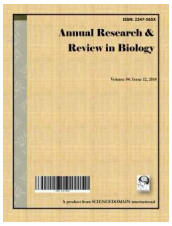

Annual Research & Review in Biology

15(5): 1-10, 2017; Article no.ARRB.35384
ISSN: 2347-565X, NLM ID: 101632869

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

Meenakshee Dwivedi[1*], Nimish Jain[1] and P. Mishra[2]

[1]Department of Horticulture, College of Agriculture, JNKVV Jabalpur -482004, MP, India.
[2]Department of Agricultural Statistics, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal- 741252, India.

Authors' contributions

This work was carried out in collaboration between all authors. Author MD designed the study, managed the literature searches, wrote the protocol and wrote the first draft of the manuscript. Author NJ managed the analyses of the study. Author PM performed the statistical analysis. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ARRB/2017/35384
Editor(s):
(1) George Perry, Dean and Professor of Biology, University of Texas at San Antonio, USA.
Reviewers:
(1) Md. Ashraful Haque, Bangladesh Agricultural University, Bangladesh.
(2) Bettina Porta, University of the Republic (Uruguay), Uruguay.
(3) Nurettin Tahsin, Agricultural University-Plovdiv, Bulgaria.
Complete Peer review History: http://www.sciencedomain.org/review-history/20528

Original Research Article

Received 11th July 2017
Accepted 10th August 2017
Published 17th August 2017

ABSTRACT

The experimental material for the present investigation was comprised of 38 genotypes of onion. These genotypes were sown in Randomized Complete Block Design with three replications, to estimate the genetic variability, heritability and genetic advance. Observations were recorded on the basis of ten random competitive plants selected from each genotype separately for morphological, yield and quality parameters were evaluated as per standard procedure. Analysis of variance revealed highly significant variance for all the traits depicting greater variability in the existing material. The mean performance of the genotypes revealed a wide range of variability for all the traits. The variation was highest for bulb yield per hectare followed by bulb yield per plant, plant height at 90 DAT, plant height at 60 DAT, plant height at 120 DAT, plant height at 30 DAT, days to maturity and bulb yield per plot. The PCV was higher than the GCV for all the characters. High PCV and GCV was observed for bulb yield per plant, neck thickness and pseudostem diameter,

**Corresponding author: E-mail: btmrampurnaikin@gmail.com;*

indicating greater diversity for these traits and their further improvement through selection. High heritability supplemented with high genetic advance as percentage of mean was manifested by bulb yield per plant followed by neck thickness, pseudostem diameter, polar diameter of bulb, number of leaves per plant at 120 DAT, pseudestem length, plant height at 120 DAT and equatorial diameter of bulb suggested that they can be improved through direct selection. Considerable variability was observed among the genotypes for foliage colour, foliage cranking, bulb shape and bulb colour. Foliage colour in green onion and shape and colour of onion bulb are most important characteristics to help customers in choosing cultivars on the market.

Keywords: Bulb onion; variance; PCV; GCV; heritability; genetic advance.

1. INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important bulbous vegetable crop grown all over the world [1]. Onion is the oriented crop earning valuable foreign exchange for the country. Onion (*Allium cepa* L.) belonging to family *Amaryllidaceae* (Alliaceae) and locally known as Pyaj. It is an old world crop and it was domesticated in Iran and Pakistan i.e. Central Asia 5000 year ago [1]. It is consumed as a vegetable and condiment. The green leaves, immature and mature bulbs are eaten raw or used in vegetable preparations. The area of onion in Madhya Pradesh is 57.30 thousand hectare, total production is 952.30 thousand million tonnes and productivity is about 16.60 tonnes per hectare (NHB 2009-10) [2].

The genetic variability and its components are the genetic fractions of observed variability that provides measures of transmissibility of the variation and response to selection [3]. The knowledge of pattern of inheritance of various traits are important consideration while, determining the most approximate breeding procedures applicable to any particular crop [3]. The breeder's choice of the material for any improvement work consequently depends on the amount of genetic variability present. The phenotype is often not the true indicator of its genotype, due to the masking effect of environment over genotype [3].

The objective in this study was to determine the magnitude of heritable and non-heritable components and genetic parameters such as genotypic and phenotypic coefficient of variation, heritability and genetic advance as percentage of mean in quantitative characters of onion.

