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Research Article

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Genetic Variability, Heritability and Genetic Advance in Onion (*Allium cepa* L.)

Chavda KA, Jethva AS, Sapovadiya MH, Vachhani JH

Junagadh Agricultural University, Junagadh, Gujarat, India

Abstract An experiment was conducted to evaluate 75 diverge genotypes of onion during *rabi* season for genetic variability, heritability and genetic advance. Analysis of variance revealed that mean squares due to genotypes were significant for all the 12 characters. The values of phenotypic coefficients of variation (PCV) were slightly higher than that of genotypic coefficients of variation GCV) for most of the traits studied indicating less effect of environment on the expression of characters studied. GCV and PCV for bolting and double onion bulb were high. This indicated the presence of wide genetic variation for these characters. High heritability (broad sense) estimates were found for bolting, double onion bulb per plot, neck thickness of bulb, pseudo stem length and TSS of bulb. Genetic advance expressed as per cent of mean was high for bolting and double onion bulb, whereas the values with moderate magnitudes were observed for number of leaves per plant, bulb weight, neck thickness of bulb, pseudo stem length, bulb equatorial diameter and bulb yield per plot.

Keywords Genetic variability, heritability, GCV, PCV, genetic advance, onion

Introduction

Onion (*Allium cepa* L.) is one of the important spice and vegetable crops grown in temperate, sub-tropical and tropical climate throughout the world. It is cultivated year round but the maximum during *rabi* season in our country.

India ranks second in the world in area and production after China and third in export after Netherland and Spain. India is producing 194.01 lakh tonnes of onion from an area of 12.03 lakh hectares with an average productivity of 16.13 t/ha (Anon., 2017a) [3]. In Gujarat, it is grown an about 0.51 lakh hectares with an average production of 13.69 lakh tones and productivity of 26.54 t/ha (Anon., 2017b) [4].

The genetic variability is determined with the help of certain genetic parameters *viz.*, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV). Heritability is the heritable portion of phenotypic variation and it is a good index of transmission of a character from one generation to another generation. If the heritability of a character is high, the phenotypic value provides a fairly close measure of the genotypic value and thus, breeders can base his selection on the phenotypic performance, thereby the knowledge of heritability helps the plant breeder in pre-assessing the results of selection for a particular character. The knowledge of heritability coupled with expected genetic advance for a trait will help us in deciding the scope of improvement of that particular trait through selection. The present study was therefore, conducted to estimate variability, heritability and genetic advance in 49 diverse onion genotypes for utilization in selection programmes aimed at productivity increase of future genotypes.

Materials and Methods

The 75 genotypes of onion were selected out of large collection of germplasm maintained at the Vegetable Research Station, Junagadh Agricultural University, Junagadh in Randomized Block Design (RBD) with two replications during *rabi* 2018. Plot size was 0.45 m × 2.0 m length with spacing of 15 cm × 10 cm. The genotypes were randomly allotted to the plots in each replication. All the recommended agronomical practices along with necessary plant protection measures were followed timely for the successful raising of the crop. The observations were recorded on five randomly selected onion plants (except days to maturity, which was recorded on plot basis) in each entry and in each replication for 12 characters *viz*., plant height (cm), number of leaves per plant, bolting (%), days to maturity, double onion bulb (%), bulb weight (g), neck thickness of bulb (cm), pseudo stem length (cm), bulb equatorial diameter (cm), bulb polar diameter (cm), TSS of bulb (%) and bulb yield (kg) and their mean values were used for statistical analysis.

Analysis of variance was carried out as per methodology given by Panse and Sukhatme (1985) [16]. Genotypic and phenotypic coefficients of variation (GCV and PCV) were calculated by the formula given by Burton and De Vane (1953) [6], heritability in broad sense (h2) and genetic advance given by Allard (1960) [2].

Results and Discussion

In the present study, analysis of variance revealed that mean squares due to genotypes were significant for all the traits (Table 1). Significant variation for the characters bulb yield and plant height was earlier reported by Chattopadhyay *et al.* (2013) [8], Dewangan and Sahu (2014) [9], Aditika *et al.* (2017) [1], Basha *et al.* (2018) [5] and Sahu *et al.* (2018) [19]. Significant variation for bulb polar diameter, bulb equatorial diameter and TSS of bulb was reported by Dhotre *et al*. (2010) [10], Chattopadhyay *et al.* (2013) [8], Dewangan and Sahu (2014) [9], Dwivedi *et al*. (2017) [11], Basha *et al*. (2018) [5] and Sahu *et al*. (2018) [19]. Significant variation for number of leaves per plant and bulb weight was reported by Aditika *et al*. (2017) [1], Basha *et al*. (2018) [5] and Sahu *et al*. (2018) [19]. Thus, considerable amount of genetic variability was present in the experimental material, which can be exploited for improvement of bulb yield and yield attributes in onion. Hence, it can be noted that systematic crossing among selected genotypes in onion generates good amount of variability in subsequent generations.

The mean, range, coefficient of variability, heritability and genetic advance are presented in Table 2. High genotypic and phenotypic coefficients of variation were observed for bolting and double onion bulb. Phenotypic coefficient of variation for number of leaves per plant, neck thickness of bulb, pseudo stem length, bulb equatorial diameter and bulb yield were moderate. Phenotypic and genotypic coefficient of variation for plant height, days to maturity, bulb weight, bulb polar diameter and TSS of bulb and were low. Genotypic coefficient of variation for neck thickness of bulb, pseudo stem length, bulb equatorial diameter and bulb yield were low. Similar results were found by Sutaria (1992) [20] for most of the characters, Ghetia (1990) [12] reported same results for double onion bulb. Plant height and days to maturity by Gurjar and Singhania (2006) [13], double onion bulb per plot and bolting by Sutaria (1992) [20], bulb polar diameter by Patil (1997) [17], days to maturity and bulb weight by Morsy (2011) [15]. High values of genotypic co-efficient of variation (GCV) was observed by Kale (2013) [14]. Low values of GCV and PCV were found for plant height and plant height.

