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Gaurav Srivastav
Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, U.P. India

Balaji Vikram
Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, U.P. India

VM Prasad
Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, U.P. India

Correspondence
Balaji Vikram
Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, U.P. India

Studies on multiple correlation between bulb yield, growth and yield attributes in different genotypes of onion (*Allium cepa* L.) under Allahabad agro-climactic condition

Gaurav Srivastav, Balaji Vikram and VM Prasad

Abstract
The comprised twenty genotypes evaluated for growth and yield component in the rabi season of onion. The investigation was laid out in RBD with three replications. There were 20 genotypes wide variation was observed among the genotypes for all traits. Results revealed that the genotype cv. Agrifound Dark Red resulted in higher yield, better size of Bulb and stand promising for cultivation under agro-economic condition of Uttar Pradesh. The maximum heritability percent was reported for Length of Leaves and Diameter of Bulb (0.96) followed by Plant Height (0.96). High genetic advance was reported for Dry Weight of Bulb (22.77) followed by Fresh Weight of Bulb (22.65), however the maximum genetic advance as percent of mean was reported for Diameter of Bulb (49.87) and Dry Weight of Bulb (40.50). High heritability coupled with high genetic advance was observed for fresh weight and dry weight. Bulb have positive significant correlation with fresh weight and dry weight both phenotypic and genotypic level. There for these characters should be given priority cheekily during selection for genetic improvement of onion. Maximum yield of onion, gross return, net return and cost: benefit ratio (1:10.76) were obtained in the Agri Found Light Red.

Keywords: Onion, variability, heritability, correlation coefficient.

Introduction

Onion belongs to the family *Alliaceae genus Allium* and *species cepa* L. with basic chromosome number x = 8 (2n = 16). Taxonomically, it belongs to Allium section cepa (Mill.) Prokh. Onion is cultivated year round but maximum during *Rabi* season in our country. The crop is grown for variety of purposes from kitchen to factory made products/food and also for dehydration. It is valued for its distinct pungent flavor and its essential ingredients cuisine. It is consumed round the year by all the sections of people through-out the world due to healing properties of onion in case of cardiac diseases, rheumatism, cancer, digestive disorders, blood sugar and prolong cough. It is a photo-sensitive crop and on the basis varieties are divided into short day and long day types. Long day types are high yielder but have poor shelf life whereas short day types have better shelf life with the low yielding capacity (Sandhu *et al.*, 2015) [14]. So, development of high yielding varieties with good quality traits is needed now days.

The development of new varieties is a long and expensive process which also needs expert scientists especially, plant breeders. However, the evaluation of the existing and available onion varieties for their adaption and productivity in the climatic conditions of India is a faster way to improve the onion production. The purpose of the on-station variety evaluation trials was to identify promising onion varieties and thus provide up-to-date variety recommendations for the onion growers. Before any final variety recommendation is made, it is extremely important to evaluate the varieties on farmer's field for their adaptation and productivity performance.

When breeding for a particular set of growing conditions, it is highly important to know the use of local populations, since in them the relationships among yield components are balanced and in harmony with the effects of the specific climatic factors (Dhotre *et al.*, 2010) [8] and (Asohk *et al.*, 2013) [14]. Therefore, it is essential to partition the overall variability into its heritable and non-heritable components, which will enhance the precision of selection. Thus, the present study was conducted to investigate genetic variability, heritability and correlation coefficients of 8 diverse genotypes of onion collected from different sources.

