allium cepa* L.) is an underground vegetable of the family Amaryllidaceae, having chromosome number 2n = 2x = 16. It is one of the most widely cultivated vegetables around the world. It is known as the "Queen of Kitchen" as it is a commonly used cooking item by all the community of people. It contains sulphur compound Allyl propyl disulphide which is responsible for its smell and pungency. It has most important properties of antioxidant, anti-cancer, antimicrobial, anti-diabetic and anti-asthmatic (Ashwini and Sathish Kumar, 2014). It is used for cuisine, salad and culinary purpose or in preserved form. Onion crop can be grown in varied types of climatic conditions, but a mild climate is most suitable. Extremes of heat, cold and rainfall are not suitable for growing onion. India is the second largest onion growing country in the world. In the fiscal year 2021-22, India produced 26.64 million

tonnes of onion bulbs from 1.62 million ha area. Low yield performance of onion genotypes was found because of traditional growing genotypes with unknown potentiality. Information about the magnitude of genetic variability present in the genetic stocks, heritability and genetic advance among various traits are important in the breeding of any crop. Characterisation of genotypes helps to ensure efficient and effective use of genotypes for further crop improvement. Heritability and genetic advance are complementary concepts and important to the selection process. Genetic advance provides information of expected genetic gain resulting in the selection of superior genotypes. Thus variability is a keystone for the breeders for developing high yielding and stable cultivars through selection from the existing genotypes. Therefore present study was conducted with the objective to study the genetic variability for yield and yield attributing traits in onion genotypes. This study will help the breeder in the selection of desirable characters for yield enhancement in onion.

Materials and Methods

The present investigation was carried out at the research farm, Department of Horticulture (Vegetable & Floriculture), BAC, Sabour, Bhagalpur during Rabi season 2021-22. Bhagalpur is geographically situated between 25^{o}' 15'40''N latitude to 87^{o}2'42''Elongitude at 46 m above mean sea level. The climate of this place is tropical to sub-tropical with slight semi-arid nature and is characterized by a very dry summer, moderate rainfall and very cold winter. December and January are usually the coldest months when the mean temperature normally falls as low as 8.50^{0}C whereas October and April are the hottest months, having the maximum average temperature of 28.07^{0}C. The rainfall is mostly distributed from middle of June to middle of October. The rainfall distribution has been erratic lately, adversely affecting the crops and increasing disease and pest intensity. During the growing season the maximum and minimum temperatures were recorded to be 36^{0}C and 10.8^{0}C, respectively. Fifteen onion genotypes were assessed in randomized block design with three replications. The observations on various traits were recorded from five randomly selected competitive plants in each treatment and replication. Data recorded on plant height, number of leaves, leaf length, leaf width, pseudostem length, neck thickness, polar diameter, equatorial diameter and average bulb weight. Analysis of variance (ANOVA) was computed as per method suggested by Panse and Sukhatme (1967). Estimation of GCV and PCV was done by technique described by Burton and Devane (1953). Heritability and genetic advance were calculated as per standard techniques suggested.

Results and Discussion

Analysis of variance indicated significant differences among the genotypes for all the characters under study as shown in Table 1. It implied that considerable amount of genetic variability was found in the genotypes included in the study. Maximum plant height was recorded in genotype Patna Red (52.87 cm) which was at par with LC-1 (49.87 cm), LC-2 (46.72 cm) and Puna Fursungi (45.60 cm). However, the minimum plant height (32.47 cm) was observed in genotype Agrifound Dark Red. The variation in plant height among different genotypes may be due to their different genetic makeup and adaptation ability to a particular environment. The maximum number of leaves per plant (7.40) was obtained in genotype LC-2 which was statistically at par with genotypes LC-1 (7.13), and Patna Red (7.07). However, the genotype Agrifound Dark Red produced least number of leaves per plant (5.33). Similar results were reported by Hosamani et al. (2010), Behera *et al.* (2017), Singh *et al.* (2017) and Pujar*et al.* (2019) for plant height and number of leaves in onion. The maximum leaf length was recorded in genotype LC-1 (43.47 cm) which was comparable to Agrifound Light Red (41.72 cm), LC-2 (41.46 cm), NHRDF local (39.49 cm) and Bhima Shakti (39.49 cm) while minimum length (30.05 cm) of leaf was found in genotype Nasik. Similar result was also reported by Jilani *et al.* (2010), Shah *et al.* (2012), Azoom *et al.* (2014). The maximum width of leaf was obtained in genotype LC-1 (1.84 cm) and it was at par with genotypes Patna Red (1.82 cm) and LC-2 (1.78 cm). However, minimum breadth of leaf was found in the genotype Red Galaxy (1.18 cm). Similar results were reported by Dangi *et al.* (2018) and Ballabh *et al.* (2013). Increase in leaf length and leaf width contributes to higher photosynthates formation. The maximum pseudostem length was recorded in genotype LC-1 (12.17 cm) which was comparable to Patna Red (11.17 cm) while minimum pseudostem length (5.27 cm) was found in genotype Agrifound Dark Red. This result was supported by