2. MATERIALS AND METHODS

The experiment was conducted at Vegetable Research Farm, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). The soil of the experimental field was medium black with good drainage and uniform texture with medium NPK status. Thirty eight genotypes of onion were included in trial. All the thirty eight genotypes of onion (*Allium cepa* L.) collected from Directorate, onion and garlic research and one local check ALR was selected for investigation.

2.1 STATISTICAL METHODOLOGY

The data obtained in respect of all the characters has been subjected to the following statistical analysis.

Mean: It was calculated by using following formula.

$$\text{Mean} = \frac{\sum x}{n}$$

Where,

Σx = The sum of all the observation
n = Number of observation

$$C.V. = \frac{\sqrt{EMS}}{GM} x100$$

$$SE\ m \pm = \sqrt{\frac{EMS}{r}}$$

$$SE\ diff = \sqrt{\frac{2\ EMS}{r}}$$

CD at 5% prob. Level = SE diff x $t_{5\%}$ table value

Where,

C.V. = Coefficient of variation
SEm ± = Standard error of means

S E diff = Standard error of difference
GM = Grand mean
C.D. = Critical difference
t 5% = t, table value 5% probability level at error d.f.

Estimation of mean, components of variance, phenotypic, genotypic and environmental coefficient of variation, heritability, genetic advance and genetic advance as percentage of mean:

The mean of different characters were calculated by conventional method:

$$\text{Mean} = \frac{\Sigma xi}{n}$$

Where,

Σx_l = The sum of all the observation for i^{th} character.
N = Number of observations.

Range was recorded by observing the lowest and the highest mean values for each character.

The component of variance was calculated as follows:

S. No.	Source	M.S.S.	Expected M.S.S.
1.	Replication	-	-
2.	Treatment	M_i	$\sigma^2 e_i + r.\sigma^2 g_i$
3.	Error	E_i	$\sigma^2 e_i$

$$\sigma^2 g_i = \frac{M_l - E_i}{r}$$

$$\sigma^2 e_i = E_i$$

$$\sigma^2 p_i = \sigma^2 g_i + \sigma^2 e_i$$

Where,

$\sigma^2 g_l$ = Genotypic variance for i^{th} character.
$\sigma^2 e_l$ = Environmental variance for i^{th} character.
$\sigma^2 p_l$ = Phenotypic variance for i^{th} character.

Phenotypic and genotypic coefficient of variation (expressed in %) were calculated by using the formula given by Burton [4]. Genotypic coefficient of variation (GCV) was calculated as below:

$$GCV\% = \frac{\sqrt{\sigma^2 g_i}}{\bar{X}_i} \times 100$$

Phenotypic coefficient of variation (PCV)

$$PCV\% = \frac{\sqrt{\sigma^2 p_i}}{\bar{X}_i} \times 100$$

Where,

X_i = General mean of the i^{th} character under consideration
$\sigma^2 g_i$ and $\sigma^2 p_i$ = Genotypic and phenotypic standard deviation of the i^{th} character respectively

2.2 Heritability and Genetic Advance

Heritability (broad sense) which is ratio of genotypic variance to the total phenotypic variance is symbolized as h^2 (BS) and expressed in percentage. Estimation of heritability was done as per the formula given by Hanson et al. [5].

$$h^2 (BS) = \frac{\sigma^2 g_i}{\sigma^2 p_i} \times 100$$

Or

$$= \frac{\text{Genotypic variance of the } i^{th} \text{ character}}{\text{Phenotypic variance of the } i^{th} \text{ character}}$$

Expected genetic advance was calculated by using the method suggested by Johnson et al. (1955) at 5% selection intensity [6,7].