Material and Methods

The experiment was conducted in the Vegetable Research Farm, Department of Horticulture,

Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad (Uttar Pradesh) during 2013-2014. All the facilities necessary for cultivation, including labor were made available in the department. Name of onion genotypes are Agri Found Light Red, Bhima Red, Arka kalian, Bhima sakti, N-241, Bhima Raj, Rampur, Bhima subhra, LR-241, Pusa madhavi, Bhima sweta, Pusa Red, Arka lalima, Bhima Kiran, Bhima Super, N-53, Arka Niketan, Arka Bindu, Arka pragati and Udaipur 101. The raised nursery beds of size 3m length, 1m breadth and 0.15 m height were prepared after bringing the soil to a fine tilth. The beds were levelled. The seeds of 20 onion genotypes were sown in lines drawn 10 cm apart on the beds on 23 octaber 2013. Before sowing nursery was prepared and levelled by mixing well rotten F.Y.M. and soil was treated with Carbendazim (0.20%) and seed were treated with Bavistin (0.2%). Immediately after sowing water was sprinkled uniformly over the bed. Carbendazim at rate of 0.2 % and copper oxychloride at rate of 0.2 % were sprayed at weekly interval to prevent damping off. Seedlings were protected from rain, whenever needed with the help of plastic sheet. The experimental field was prepared by ploughing with a Tractor drawn disc plough followed by two cross harrowing and planking. The field was thoroughly leveled by a leveler before it was laid out. Manure and fertilizer were applied according to recommended doses foronion i.e. 25-30 t/ha. FYM or compost along with fertilizer N: P: K @ 80-125: 50-75:80-125 kg per ha^{-1}. FYM was well incorporated in plots at least 20 days before transplanting. Apply 50% nitrogen and entire dose of P_2O_5 and K_2O before transplanting or set sowing and remaining half nitrogen is top dressed 5-6 week after transplanting. Seven week old seedlings were transplanted in the experimental plots after allotting entries randomly in each replication. Before transplanting, healthy and uniform seedlings were selected and the selected seedlings were dip the roots in the solution of Bavistin @ 2g/liter to save the crop from pink rot diseases. On the day of transplanting, the field was irrigated and seedlings were transplanted. Gap filling was done seven days after transplanting. Hand weeding was done five times at 20, 40, 65, 90 and DAT. The correlation coefficient was calculated as per the method suggested by Singh and Choudhary (1977) [17]. Path coefficient analysis was done according to Dewey and Lu (1959) [7].

