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

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Abstract
An experiment was conducted to evaluate 49 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 highly significant for 11 characters out of 13 characters. Maximum coefficient range of variation was observed for bolting (%), fresh weight of leaves, neck thickness of bulb, weight of bulb, double onion bulb per plot (%) and bulb yield per plot. Plant height, number of leaves per plant, equatorial diameter of bulb and polar diameter of bulb expressed a moderate coefficient range of variation. The values of GCV were slightly higher than that of PCV for all the traits studied. The high values of GCV and PCV were recorded for bolting (%), fresh weight of leaves, dry weight of leaves, neck thickness of bulb and bulb yield per plot. This indicated the presence of wide genetic variation for these characters. High heritability (broad sense) value were found for bulb yield per plot, weight of bulb, number of leaves per plant, neck thickness of bulb, double onion bulb per plot and TSS of bulb. Moderate values of heritability were observed for plant height, equatorial diameter of bulb and polar diameter of bulb. Genetic advance expressed as per cent of mean was high for bulb yield per plot, weight of bulb, bolting (%), fresh weight of leaves, dry weight of leaves, neck thickness of bulb, double onion bulb per plot (%) and TSS of bulb. The values with moderate magnitude were observed for number of leaves per plant and days to maturity, which may be attributed to the preponderance of additive gene action and passes high selective value and thus, selection pressure could profitably be applied on these characters for their rationale improvement.

Keywords: Genetic variability, heritability, genetic advance, onion.

Introduction
Onion (*Allium cepa* L.) is one of the most important bulbous vegetable crops grown all over the world. Onion is the oriented crop earning valuable foreign exchange for the country. It is the second only to tomato in their importance as a vegetable in the tropics. The demand for onion is worldwide.

India is next to china in area and production of onion. Among the different states Maharastra is leading state in terms of area and production. Other major onion producing states are Karnataka, Madhya Pradesh, Gujarat, Rajasthan and Odisha.

India is producing 194.01 lakh tonnes of onion from an area of 12.03 lakh hactares with an average productivity of 16.13 t/ha. In Gujarat, it is grown an about 51.60 thousand hectares with an average production of 1369.34 thousand metric tonnes and productivity 26.54 t/ha (Anon., 2017a) [1]. Onion is now become one of the important crops of Saurastra region of Gujarat State. It is also noteworthy that saurastra region alone contributes area of 48.18 thousand hectares in onion cultivation and 1218.92 thousand metric tonnes of onion production in year 2017.

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

49 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 three replications during *Rabi* 2017. Each genotype was accommodated in a three rows of 200 cm length with a spacing of 15 cm between row and 10 cm between plants within the row. Other recommended agronomical practices in vogue were followed for raising good crop. The observations were recorded on five randomly selected onion plant in each entry and in each replication for 13 characters *viz.*, plant height (cm), number of leaves per plant, days to maturity, fresh weight of leaves (g), dry weight of leaves (g), neck thickness of bulb (cm), equatorial diameter of bulb (cm), polar diameter of bulb (cm), bolting (%), double onion bulb per plot (%), weight of bulb (g), bulb yield per plot (Kg) and TSS of bulb and their mean values were used for statistical analysis.

Analysis of variance was carried out as per methodology given by Panse and Sukhatme (1985) [2]. Genotypic and phenotypic coefficients of variation (GCV and PCV) were calculated by the formula given by Burton and De Vane (1953) [3], heritability in broad sense (h^2) and genetic advance given by Johnson *et al.* (1955) [4].

Results and Discussion

Table 1: Analysis of variance showing mean squares for 13 characters in 49 genotypes of onion

Source of variation	d. f.	Plant height (cm)	Number of leaves per plant	Days to maturity	Bolting (%)	Fresh weight of leaves (g)	Dry weight of leaves (g)	Neck thickness of bulb (cm)
Replications	02	4.2684 **	0.8690 **	02.6326 **	0.0060 **	03.3126 **	0.3587 **	0.0292 **
Genotypes	48	29.3068 **	4.5766 **	113.2080 **	1.1337 **	51.6181 **	5.7028 **	0.0904 **
Error	96	7.9052	0.7646	05.8687	0.0065	02.0627	0.1536	0.0115

Source of Variation	d. f.	Equatorial diameter of bulb (cm)	Polar diameter of bulb (cm)	Weight of bulb (g)	Double onion bulb per plot (%)	Bulb yield per plot (kg)	TSS of bulb (%)
Replications	02	0.5710 *	0.2896 *	09.8554 **	0.0057 **	0.1450 **	0.1516 **
Genotypes	48	0.6095 *	0.4030 *	344.9056 **	1.2760 **	1.2711 **	5.4493 **
Error	96	0.2594	0.1396	47.7295	0.0195	0.2953	0.1376

*, ** Significant at 5 % and 1% levels, respectively

The analysis of variance (Table 1) revealed that the mean squares due to genotypes were significant for 11 characters out of 13 characters indicating the presence of sufficient amount of genetic variability among genotypes for bulb yield per plot and other yield contributing traits. These findings are in accordance with the findings of Ghetia (1990) [5] and Sutaria (1992) [6] for most of the characters. Hence, it can be noted that systematic crossing among selected genotypes in onion generates good amount of variability in subsequent generations.