Genetic advance (GA) = $K. P_i .h^2_i$

Genetic advance as percentage of mean was calculated as follows:

$$\frac{\text{Genetic advance}}{\bar{X}_i} \times 100$$

Where,

K= Selection intensity its value at 5% selection level is 2.06
P_i = Phenotypic standard deviation of the i^{th} character

h^2_i = Broad sense heritability (fraction) of the i^{th} character

X_i = General mean of the i^{th} character under consideration

3. RESULTS AND DISCUSSION

Plant height varied from 21.33 to 35.20 cm, 25.77 to 41.43 cm, 32.70 to 49.10 cm and 27.67 to 41.83 cm with overall mean performance of 29.00, 35.01, 41.08 and 34.49 cm at 30, 60, 90 and 120 DAT respectively. Genotypes ASRO-1109 was recorded maximum plant height 35.20, 41.43, 49.10 and 41.83 cm and genotype CSRO-1160 was observed minimum plant height of 21.33, 25.77, 32.70 and 27.67 cm at 30, 60, 90 and 120 DAT respectively. Number of leaves per plant ranged from 3.40 to 4.90, 3.83 to 5.83, 4.70 to 7.10 and 4.93 to 8.87 leaves per plant with grand mean performance of 4.04, 4.80, 5.46 and 6.46 leaves at 30, 60, 90 and 120 DAT respectively. Highest number of leaves 4.90, 5.83, 7.10 and 8.87 were recorded in genotype Agrifound Light Red (local check) and minimum was noted in CSRO-1160, 3.40, 3.83, 4.70 and 4.93 at 30, 60, 90 and 120 DAT respectively for the same traits. The maximum 10.60 cm length of pseudostem was recorded in genotypes ASRO-1109, while it was found minimum 5.83 cm in genotype CSRO-1160. The average for pseudostem length was 8.65 cm and it varied from 5.83 to 10.60 cm. Pseudostem diameter lied between 0.49 to 1.12 cm with the average performance of 0.75 cm. Agrifound Light Red was recorded the maximum (1.12 cm) pseudostem diameter, while it was minimum in ASRO-1115 (0.49 cm). Early maturity was recorded in genotype BSRO-1125 (122.00 days) followed by CSRO-1143, CSRO-1173, CSRO-1175 and BSRO-1123 which mature in 123.0 days. However late maturity was observed in CSRO-1181 (133.30 days). The average days for maturity were 126.44 days and it varied from 122.00 to 133.30 days. Neck thickness varied from 0.40 to 1.40 cm with an overall mean performance of 0.71 cm. Genotype BSRO-1121 was recorded minimum neck thickness (0.40 cm) while, it was showed maximum in ASRO-1111 (1.40 cm). It was ranged between 3.08 to 5.20 cm with a mean value of 3.95 cm. The maximum 5.20 cm polar diameter of bulb was observed in CSRO-1179 and minimum (3.08 cm) was recorded in CSRO-1148. Equatorial diameter of bulb ranged from 3.07 to 4.67 cm with average being 3.76 cm. The genotype ASRO-1111 was recorded maximum (4.67 cm) equatorial diameter of bulb, while it was minimum in genotypes ASRO-1101 (3.07 cm). Genotype CSRO-1179 was recorded maximum bulb yield per plant (97.67 g) followed by ASRO-1115 (82.00 g) and CSRO-1177 (79.33 g) while it was noted minimum in genotype BSRO-1125 (23.67 g). The average yield per plant was 49.01 g and it ranged from 23.67 to 96.67 g. Bulb yield per plot varied from 13.660 kg to 23.207 kg. with an overall mean performance of 17.84 kg. Highest 23.207, 23.100 and 22.967 kg bulb yield per plot were recorded in CSRO-1179, ASRO – 1115 and CSRO-1177 respectively and which were at par with each other [1]. Therefore, lowest 13.660 kg bulb yield was recorded in BSRO-1125. Highest 387.06, 384.84 and 383.18 q/ha bulb yield were exhibited in genotypes CSRO-1179, ASRO - 1115 and CSRO-1177 receptively and which were at par with each other. However, lowest 227.57 q/ha bulb yield was recorded with BSRO-1125. The mean performance of 297.56 q/ha and it was varied from 227.57 to 387.06 q/ha. Minimum 0.10 kg unmarketable bulb yield per plot was recorded in BSRO-1125, while it was maximum 2.39 kg/plot in genotypes ASRO-1106. The unmarketable bulb yield varied form 0.10 kg to 2.39 kg/plot with an average of 1.40 kg/plot. Lowest unmarketable bulb yield was noted in genotype BSRO-1125 (1.66 q/ha) and highest was recorded in genotype ASRO-1106 (39.70 q/ha). The unmarketable bulb yield (q/ha.) varied from 1.66 q/ha to 39.70 q/ha and average unmarketable yield in quintal per hectare was fond to be 23.40 q/ha. Minimum (0.0%) splitting percentage was recorded in genotypes viz., CSRO-1139, CSRO-1148, CSRO-1165, CSRO-1170, BSRO-1121, ASRO- 1109 and ASRO-1121. Genotype CSRO-1188 was recorded maximum (2.50%) split bulb. Bolting percentage was recorded 0.0% in genotypes. viz, CSRO-1119, CSRO-114, CSRO-1157, BSRO-1119, BSRO-1123, BSRO-1129, and Agrifound Light Red. Highest bolting percent was recorded in ASRO 1113 (9.33%). Maximum 17.00 percent total soluble solid was obtained in genotype BSRO-1115 followed by ASRO-1106 (16.80%) and it was recorded minimum in genotype CSRO-1148 (12.40%). The total soluble solid varied from 12.40% to 17.00% with an average of 15.00%. Estimation of components of genetic parameters of variation for yield and its attributes exhibited a wide range of variation for the characters studies [8]. Result indicated that the value of phenotypic coefficient of variations were higher in magnitude than that of genotypic coefficient of variation for all the characters showing that the environment had an important role in influencing the expression of the