The maximum heritability (broad sense) was recorded for bolting followed by double onion bulb, TSS of bulb, neck thickness of bulb and pseudo stem length. While, moderate heritability was recorded in plant height, number of leaves per plant, days to maturity, bulb weight, bulb equatorial diameter, bulb polar diameter and bulb yield per plot (Table 2). High heritability estimates indicated that the characters were the least influenced by the environmental effects and high capacity of the characters for transmission to subsequent generations. This also suggested that the phenotypes were the true representative of their genotypes for these traits and selection based on phenotypic value could be reliable. The high magnitude of heritability in onion has also been reported by Ghetia (1990) [12] for bulb weight. Sutaria (1992) [20] showed high heritability for all the characters except number of leaves per plant and polar diameter of bulb. Chattopadhyay *et al.* (2013) [8] reported high heritability for all the traits except polar diameter of bulb. Dewangan and Sahu (2014) [9] reported high heritability for total bulb yield and bulb weight. Chattoo *et al.* (2015) [7] observed high heritability for double onion bulb and bolting. Aditika *et al.* (2017) [1]

observed high heritability for TSS of bulb. The high values for genetic advance were observed for bulb weight followed by days to maturity. While, the values of it were moderate for plant height, number of leaves per plant, TSS of bulb, bolting and pseudo stem length. The remaining traits *viz*., double onion bulb, bulb yield per plot, bulb equatorial diameter, bulb polar diameter and neck thickness of bulb recorded low genetic advance. The higher values of genetic advance was also reported by Ram *et al.* (2011) [18] for weight of bulb. Chattoo *et al.* (2015) [7] observed high values of genetic advance for double onion bulb.

Conclusion

It can be concluded that the highest range of variation, high genotypic coefficient of variation and phenotypic coefficient of variation were observed in bolting and double onion bulb were high. High heritability estimates were observed for bolting, double onion bulb per plot, neck thickness of bulb, pseudo stem length and TSS of bulb. Genetic advance expressed as per cent of mean was high for bolting and double onion bulb.

Table 1: Analysis of variance for 12 characters in 75 genotypes of onion

Source of variation	d. f.	Plant height (cm)	No. of leaves per plant	Bolting (%)	Days to maturity	Double onion bulb (%)	Bulb weight (g)
Replications	1	71.4150**	8.1667*	0.1193*	185.9267**	0.1693*	135.7553*
Genotypes	74	10.7975*	2.6256**	0.7388**	9.6130**	0.4622**	75.9842**
Error	74	6.9231	1.1802	0.0286	5.1834	0.0369	31.6613

Table 1. (Contd.)

Source of variation	d. f.	Neck thickness of bulb (cm)	Pseudo stem length (cm)	Bulb equatorial diameter (cm)	Bulb polar diameter (cm)	TSS of bulb (%)	Bulb yield per plot (kg)
Replications	1	0.0214*	1.5140*	1.4250*	0.8588*	1.3048*	1.8906*
Genotypes	74	0.0158**	1.1363**	0.6001**	0.3602**	1.3192**	0.6980**
Error	74	0.0049	0.3727	0.3238	0.1934	0.2992	0.3359

*, ** Significant at @ 5% and 1% levels, respective

Table 2: Mean performance and range including variability parameters for twelve characters in onion

Characters	Phenotypic range	Coefficient of range (%)	Mean	Phenotypic coefficient of variation (%)	Genotypic coefficient of variation (%)	Heritability (broad sense) (%)	Genetic advance	Gs as Percentage of mean (%)
Plant height (cm)	43.6 to 54.75	11.34	50.88	4.57	2.74	35.88	1.72	3.38
No. of leaves per plant	9.00 to 14.00	21.74	11.27	10.16	7.54	55.05	1.30	11.53
Bolting (%)	0.00 to 2.55	100.00	1.23	49.35	48.39	96.13	1.20	97.73
Days to maturity	106.5 to 116.5	4.48	111.74	1.96	1.33	46.08	2.08	1.86
Double onion bulb (%)	1.06 to 3.08	48.79	1.75	27.45	26.34	92.02	0.91	52.04
Bulb weight (g)	54 to 81.25	20.15	65.00	9.48	7.24	58.33	7.41	11.40
Neck thickness of bulb (cm)	0.61 to 1.00	24.22	0.81	11.04	9.18	69.07	0.13	15.71
Pseudo stem length (cm)	4.06 to 8.36	34.62	6.27	12.02	9.85	67.20	1.04	16.63
Bulb equatorial	4.01 to 6.24	21.76	5.05	10.84	7.36	46.04	0.52	10.28

diameter (cm)								
Bulb polar diameter (cm)	4.07 to 6.12	20.12	4.74	8.96	6.10	46.32	0.41	8.55
TSS of bulb (%)	10.32 to 15.16	19.00	13.34	6.09	5.35	77.32	1.29	9.70
Bulb yield per plot (kg)	2.15 to 6.48	50.17	4.37	13.51	9.73	51.87	0.63	14.43

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