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Genetic variability, heritability and genetic advance in onion (*Allium cepa* L.) for bulb yield and its component characters

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Abstract
The present investigation on "Genetic variability, heritability and genetic advance in onion (*Allium cepa* L.) for bulb yield and its component characters" was carried out at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka, during the *rabi* season of 2021-2022. The study was undertaken to evaluate the variability present among the *rabi* genotypes and predict the results for hybridization programme. Thirty-seven genotypes of onion were used for the experiment. On the basis of mean performance RVC-21-40 was found best performing genotype with highest bulb yield (35.20 t/ha). Higher estimates of heritability were found for pyruvic acid followed by bulb weight, yield, TSS, polar diameter and equatorial diameter characters, indicating the presence of high variability, which suggests that these traits can aid in simple selection which could be helpful for further crop improvement.

Keywords: Onion, variability, heritability, genetic advance

Introduction
Onion (*Allium cepa* L.) is widely cultivated vegetable crop, under the genus *Allium*, belongs to family *Alliaceae* and having chromosome number 2n (2x) = 16. It has become an important commercial crop because of its medicinal and nutritive values. It is native to Southwest Asia and Mediterranean regions. In the world it is grown commercially in China and India. India is the second largest onion producing country in the world with production of 26.09 million tonnes from 1.43 million hectares area with a productivity of 18.23 tonnes per hectare (Anon., 2021) [9]. Major onion producing states in India are Maharashtra, Karnataka and Madhya Pradesh. In Karnataka, it is grown in an area of 1.66 lakh hectares with production of 25.58 lakh tonnes (Anon., 2018) [9]. The major growing districts in the state are Chitradurga, Gadag, Vijayapura, Bagalkot and Dharwad.
Yield of any crop is a complex character which is mainly determined by interaction of many heritable characters with soil, climate and agronomic conditions (Makasheva, 1983) [12] and the degree of interclonal variability and the probability that this variability is descended to succeeding generations determine how effective an improvement programme will be. High heritability estimates along with high genetic advance are more advised for selection than heritability estimates alone (Johnson *et al*., 1955) [11]. In order to choose the appropriate genotypes for further breeding programmes, information on the nature and extent of genetic diversity existing in the heritability, genetic stocks and genetic progress among various traits is of great value. The most significant quantitative characteristic that is yield, has received very little attention. In order to determine the genetic variability existing in the onion germplasm, this study was carried out.

Material and Methods
The present investigation on "Genetic variability, heritability and genetic advance in onion (*Allium cepa* L.) for bulb yield and its component characters" was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *rabi* 2021-22. Thirty-seven genotypes were collected from different institutions and geographical diverse locations and evaluated using randomized complete block design (RCBD) consisting of three replications. Five plants were selected randomly from each replication and data were recorded for the characters *viz.*, number of leaves per plant, plant height (cm), neck diameter (cm), equatorial diameter (cm), polar diameter (cm), bulb weight (g), TSS (°Brix), pyruvic acid (µ moles/ g) and yield (t/ha).

Analysis of variance was computed as per the procedures given by Panse and Sukhatme (1961) [14] and genetic parameters such as mean, range, genotypic and phenotypic characters were analysed as suggested by Burton (1953) [3]. Heritability and genetic advance were worked according to Johanson *et al*. (1955) [11].

Results and Discussion

One of the most crucial and critical requirements in any breeding programme is the nature and degree of genetic variability. The ability to predict the degree of variability present in a given set of genetic material is greatly aided by knowledge of various parameters of variability, including general mean, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), range, genetic gain, and broad sense heritability. For all the observed characters the estimates of PCV and GCV were evaluated. The coefficient of variability is classified as low, moderate and high and these are helpful in determining the extent of genetic variability present among the genotypes and predict the results of hybridization programmes. Heritability is a measure of enormous importance to breeders since its magnitude shows the accuracy with which a genotype may be identified by its phenotypic manifestation. Studying genetic improvement with heredity is more crucial for evaluating the true effects of selection because heritability alone is insufficient. The estimates of genetic parameters *viz.*, heritability, genotypic coefficient of variation, phenotypic coefficient of variation, and genetic advance (GA) as percent of mean for different traits of onion genotypes were carried out.

The data presented in table. 1 indicates the existence of wide range of phenotypic variability in experimental material. The estimates of PCV were higher than corresponding GCV for all characters studied which indicated that the apparent variation is not only due to genotypes but also due to the influence of environment. The higher estimates of GCV and PCV were recorded for yield (GCV= 24.54%; PCV=26.18%). Moderate estimates of GCV and PCV was registered for bulb weight (GCV = 13.23%, PCV = 13.89%). Moderate estimate of PCV and lower estimate of GCV was found in the traits neck diameter (PCV = 10.99%, GCV = 6.22%) and polar diameter (PCV = 10.57%, GCV = 9.54%). Lowest GCV and PCV were recorded for pyruvic acid (GCV = 9.89, PCV = 9.91%), equatorial diameter (GCV = 7.19%, PCV = 8.12%), TSS (GCV= 6.60%, PCV = 7.05%), number of leaves per plant (GCV = 3.06%, PCV= 5.31%) and plant height (GCV= 2.11%, PCV = 4.61%).

The higher estimates of GCV and PCV for above characters indicates the existence of sufficient variability among the genotypes for these characters. Thus, simple selection could be helpful for further improvement. The similar outcome of results was recorded by Trivedi *et al*. (2006) [21], Rajya Lakshmi (2015) [15], Chattoo *et al*. (2015) [4], Tripathy and Sahoo (2018) [20] and Tahaseen (2019) [19]. The observed moderate estimates of variance had similar findings with Tahaseen (2019) [19] and lower estimates of variance results are in line with Singh and Singh (1994), Balareddy (1999) [2], Haydar *et al*. (2007) [6], Tripathy and Sahoo (2018) [20] and Tahaseen (2019) [19].