Results and Discussion

The mean of the different traits for 20 genotypes of Onion (*Allium cepa L.*) have been presented in table 1. Analysis of variance revealed that the difference among the genotypes were highly significant for all the characters studied. High ranges of genotypic and phenotypic coefficients of variation (PCV & GCV) were noticed for leaf height (cm.) was obtained Pusa Madhavi (63.76) to Arka Kalyan (52.02) at 90 DAT with mean 45.72. At 90 DAT the maximum leaf height in Pusa Madhavi (63.76) followed by Bhima Shakti (60.27) and the minimum leaf height was recorded an Arka Kalyan (52.02) and followed by Arka Niketan (53.31) and Bhima Super (56.48). (Haydar *et al.,* 2007) [9], bulb dry weight per plant ranged from Pusa Madhavi (171.00) to Arka kalyan (96.66) at 90 DAT with mean 117.71. Maximum bulb weight per plant (gm) was obtained in Pusa Madhavi (171.00) followed by Bhima shakti (126.00) and minimum bulb weight per plant was observed in Arka Kalyan (96.66) so the genotype Pusa Madhavi was highest per plant while the genotype Arka Kalyan was lowest in bulb weight per plant and bulb weight per plant ranged from Pusa Madhavi to Arka Niketan at 90 DAT with mean 141.11. Maximum bulb weight per plant (gm) was obtained in Pusa Madhavi (192.40) followed by Bhima Shakti (154.66) and minimum bulb weight per plant was observed in Arka Niketan (127.20) so the genotype Pusa Madhavi was height per plot while the genotype Arka Niketan was lowest in bulb weight per plant Hosamani *et al.,* 2010 [10] and Chattoo *et al.,* 2015 [5]. Selection for these characters would be much effective. Singh *et al.* (2010) [18] also reported similar results. The estimates of PCV were higher than GCV, indicating that characters studied were influenced by environment. However the differences between phenotypic and genotypic coefficients of variation were low. Hence the characters studied were influenced by environment to lesser extent. Highest genetic advance was predicted for bulb yield per plot ranged from PusaM adhavi (5.77) to Arka Kalyan (3.48) at 90 DAT with mean 4.20. Maximum bulb weight per plot (kg) was obtained in Pusa Madhavi (5.77) followed by Bhima Shakti (4.64) and minimum bulb weight per plot was observed in Arka Kalyan (3.48) So the genotype Pusa Madhavi was highest per plot while the genotype Arka Kalyan was lowest in bulb weight per plot and The bulb yield per hectare ranged from Pusa Madhavi (38.48) to Arka Kalyan (23.22) at 90 DAT with mean 28.03. The maximum yield per hectare was observed in genotype Pusa Madhavi (38.48) tones followed by Bhimashakti (30.93) and Bhima Kiran (30.16) and the minimum yield per hectare was observed in genotypes ArkaKalyan (23.22) followed by Bhimasweta (23.94) and Arka Niketan (24.05). Ram *et al.* (2011) [13] and Mohanty (2002) [12] are also reported high genetic advance for plant height and bulb weight. Bulb weight was positively and significantly correlated with bulb diameter, dry weight, plant height, at both genotypic and phenotypic level. Therefore, bulb yield can be improved by selecting genotypes having high value of equatorial diameter, clove length, bulb polar diameter and plant height. Ananthan and Balakrishnamoorthy (2007) [2] and Ullah *et al.* (2005) [20] also reported similar studies in onion. With a view to understand the extent to which the observes variation are due to genetic factors, the phenotype variance (PV) and genotype variance (GV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), broad sense variability (h^2) genetic advance (GA) and genetic advance over mean (GAM) were worked out and presented in table 2. The data revealed the existence of large amount of variability for the most of the characters studied. Path coefficient studies indicated that plant height At 90 DAT maximum plant height was in Pusa Madhavi (68.50) followed by Bhima Krian (64.66) and the minimum plant height was recorded in Arka Kalyan (58.88) followed by Arka Niketan (59.54) and Bhima Super (61.02) Dhotre *et al.,* 2010 [8] and Singh *et al.* (2013) [19]. The plant height (cm.) was obtained Pusa Madhavi (68.50) to Arka Kalyan (58.88) at 90 DAT with mean 50.62, number of leaves per plant, number of leaves (cm.) was obtained Pusa Madhavi (68.50) to Arka Kalyan (58.88) at 90 DAT with mean 20.72. At 90 DAT the maximum number of leaves was Pusa Madhavi (12.00) followed by Bhima Sweta (11.73) and minimum number leaves was noticed in genotype Arka Niketan (9.40) and followed by Bhima Super (9.66) and Bhima Kiran (10.13), bulb diameter ranged from Pusa Madhavi (8.00) to Arka Kalyan (4.80) at 90 DAT with mean 6.14. Maximum bulb diameter (cm) was obtained in Pusa Madhavi (8.00) followed by Bhima Super (7.20) and minimum bulb diameter was observed in Arka Kalyan (4.80)

So the genotype Pusa Madhavi was highest bulb diameter while the genotype Arka Kalyan was lowest in bulb diameter. These findings are in close association with Dewangan, and Sahu (2014) [6] in onion. High heritability along with high genetic advance was observed for plant height, bulb weight and number of cloves per bulb which govern that these characters are controlled by additive gene effects. The bulb weight was positively and significantly correlated with bulb diameter, bulb diameter, plant height at both genotypic and phenotypic level. Path coefficient studies indicated that bulb diameter, and number of leave per plant had greater direct influence on bulb weight, and hence selection of genotype on basis of these characters may be effective for improvement of yield Mahanthesh *et al*. (2008) [11].