Table 1. Mean performance of morphological parameters of onion

Genotypes	Plant height (cm) at DAT				Leaves per plant at DAT				Pseudo stem length (cm)	Pseudo stem diameter (cm)	Days to maturity
	30	60	90	120	30	60	90	120			
CSRO 1115	27.23	36.3	37.63	37.6	3.67	4.57	5.43	6	9.27	0.91	128
CSRO 1119	27.8	33.9	42.13	36.2	3.93	4.67	4.9	6.1	9.37	0.74	126
CSRO 1139	28.7	35.03	42.9	28.47	3.97	5.17	5.23	5.37	10.33	0.56	124
CSRO 1141	28.7	36.57	43.6	34.53	3.47	4.87	5.07	5.93	10.23	0.83	126
CSRO 1143	29.13	32.86	37.4	34.27	4.17	4.97	5.33	5.63	7.83	0.66	123
CSRO 1148	24.7	31.53	39.73	31.4	3.7	4.43	5.03	5.9	8.57	0.59	125
CSRO 1155	28.36	32.53	42.97	38.5	3.5	4.43	5.4	7.97	7.97	0.99	127
CSRO 1157	27.76	32.47	38.5	35.43	3.57	4.27	5.3	7.2	7.7	1.05	130
CSRO 1160	21.33	25.77	32.7	27.67	3.4	3.83	4.7	4.93	5.83	0.55	132
CSRO 1163	27.8	34.07	42	30.2	4.27	4.43	5.53	5.53	9.17	0.69	127
CSRO 1165	26.06	32.27	38.4	32.27	3.57	4.83	5.6	6.17	8.53	0.55	128
CSRO 1168	26.43	31.57	38.93	32.23	4.27	4.63	5.33	6.27	7.27	0.63	126
CSRO 1170	26.2	30.77	34.43	33.67	3.73	4.43	5.03	6.23	7.63	0.54	125
CSRO 1173	28.46	30.63	38.83	36.13	3.67	4.3	5.57	6.03	7.4	0.78	123
CSRO 1175	24.8	36.53	42.83	40.23	4.17	5.03	5.63	6.17	7.77	0.95	123
CSRO 1177	29.13	36.1	41.37	35.17	4.23	5.53	5.8	5.8	9.63	0.93	125
CSRO 1179	31.63	37.27	45.03	35.67	4.6	4.93	5.57	6	9.63	0.88	132
CSRO 1181	32.26	38.13	38.93	34.4	3.8	4.73	5.33	6.17	9.27	0.77	133.3
CSRO 1186	29	35.3	44.17	32.8	3.93	5.2	4.87	5.53	10.23	0.72	127
CSRO 1188	30.4	35	44.73	36.97	3.83	5.07	5	7.67	9.23	0.94	129
CSRO 1190	30.16	38.7	46.63	41	3.57	5.37	5.83	7.73	8.97	0.95	131
BSRO 1115	31.2	34.93	38.67	32.67	3.83	4.83	5.9	5.93	7.43	0.64	128
BSRO 1119	30.83	33	39.17	27.77	3.83	5.03	5.63	6.1	7.77	0.67	125
BSRO 1121	32.76	33.73	41.53	29.77	4.53	4.7	5.53	6.23	7.47	0.52	124
BSRO 1123	32.83	36.57	41.03	34.6	4.27	5.67	5.67	6.7	8.33	0.76	123
BSRO 1125	24.7	33.73	34.83	28.63	4.17	4.67	5.6	6.13	7.03	0.62	122