Alam *et al.* (2010), Ballabh and Rana (2012) and Manna and Maity (2016) in onion. Higher pseudostem length is desirable in onion as it might have account for lesser incidence of soil borne diseases. Maximum neck thickness was observed in genotype Agrifound Dark Red (1.33 cm) which was at par with Red Galaxy (1.23 cm) while, the least neck thickness was noted in genotype LC-1 (0.42 cm). Lesser neck thickness is desirable as it contributes to fewer incidences of storage diseases and storage losses. The longest polar diameter of bulb was observed in Patna Red (5.17 cm) out of 15 genotypes which was at par with LC-1 (5.13 cm), Phule Samarth (5.02 cm), Bhima Kiran (5.02 cm), Bhima

Table 1. Mean performance for morphological, yield and yield attributes

	Plant height (cm)	No of leaves/ plant	Leaf length (cm)	Leaf width (cm)	Pseudostem length (cm)	Neck thickness (cm)	Polar diameter (cm)	Equatorial diameter (cm)	Bulb size index	Average bulb weight(g)
NHRDF local	43.85	6.13	39.49	1.42	6.55	0.96	4.33	4.27	1.02	53.4
N-53	37.67	6.13	33.15	1.23	6.06	1.09	4.26	3.87	1.11	46.13
Nasik	39.84	5.53	30.05	1.31	5.47	1.2	4.12	3.43	1.21	42.33
LC-1	49.87	7.13	43.47	1.84	12.17	0.42	5.13	4.04	1.28	62.13
Red Galaxy	37.47	5.43	32.11	1.18	5.35	1.23	3.7	3.59	1.04	40.6
Phule Samarth	39.25	6.24	32.9	1.43	6.13	1.07	5.02	4.07	1.23	47.33
Bhima Kiran	42.91	6.4	38.21	1.55	6.21	1.03	5.02	4.55	1.12	49.47
LC-2	46.72	7.4	41.46	1.78	10.14	0.86	4.23	3.21	1.31	58.53
AFDR	32.47	5.33	30.72	1.29	5.27	1.33	4.35	3.3	1.32	41.67
AFLR	44	6.33	41.72	1.22	7.67	0.94	4.35	4.02	1.09	56.87
Patna Red	52.87	7.07	35.36	1.82	11.17	0.91	5.17	4.48	1.16	57.8
Puna Fursungi	45.6	6.47	38.24	1.55	6.2	0.98	4.83	4.47	1.09	49.73
White Manik Moti	38.27	5.67	30.58	1.39	5.73	1.17	3.95	3.53	1.13	42.53
Bhima Shakti	40.61	6.53	39.41	1.62	8.68	0.89	4.8	4.21	1.14	57.28
Bhima Super	38.56	5.73	32.65	1.49	5.73	1.11	4.93	3.26	1.52	42.72
Mean	42	6.24	35.97	1.47	7.24	1.01	4.55	3.89	1.18	49.9
C.V.	7.7	5.23	5.32	4.99	9.39	5.27	6.73	5.31	5.25	5.33
S.E.	1.87	0.19	1.1	0.04	0.39	0.03	0.18	0.12	0.04	1.54
C.D. 1%	**7.3**	**0.74**	**4.31**	**0.17**	**1.53**	**0.12**	**0.69**	**0.47**	**0.14**	**6**