Table 1: Range and Mean Performance of onion genotypes for growth parameters in year 2013-2014.

Genotypes	Plant height (cm)	Length of leaves (cm)	Number of leaves per plant	Diameter of Bulb (cm)	Fresh Weight of Bulb(g)	Dry Weight of Bulb (g)	Vit. C (Mg / 100g)	Bulb Yield/ Plot (kg)	Yield t/ha
Arka Niketan	30.73	26.51	4.00	6.10	78.38	60.30	10.90	6.06	28.30
Arka kalyan	33.31	30.15	4.05	6.20	79.25	61.05	11.00	6.11	28.47
Bhima Super	32.06	28.05	3.62	5.45	70.70	52.50	10.83	5.25	24.50
Bhima subhra	32.78	28.80	3.38	4.60	63.65	45.45	11.17	4.55	21.20
Bhima sakti	34.88	30.42	4.30	6.80	81.20	63.33	11.20	6.33	29.40
Bhima Kiran	30.37	26.18	3.85	5.95	76.85	58.65	10.93	5.87	27.40
Bhima sweta	32.09	27.73	3.77	5.80	74.30	56.10	11.80	5.61	26.20
N-241	32.95	29.82	4.15	6.50	81.05	63.18	10.90	6.29	29.30
N-53	31.22	26.72	3.70	5.70	70.70	52.50	11.03	5.25	24.73
Agri Found Light Red	37.08	32.95	4.90	7.80	90.05	71.85	13.10	7.20	33.50
Pusa Red	31.66	27.02	3.55	5.30	68.30	50.10	10.37	5.01	23.40
Bhima Red	35.23	32.55	4.46	7.40	85.70	67.50	9.97	6.75	31.53
Bhima Raj	33.00	29.58	3.35	4.40	63.65	45.45	11.07	4.55	21.18
Arka lalima	31.80	27.12	3.40	4.80	63.80	45.60	10.90	4.56	21.30
Arka Bindu	29.72	25.75	3.30	3.60	59.30	41.10	12.37	4.11	19.21
Pusa madhavi	32.40	28.16	3.92	6.05	78.60	60.45	11.20	6.04	28.20
Arka pragati	29.42	25.13	3.33	4.05	54.95	36.75	9.60	3.68	17.39
Udaipur 101	29.47	25.50	3.45	4.25	65.75	47.55	10.47	4.76	22.20
LR-241	32.67	28.47	3.48	5.15	68.00	49.80	11.17	4.98	23.25
Rampur	32.89	29.16	3.40	5.05	65.75	47.55	10.77	4.76	22.18
Mean	32.29	28.29	3.77	5.55	72.00	53.84	11.04	5.39	25.14
C.V.	1.72	0.75	1.65	3.72	2.33	3.34	5.54	11.47	6.13
F ratio	36.75	321.02	147.93	86.09	90.40	79.49	4.58	6.74	23.18
F Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S.E.	0.32	0.12	0.04	0.12	0.97	1.04	0.35	0.36	0.89
C.D. 5%	0.92	0.35	0.10	0.34	2.78	2.97	1.01	1.02	2.55
C.D. 1%	1.23	0.47	0.14	0.46	3.72	3.98	1.35	1.37	3.41
Range Lowest	29.42	25.13	3.30	3.60	54.95	36.75	9.60	3.68	17.39
Range Highest	37.08	32.95	4.90	7.80	90.05	71.85	13.10	7.20	33.50

Table 2: Variance, coefficient of variations, heritability, genetic advance and genetic advance as percent of mean for 10 traits in Onion Genotypes.