The potential of a particular trait to be passed on from one generation to the next is known as heritability. It is an important measure to breeders since its magnitude tells us how reliably a genotype can be identified by its phenotypic expression. Higher the variation in heritability among the genotypes for a particular character greater will be the chances for its improvement by selection. Hence, heritability studies are of great significance to know whether the variability for a particular trait is heritable or the extent to which it is being affected by the environmental factors. Heritability estimations and genetic progress together offer a greater chance for selection than any of the criteria alone (Johnson *et al.*, 1955) [11].

The estimates of heritability ranged from 21.10% to 99.93% for various characters (Table 1). Heritability was maximum for pyruvic acid (99.93%) followed by bulb weight (90.73%), yield (87.69%), TSS (87.51%), polar diameter (81.32%) and equatorial diameter (78.43%). Moderate estimates of heritability were observed for number of leaves per plant (33.39%) and neck diameter (32.07%). While lower estimates of heritability were recorded for plant height (21.10%).

The high heritability for TSS was in confirmation with the results obtained by Vidyasagar and Monika (1993) [22], Balareddy (1999) [2], Ananthan and Balakrishnamoorthy (2007) [1] and Hosamani *et al*. (2010) [7] and for parameters like yield, polar diameter and equatorial diameter confirms with the reports of Mohanty (2002) [13], Ibrahim *et al*. (2013) [10] and Tahaseen (2019) [19]. It means that selection based on phenotypic performance would be accurate and that the environment had the least impact on the high heritability traits. It also means that the phenotypes were a true representation of the genotypes. Moderate estimates of heritability were in accordance with Vidyasagar and Monika (1993) [22], Chattoo *et al*. (2015) [4] and Tahaseen (2019) [19].

Genetic advancement is described as an annual rise in performance of a certain characteristic or an annual intensification of and TSS (12.72%). While lowest values of genetic advance as percent of mean was registered for neck diameter (7.53%), that particular traits performance. The moderate genetic advance was recorded for bulb weight (19.80%) and low estimates of genetic advance were recorded for yield (9.68%), TSS (1.61%), plant height (1.19%), polar diameter (0.98%), pyruvic acid (0.94%), equatorial diameter (0.81%), number of leaves per plant (0.39%) and neck diameter (0.11%) (Table 1). These observed results on moderate genetic advance are in line with previous researchers for the character bulb weight (Singh *et al*., 2017, Tripathy and Sahoo, 2018 [20] and Tahaseen, 2019) [19]. These results for low genetic advance are in consistent with works of Chattoo *et al*. (2015) [4] for plant height.

Genetic advance as percent of mean (genetic gain) is the percentage of population mean. The data pertaining to genetic gain presented in table.1 showed the preponderance of low (0-10%), medium (10-20%) and high (>20%) genetic gain for different characters under study. Maximum genetic advance as percent of mean was observed for yield (47.30%), bulb weight (25.95%), pyruvic acid (20.16%). Moderate values of genetic advance as percent of mean was noticed for polar diameter (17.73%), equatorial diameter (13.24%) number of leaves per plant (3.62%) and plant height (2.00%). The similar findings of high genetic advance as percent of mean for yield was reported by Solanki (2015) [18], Dinkar (2017) [5] and Tahaseen (2019) [19]. Moderate values of genetic advance as percent of mean for characters like equatorial diameter and TSS are in consistent with Singh *et al*. (2017) [17], Tripathy and Sahoo (2018) [20] and Tahaseen (2019) [19]. These results

for low genetic advance as percent of mean are in consistent with works of Chattoo *et al.* (2015) [4] for plant height and Dinkar (2017) [5] for number of leaves per plant.

High heritability coupled with high genetic advance as percent of mean was recorded in bulb weight and yield which indicates the additive gene effects controlling the inheritance of characters and simple direct selections would lead to improvement in that particular character.

Table 1: Mean, coefficient of variation, heritability, genetic advance and genetic advance as percent of mean for various characters in onion genotype

Sl. No.	Characters	Mean	Range		Variance		Coefficient of variance		Heritability (Percent)	Genetic advance (%)	Genetic advance as percent of mean (Genetic Gain) (%)
			Min.	Max.	Genotypic	Phenotypic	Genotypic	Phenotypic			
1	X_1	10.76	10.04	11.85	0.10	0.32	3.06	5.31	33.39	0.39	3.62
2	X_2	59.32	54.85	63.00	1.60	7.48	2.11	4.61	21.10	1.19	2.00
3	X_3	1.52	1.19	1.78	0.01	0.03	6.22	10.99	32.07	0.11	7.53
4	X_4	6.10	4.77	6.75	0.20	0.25	7.19	8.12	78.43	0.81	13.24
5	X_5	5.51	4.22	6.38	0.30	0.34	9.54	10.57	81.32	0.98	17.73
6	X_6	76.29	58.14	95.38	101.80	112.20	13.23	13.89	90.73	19.80	25.95
7	X_7	12.68	10.50	14.21	0.70	0.80	6.60	7.05	87.51	1.61	12.72
8	X_8	4.68	3.00	5.50	0.19	0.21	9.89	9.91	99.93	0.94	20.16
9	X_9	20.46	9.47	35.20	25.17	28.70	24.52	26.18	87.69	9.68	47.30

Conclusion

Significant genotypic and phenotypic differences were observed for all the traits under study. High genotypic coefficient of variation was recorded for yield indicating presence of ample amount of variability and less influence of environment on their expression.

From the present investigation, it is indicating that characters like bulb weight and yield recorded high heritability and genetic gain. Hence, it could facilitate the identification of superior genotypes in onion by direct selection for these traits.

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