Table 2: Mean, range, phenotypic and genotypic coefficients of variation, heritability (Broad Sense), genetic advance and genetic advance expressed as percentage of mean for 13 characters in 49 genotypes of onion

Character	Mean	Range	Phenotypic coefficient of variation (%)	Genotypic coefficient of variation (%)	Heritability (Broad Sense) (%)	Genetic advance	Genetic advance expressed as percentage of mean
Plant height (cm)	45.93	39.96 – 52.26	08.44	05.81	47.44	03.78	08.24
Number of leaves per plant	09.95	07.73 – 13.00	14.33	11.32	62.43	01.83	18.43
Days to maturity	109.26	98.00 – 120.66	05.90	05.47	85.91	11.42	10.45
Bolting (%)	00.58	00.00 – 01.43	105.32	104.40	98.28	01.25	213.22
Fresh weight of leaves (g)	13.99	05.96 – 26.85	30.80	29.04	88.90	07.89	56.41
Dry weight of leaves (g)	04.15	02.49 – 07.72	34.09	32.76	92.33	02.69	64.84
Neck thickness of bulb (cm)	01.03	00.68 – 01.36	18.81	15.68	69.51	00.27	26.94
Equatorial diameter of bulb (cm)	05.18	04.03 – 06.24	11.83	06.59	31.03	00.39	07.56
Polar diameter of bulb (cm)	04.57	03.81 – 05.39	10.42	06.48	38.61	00.37	08.29
Weight of bulb (g)	70.03	43.76 – 92.12	17.29	14.21	67.48	16.84	24.04
Double onion bulb per plot (%)	01.56	00.00 - 03.00	42.27	41.31	95.54	01.30	83.19
Bulb yield per plot (kg)	04.17	02.61 – 05.80	18.88	13.67	52.41	00.85	20.39
TSS of bulb (%)	12.78	10.64 – 15.90	10.80	10.40	92.78	02.64	20.64

The mean, range, coefficient of variability, heritability and genetic advance are presented in Table 2. On the basis of mean and range maximum range of variation was observed for number of leaves per plant, fresh weight of leaves, dry weight of leaves, weight of bulb, bulb yield per plot and TSS of bulb. A wide phenotypic range for the traits further suggested the existence of variation in the material studied. Therefore, there is an ample scope of improving these traits. A wide range of variability for various traits has been observed earlier by Raghuwanshi (2016) [8] and Santra *et al.* (2017) [9]. In the present study, there has been high genotypic and phenotypic coefficient of variation for bolting, fresh weight of leaves, dry weight of leaves, neck thickness of bulb, weight of bulb, double onion bulb per plot and bulb yield per plot. The estimates of both levels of variation for number of leaves per plant, equatorial diameter of bulb, polar diameter of bulb and TSS of bulb had values of moderate magnitude. Phenotypic and genotypic coefficient of variation for plant height and days to maturity were low. Similar result was found by Sutaria (1992) [6] for most of the characters, Ghetia (1990) [5] reported same result for double onion bulb, fresh weight of leaves and bulb weight.

The estimate of heritability is more advantageous when expressed in terms of genetic advance. Johnson *et al.* (1955)

[4] suggested that without genetic advance the estimate of heritability will not be practical value and emphasized the concurrent use of genetic advance along with heritability. Hanson (1963) stated that heritability and genetic advance are two complementary concepts. Based on this consideration, high heritability estimates were observed for bolting followed by double onion bulb per plot, TSS of bulb, dry weight of leaves, fresh weight of leaves, days to maturity, neck thickness of bulb, weight of bulb, number of leaves per plant, bulb yield per plot. While, moderate heritability was recorded in plant height, polar diameter of bulb and equatorial diameter of bulb (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. Chattoo *et al.* (2015) [10] observed high heritability for double onion bulb, bolting, bulb yield and weight of bulb.

Johnson *el al*. (1955) [4] suggested that the heritability and genetic advance when considered together would be more reliable and useful in predicting the resultant effects of selection. Rapid progress in selection can be achieved when high heritability is accompanied with high genetic advance, which forms the most reliable index of selection (Burton, 1952) [11]. In the present study, the high values for genetic advance was observed for bolting, fresh weight of leaves, dry weight of leaves, neck thickness of bulb, weight of bulb, double onion bulb per plot, bulb yield per plot and TSS of bulb. While, number of leaves per plant and days to maturity observed moderate genetic advance. The remaining traits *viz*., plant height, equatorial diameter of bulb, polar diameter of bulb recorded low genetic advance (Table 2). The higher values of genetic advance was also reported by Ram *et al*. (2011) [7] for bulb yield and weight of bulb.

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