Genotypes	Plant height (cm) at DAT				Leaves per plant at DAT				Pseudo stem length (cm)	Pseudo stem diameter (cm)	Days to maturity
	30	60	90	120	30	60	90	120			
BSRO 1127	28.53	37.73	38.8	32.53	4.03	5.33	6.37	5.8	8.1	0.57	125
BSRO 1129	25.36	31.87	35.53	29.47	3.73	4.4	5.2	6.17	7.03	0.72	125
ASRO 1101	31.96	36.27	43.2	35.4	4.33	4	5.4	8.6	8.4	0.88	124
ASRO 1104	32.43	35.3	42.43	40.2	4	4.43	5.57	8.1	9.67	0.86	125.3
ASRO 1106	35.03	40.3	45.83	39.9	4.27	5.13	5.6	6.6	8	1.01	126.3
ASRO 1109	35.2	41.43	49.1	41.83	4.3	4.83	4.9	6.33	10.6	0.57	125
ASRO 1111	30.2	37.6	47.13	40.2	4.27	4.73	5.83	7.57	10.57	1.03	126
ASRO 1113	29.1	34.47	44.03	30.4	4.67	4.53	5.57	6.57	10.23	0.66	128
ASRO 1115	27.86	39.87	45.53	35.43	4.73	4.97	6	7.03	10.13	0.49	124
ASRO 1119	29.46	34.9	39.4	35.63	4.6	4.9	5.17	6.57	10	0.86	129
ASRO 1121	31.83	38.83	38	30.6	4.27	4.63	5.1	6.03	7.63	0.65	130
ALR(L.C)	26.7	36.87	42.97	40.87	4.9	5.83	7.1	8.87	8.5	1.12	125
S.Em±	1.16	0.64	0.64	0.15	0.14	0.13	0.07	0.08	0.13	0.1	0.44
C.D.5% level	3.31	1.84	1.83	0.45	0.4	0.37	0.22	0.24	0.37	0.03	1.26

Table 2. Mean performance of sink parameters of onion

Genotypes	Neck thickness (cm)	Polar diameter of bulb(cm)	Equatorial diameter of bulb (cm)	Bulb yield /plant (g)	Bulb yield /plot (kg)	Bulb yield/ha. (q)
CSRO 1115	1.09	5.13	3.73	49.33	19.783	329.53
CSRO 1119	0.71	4.05	3.7	75.67	21.017	355.78
CSRO 1139	0.76	4.06	4.03	61	18.883	314.59
CSRO 1141	1.01	4.3	4.23	60.67	19.183	319.26
CSRO 1143	0.45	3.67	3.4	36.33	17.7	294.88
CSRO 1148	0.56	3.08	3.17	24.33	16.8	279.88
CSRO 1155	1.04	4.03	3.83	29.67	15.125	252.67
CSRO 1157	0.57	3.43	4.01	49.67	17.25	287.38
CSRO 1160	0.43	3.23	3.73	24.33	15.573	231.68
CSRO 1163	0.66	4.02	4.3	66	16.5	274.89
CSRO 1165	0.53	3.43	3.73	25	17.45	290.71
CSRO 1168	0.59	3.6	3.8	30.33	14.45	240.73
CSRO 1170	0.51	3.4	3.53	26.67	14.25	282.73
CSRO 1173	1.16	3.3	3.33	30	14.1	234.9
CSRO 1175	0.96	4.2	4.4	61.33	22.877	381.12
CSRO 1177	0.55	4.08	3.27	79.33	22.967	383.18
CSRO 1179	0.78	5.2	3.87	97.67	23.207	387.06
CSRO 1181	0.6	4.5	3.67	49.67	18.3	304.87
CSRO 1186	0.47	4.37	3.97	62	20.1	335.42
CSRO 1188	0.93	4.63	4.02	75	22.417	373.45
CSRO 1190	0.72	4.6	4.23	60	21.533	358.74
BSRO 1115	0.64	4.03	3.7	28.67	18.017	300.15
BSRO 1119	0.6	3.13	3.47	30	14.542	242.26
BSRO 1121	0.4	3.23	3.5	27	21.9	364.85
BSRO 1123	0.5	3.67	3.73	29.67	15.917	274.17
BSRO 1125	0.44	3.7	3.2	23.67	13.66	227.57
BSRO 1127	0.56	4.57	3.3	29.33	15.337	259.39
BSRO 1129	0.9	3.2	3.43	31	14.7	244.9
ASRO 1101	1.01	3.37	3.07	50.67	15.76	262.56
ASRO 1104	0.82	4.01	3.27	51	16.253	270.78
ASRO 1106	1.03	4.33	4.01	79.33	20.417	340.14
ASRO 1109	0.63	3.6	4.3	51.33	15.6	259.89
ASRO 1111	1.4	3.87	4.67	75	17.25	284.05
ASRO 1113	0.71	3.4	4	48.67	18.5	280.44
ASRO 1115	0.65	4.57	4.37	82	23.1	384.84
ASRO 1119	0.43	4.33	3.67	59	18.083	301.26
ASRO 1121	0.41	3.73	3.3	40.33	14.697	246.51
ALR(L.C)	0.82	5.13	4.07	52	15.017	250.17
S.Em±	0.007	0.07	0.074	1.36	0.36	10.23
C.D.5% level	0.03	0.21	0.21	3.9	1.04	28.93