Table 2. Variability parameters for yield and yield related traits in onion

TRAITS	RANGE	GCV(%)	PCV(%)	Heritability (%)	Genetic Advance (GA) (%)	GA as % of Mean (%)
Plant height	32.47-52.87	11.816	14.104	70%	10.976	26.135
No of leaves	5.33-7.40	9.668	10.992	77%	1.4	22.449
Leaf length	30.04-43.47	12.259	13.361	84%	10.679	29.691
Leaf width	1.18-1.84	14.475	15.31	89%	0.533	36.132
Pseudostem length	5.26-12.17	30.585	31.995	91%	5.585	77.187
Neck thickness	0.42-1.33	20.918	21.57	94%	0.542	53.553
Polar Diameter	3.7-5.17	9.468	11.618	66%	0.926	20.369
Equatorial diameter	3.22-4.55	11.666	12.817	83%	1.09	28.033
Bulb size index	1.02-1.52	10.612	11.841	80%	0.297	25.109
Average bulb weight	40.60-62.13	14.242	15.206	88%	17.572	35.214

Super (4.93 cm), Puna Fursungi (4.83 cm) and Bhima Shakti (4.80 cm). The lowest polar diameter was recorded in genotype Red Galaxy (3.70 cm). The genotype Bhima Kiran (4.55 cm) recorded highest equilateral diameter of bulb and was at par with Patna Red (4.48 cm), Puna Fursungi (4.47 cm), NHRDF local (4.27 cm) and Bhima Shakti (4.21 cm). The lowest equatorial diameter (3.21 cm) was recorded in genotype LC-2. This was supported by findings of Hosamani *et al.* (2010), Singh and Dubey (2011), Singh *et al.* (2017), Pujar *et al.* (2019), Komali *et al.* (2021) in onion. The highest bulb size index was recorded in the genotype Bhima Super (1.52) which was at par with Agrifound Dark Red (1.32) and LC-2 (1.31). The lowest bulb size index was found in NHRDF local (1.02). Low bulb size indicated that the bulbs were more or less globular in shape. The highest average weight of onion bulb was recorded in genotype LC-1 (62.13g) which was at par with LC-2 (58.53g), Patna Red (57.80g), Bhima Shakti (57.28 g) and Agrifound Light Red (56.87g) while, the lowest average bulb weight was obtained in genotype Agrifound Dark Red (41.67g) which had statistical parity with Nasik (42.33g), White Manik Moti (42.53g), Bhima Super (42.72g) and N-53 (46.13g). Higher polar and equatorial diameter contributes to higher bulb weight. Also, more leaf length and leaf width also contributes to higher bulb weight by providing for higher accumulation of photosynthates in the bulb. The results of present study were quite similar to Hosamani *et al.* (2010), Behera *et al.* (2017), Pujar *et al.* (2019), and Komali *et al.* (2021) in onion.

For all the traits studied, phenotypic coefficients of variation were higher in magnitude than genotypic coefficients of variation, though the difference was very less in majority of cases, thus showing that these traits are less influenced by environmental factors. Coefficients of variation varied in magnitude from trait to trait, either low or moderate or high has been presented in Table 2. High PCV and GCV were recorded for pseudostem length and neck thickness. Moderate GCV and PCV were found in leaf width, average bulb weight, plant height, leaf length, equatorial diameter and bulb size index. It showed that genotypic variance for these characters are probably due to additive gene effect (Panse, 1967). These findings were in conformity with the results of Hyder *et al.* (2007) for plant height; Mohanty (2002) and Mohanty (2004) for neck thickness; Vidyasagar *et al.* (1993) for polar and equatorial diameter; Navaldey *et al.* (2011) for bulb size index; Dhotre (2009) for average bulb weight in onion. High heritability and high genetic advance were recorded for plant height, number of leaves, leaf length, leaf width, pseudostem length, neck thickness, polar diameter, equatorial diameter, bulb size index and average bulb weight and thus these attributes might form a selection criterion in onion improvement. Dhotre (2009) also recorded height heritability along with genetic advance as percent of mean for average bulb weight. This result was in agreement to the findings of Ram *et al.* (2011) for plant height; Hyder *et al.* (2007) for number of leaves; Ananthan and Balkrishnamoorthy (2007) and Hosamani *et al.* (2010) for neck thickness; Dhotre (2009) for average bulb weight.

Conclusion

The result obtained from the present investigation showed that high variability was found for different characters among the genotypes under study. Genotypes namely genotypes LC-1, LC-2, Patna Red and Bhima Shakti were identified as promising ones for the yield and yield-related traits. These may be used in future breeding programmes for evaluation and testing of quality parameters and the development of superior onion varieties.

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