Character	GV	PV	GA		GCV	PCV	h^2 (bs) (%)	GA as percent on mean	
			2013-2014					2013-2014	
	2013-2014	2013-2014	5%	1%	2013-2014	2013-2014	2013-2014	5%	1%
Plant Height (cm) 90 DAT	19.02	19.41	8.89	11.39	7.37	7.45	0.98	15.04	19.27
Length of Leaves (cm) 90 DAT	26.24	26.35	10.53	13.49	9.97	10.00	0.99	20.51	26.28
Leaves/ Plant 90 DAT	1.18	1.20	2.23	2.85	10.10	10.17	0.98	20.68	26.50
Diameter of Bulb (cm)	1.20	1.24	2.22	2.84	19.79	20.14	0.96	40.07	51.36
Fresh Weight of Bulb(g)	84.08	86.91	18.58	23.81	12.73	12.94	0.96	25.80	33.07
Dry Weight of Bulb (g)	84.71	87.95	18.60	23.84	17.09	17.42	0.96	34.56	44.29
TSS (ºBrix)	0.95	1.15	1.83	2.35	8.27	9.08	0.82	15.51	19.88
Vit. C (100gm /Mg)	0.44	0.82	1.01	1.30	6.05	8.21	0.54	9.20	11.79
Bulb Yield/ Plot (kg)	0.73	1.11	1.42	1.82	15.87	19.58	0.65	26.50	33.96
Yield t/ha	17.55	19.93	8.10	10.38	16.66	17.75	0.88	32.22	41.29

Variability for growth parameters of onion

The genotypic and phenotypic variances of plant height 90 DAT were (7.84) and (19.54) respectively. The estimate of genotype coefficient of variance were low (4.43) and

phenotype coefficient of variance were low (7.00) respectively. The estimate of heritability is medium (40.1) with low genetic advance (3.65) and low genetic advancement as percent of mean (5.79%). The genotypic and phenotypic variances of leaf height 90 DAT were (14.15) and (22.48) respectively. The estimate of genotype coefficient of variance were low (6.50) and phenotype coefficient of variance were low (8.20) respectively. The estimate of heritability is high (62.9) with low genetic advance (6.14) and medium genetic advancement as percent of mean (10.63%) Singh *et al*. (2011) [16] and Bharti *et al*. (2011) [4].

The genotypic and phenotypic variances of number of leaves 90 DAT were (0.74) and (1.45) respectively. The estimate of genotype coefficient of variance were low (8.16) and phenotype coefficient of variance were low (11.41) respectively. The estimate of heritability is medium (51.1) with low genetic advance (1.26) and medium genetic advancement as percent of mean (12.02%). The genotypic and phenotypic variances of fresh weight of bulb were (646.94) and (902.60) respectively. The estimate of genotype coefficient of variance were medium (18.02) and phenotype coefficient of variance were high (21.29) respectively. The estimate of heritability is high (71.7) with high genetic advance (44.35) and high genetic advancement as percent of mean (31.43%). The genotypic and phenotypic variances of dry weight of bulb were (564.64) and (869.20) respectively. The estimate of genotype coefficient of variance were high (20.18) and phenotype coefficient of variance were high (25.04) respectively. The estimate of heritability is high (65.0) with high genetic advance (39.45) and high genetic advancement as percent of mean (33.51%). The genotypic and phenotypic variances of bulb diameter were (1.10) and (1.84) respectively. The estimate of genotype coefficient of variance were medium (17.12) and phenotype coefficient of variance were high (22.12) respectively. Singh *et al.* (2015) [15] and Aliyu *et al.* (2007) [1] reported that the similar trend for estimate of heritability is medium (59.9) with low genetic advance (1.67) and high genetic advancement as percent of mean (27.29%). The genotypic and phenotypic variances of bulb yield per plot were (0.55) and (0.96) respectively. The estimate of genotype coefficient of variance were medium (17.74) and phenotype coefficient of variance were high (23.31) respectively. The estimate of heritability is medium (57.9) with low genetic advance (1.17) and high genetic advancement as percent of mean (27.81%). The genotypic and phenotypic variance of yield (t/ha) were (24.74) and (42.72) respectively. The estimate of genotype coefficient of variance were medium (17.74) and phenotype coefficient of variance were high (23.31) respectively. The estimate of heritability is medium (57.9) with low genetic advance (7.79) and high genetic advancement as percent of mean (27.81%) have been presented in table 3. The extent of progress that could be achieved in any crop depends on the primary raw material, the variability existing in the base material. In the absence of which there shall be no response to selection. The phenotypic coefficient of variability (PCV) was much larger than genotypic coefficient of variances (GCV) for all characters, indicating that all the characters under study are influenced to various degrees by the environmental factors. On the basis of presence performance for different characters genotype Agri Found Light Red was found superior in terms of bulb yield per hectare. Large amount of variability was observed in the experimental for selection. Characters like plant height, leaf height, leaves per plant, diameter of bulb, fresh weight of bulb, dry weight of bulb, bulb yield per plot high and heritability coupled with high to moderate genetic advance.