characters. The phenotypic and genotypic coefficient of variation varied from 2.26% to 41.39% and 2.18% to 41.10% respectively. The highest PCV and GCV were recorded for bulb yield per plant (41.39%), neck thickness (34.30%) and pseudostem diameter (23.11%). However, it was exhibited in low for character viz., days to maturity (2.26 %), number of leaves per plant at 90 DAT (8.38%), plant height at 60 DAT (9.24%), plant height at 90 DAT (9.36%) and number of leaves per plant at 60 DAT (9.70%). Rest of the characters i.e. polar diameter of bulb (14.92%), number of leaves per plant 120 DAT (14.03%), psedostem length (14.03%), plant height at 30 DAT (11.76%) and at 120 DAT (11.67%) exhibited lowest phenotypic coefficient of variation. Equatorial diameter of bulb (10.91%), number of leaves per plant at 30 DAT (10.79%) and TSS (10.27%) were found to be moderate phenotypic coefficient of variation.

Table 3. Mean performance of various parameters of onion

Genotypes	Unmark. Bulb yield /plot (kg)	Unmark. Bulb yield /ha.(q)	Split bulb (%)	Bolting (%)	TSS (%)
CSRO 1115	1.38	23.04	0.33	0.08	14.3
CSRO 1119	1.89	31.43	0.33	0	16
CSRO 1139	1.85	30.81	0	0.83	15
CSRO 1141	2.31	38.48	0.25	0	16
CSRO 1143	1.7	28.37	0.75	0.33	15.8
CSRO 1148	1.82	30.37	0	0.5	12.4
CSRO 1155	1.38	23.04	0.67	0.08	15.4
CSRO 1157	1.79	29.81	0.67	0	15
CSRO 1160	1.07	17.76	0.08	1.58	15.8
CSRO 1163	1.12	18.6	0.17	1.33	14.2
CSRO 1165	1.28	21.26	0	2.33	14.2
CSRO 1168	1.05	17.54	0.08	2.25	14
CSRO 1170	1.31	21.87	0	2	14
CSRO 1173	0.61	10.15	0.17	0.08	16.4
CSRO 1175	0.37	6.16	0.25	0.17	16.5
CSRO 1177	0.52	8.66	0.42	1.5	14
CSRO 1179	1.12	18.71	0.92	0.42	14.2
CSRO 1181	1.73	28.87	1.08	0.25	13
CSRO 1186	1.49	24.76	0.17	0.17	14
CSRO 1188	1.25	20.82	2.5	0.17	14.2
CSRO 1190	1.21	20.15	0.08	0.08	15.8
BSRO 1115	1.07	17.76	0.08	0.25	17
BSRO 1119	0.77	12.87	0.17	0	15
BSRO 1121	0.24	3.99	0	0.33	15
BSRO 1123	0.86	14.26	0.75	0	13
BSRO 1125	0.1	1.66	0.25	0.08	15.4
BSRO 1127	0.77	12.88	0.5	0.42	15.4
BSRO 1129	0.69	11.54	0.08	0	16
ASRO 1101	0.84	13.6	0.83	0.25	12.4
ASRO 1104	2.37	39.42	1.25	0.17	16
ASRO 1106	2.39	39.7	0.5	0.42	16.8
ASRO 1109	1.97	32.87	0	0.75	15
ASRO 1111	1.65	27.54	1	0.42	16.2
ASRO 1113	2.22	36.92	0.08	9.33	16.4
ASRO 1115	1.71	28.48	0.33	0.75	14
ASRO 1119	2.28	38.03	0.08	0.08	14.8
ASRO 1121	1.92	31.92	0	1.67	16
ALR(L.C)	0.83	13.82	1.5	0	14.3
S.Em±	0.09	1.57	0.13	0.38	0.76
C.D.5% level	0.26	4.48	0.39	1.11	2.19