Table 3: Genotypic correlation coefficient for 16 characters for onion genotypes:

S.N.	Characters	Plant height (cm) 30 DAT	Plant height (cm) 60 DAT	Plant height (cm) 90 DAT	Leaf height (cm) 30 DAT	Leaf height (cm) 60 DAT	Leaf height (cm) 90 DAT	Leaves/plant 30 DAT	Leaves/plant 60 DAT	Leaves/plant 90 DAT	Bulb diameter (cm)	Fersh weight of bulb (g)	Dry of bulb (g)	TSS (ºBrix)	Vitamin 'c' (100gm/mg)	Bulb yield per plot (kg)	Yield (t/ha)
1	Plant height (cm) 30 DAT	1.00	1.16**	1.36**	1.01**	1.18**	1.15**	0.74**	0.95**	1.13**	0.75**	0.90**	0.98**	0.48*	0.83**	0.94**	0.94**
2	Plant height (cm) 60 DAT		1.00	1.05**	1.26**	1.01**	0.92**	0.97**	0.95**	0.98**	0.81**	0.80**	0.90**	0.45*	1.38**	0.81**	0.81**
3	Plant height (cm) 90 DAT			1.00	1.47**	0.98**	1.03**	1.10**	0.90**	0.95**	0.79**	0.99**	0.99**	0.51*	0.92**	0.96**	0.96**
4	Leaf height (cm) 30 DAT				1.00	1.28**	1.25**	0.74**	1.03**	1.21**	0.83**	0.95**	1.01**	0.51*	0.86**	0.98**	0.98**
5	Leaf height (cm) 60 DAT					1.00	0.87**	1.13**	1.01**	0.92**	0.79**	0.84**	0.96**	0.60**	1.41**	0.84**	0.84**
6	Leaf height (cm) 90 DAT						1.00	0.85**	0.67**	0.83**	0.82**	0.91**	0.91**	0.35	0.82**	0.92**	0.92**
7	Leaves/plant 30 DAT							1.00	1.03**	0.81**	1.00**	0.95**	1.05**	0.96**	1.46**	0.98**	0.98**
8	Leaves/plant 60 DAT								1.00	0.92**	0.54*	0.69**	0.88**	0.68**	1.17**	0.73**	0.73**
9	Leaves/plant 90 DAT									1.00	0.77**	0.46*	0.66**	0.22	0.98**	0.47*	0.47*
10	Bulb diameter (cm)										1.00	0.68**	0.77**	0.37	0.93**	0.69**	0.69**
11	Fresh weight of bulb (g)											1.00	0.99**	0.76**	1.13**	1.01**	1.01**
12	Dry weight of bulb (g)												1.00	0.81**	1.24**	0.98**	0.98**
13	TSS (ºBrix)													1.00	1.07**	0.76**	0.76**
14	Vitamin 'c' (100gm/mg)														1.00	1.13**	1.13**
15	Bulb yield per plot (kg)															1.00	1.00**
16	Yield (t/ha)																1.00

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