The heritability (BS) was computed for each of the characters by the variance components for estimating their relative magnitudes of genotypic and phenotypic variability contributed through environmental factors. The estimates of heritability (BS) for all the characters have been discussed as fallows (Table 4). It was partitioned as very high (above 90%), high (70 to 90%), medium (50-70%) and low (less than 50%). Results revealed that the heritability estimate were very high form neck thickness (99.74%) followed by plant height at 120 DAT (99.52%), pseudostem diameter (98.87%), bulb yield per plant (98.60%), number of leaves per plant at 120 DAT (97.33%), pseudostem length (96.39%), polar diameter of bulb (95.17%), days to maturity (92.65%), plant height at 90 DAT (91.40%) and number of leaves per plant at 90 DAT (91.21%). However, high heritability was recorded in the character viz., equatorial diameter of bulbs (89.82%), plant height at 60 DAT (87.79%) and number of leaves per plant at 60 DAT (75.42%). However, it was recorded to be moderate for number of leaves per plant at 30

Table 4. Genetic parameters in twenty two characters in onion

Characters	Grand mean	Range		Coefficient of variations		Heritability % (BS)	Genetic advance	GA as % of mean
		Min.	Max.	Phe.	Gen.			
Plant height 30 DAT	29	21.33	35.2	11.76	9.42	64.29	4.51	15.57
Plant height 60 DAT	35.01	25.77	41.43	9.24	8.66	87.79	5.85	16.71
Plant height 90 DAT	41.08	32.7	49.1	9.36	8.95	91.4	7.24	17.63
Plant height 120 DAT	34.49	27.67	41.83	11.67	11.64	99.52	8.25	23.93
Leaves / plant 30 DAT	4.04	3.4	4.9	10.79	8.87	67.52	0.6	15.01
Leaves / plant 60DAT	4.8	3.83	5.83	9.7	8.42	75.42	0.72	15.07
Leaves / plant 90 DAT	5.46	4.7	7.1	8.38	8	91.21	0.86	15.75
Leaves / plant 120 DAT	6.46	4.93	8.87	14.03	13.84	97.33	1.81	28.14
Pseudostem length (cm)	8.65	5.83	10.6	14.03	13.77	96.39	2.41	27.86
Pseudostem diameter (cm)	0.75	0.49	1.12	23.11	22.98	98.87	0.35	47.08
Days to maturity	126.44	122	133.33	2.26	2.18	92.65	5.46	4.32
Neck thickness (cm)	0.71	0.4	1.4	34.3	34.25	99.74	0.5	70.48
Polar diameter of bulb(cm)	3.95	3.08	5.2	14.92	14.56	95.17	1.15	29.26
Equatorial diameter of bulb (cm)	3.76	3.07	4.67	10.91	10.34	89.82	0.76	20.19
Bulb yield /plant (g)	49.01	23.67	97.67	41.39	41.1	98.6	41.21	84.07
TSS (%)	15	12.4	17	10.27	4.98	23.53	0.74	4.98

DAT (67.52%) and plant height at 30 DAT (64.29%). Low estimate of heritability was recorded in total soluble solid (23.53%) [9-11].

Based on the estimate of heritability (BS), expected genetic advance was computed on the hypothetical selection at 5 per cent best individual (K=2.06). Due to masking influence of environment upon characters concerned, values of genetic advance exhibited high fluctuations. Therefore, to attain relative comparison of the characters in relation to environment genetic advance as percentage of mean was calculated to predict the genetic gain (Table 4). The highest estimate of genetic advance as percentage of mean was recorded for bulb yield per plant (84.07%) followed by neck thickness (70.48%), pseudostem diameter (47.08%), polar diameter of bulb (29.26%), number of leaves per plant at 120 DAT (28.14%), pseudestem length (27.86%), plant height at 120 DAT (23.93%) and equatorial diameter of bulb (20.19%). Plant height at 90 DAT (17.63%), plant height at 60 DAT (16.71%), number of leaves per plant (15.75%), plant height at 30 DAT (15.57%) number of leave per plant at 60 DAT (15.07%) and at 30 DAT (15.01%) exhibited moderate value, while total soluble solid (4.98%) and days to maturity (4.32%) had the lowest estimate [12,13,14].

4. CONCLUSION

Analysis of variance revealed highly significant variance for all the traits depicting greater variability in the existing material. The PCV was higher than the GCV for all the characters. High PCV and GCV were observed for bulb yield per plant, neck thickness and pseudostem diameter, indicating greater diversity for these traits and

their further improvement through selection. High heritability supplemented with high genetic advance as percentage of mean was manifested by bulb yield per plant followed by neck thickness, pseudostem diameter, polar diameter of bulb, number of leaves per plant at 120 DAT, pseudestem length, plant height at 120 DAT and equatorial diameter of bulb suggested that they can be improved through direct selection.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Fritsch RM, Friesen N. Evolution, domestication and taxonomy. Allium crop science: Recent advances; 2002.
2. Indian Horticulture Database 2009-10 - National Horticulture Board [NHB].
3. Hosamani RM, Patil BC, Ajjappalavara PS. Genetic variability and character association studies in onion (*Allium cepa* L.). Karnataka Journal of Agricultural Sciences. 2010;23 (2):302-305.
4. Burton GW. Quantitative inheritance in grasses. Proceedings of 6th International Grassland Congress. 1952;1:277-283.
5. Hanson CH, Robinson HR, Comstock RS. Biometrical studies of yield segregating populations of Korean lespedesa. Agronomy Journal. 1956;48:268-272.
6. Johnson HW, Robinson HF, Comstock RE. Estimates of genetic and environmental variability in soybeans. Agronomy Journal. 1955a;47(7):314-318.
7. Johnson HW, Robinson HF, Comstock RE. Genotypic and phenotypic corelations in soybeans and their implications in selection. Agronomy Journal. 1955b; 47(10):477-483.
8. Singh RK, Dubey BK, Bhonde SR, Gupta RP. Variability studies for some quantitative characters in white onion (*Allium cepa* L.) advance lines. Veg. Sci. 2010;37(1):105-107.
9. Haydar A, Sharker N, Ahmed MB, Hannan MM, Razvy MA, Hussain M, Hoque A, Karim R. Genetic variability and interrelationship in onion (*Allium cepa* L.). Middle East J. Sci. Res. 2007;2(3&4):132-134.
10. Morsy MG, Marey RA, Geries LSM. Genetic variability, heritability, genetic advance and phenotypic correlation in some onion varieties. J. Agric. Res. Kafer El-Sheikh Univ. 2011;37(1):57.
11. Duangjit J, Bohanec B, Chan AP, Town CD, Havey MJ. Transcriptome sequencing to produce SNP-based genetic maps of onion. Theoretical and Applied Genetics International Journal of Plant Breeding Research. 2013;126(8):2093–2101.
12. Pramoda HP, Gangaprasad S. Biometrical basis of handling segregation population for improving productivity in onion (*Allium cepa* L.). J. Asian Hort. 2007;3(4):278-280.
13. Melke A, Ravishankar H. Variability and association among bulb yield and yield-related traits in onion (*Allium cepa* L.). Trop. Agric. (Trinidad). 2006;83(4):112-119.
14. Yaso IAA. Performance and genetic parameters for six onion genotypes in Nubaria area. Egyptian Journal of Plant Breeding. 2007;11(3):307-318.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/20528