



Research Article

STUDIES ON GENETIC DIVERSITY AND VARIABILITY FOR YIELD AND YIELD ATTRIBUTES IN GARLIC (*ALLIUM SATIVUM* L.) UNDER DHAMPUR CONDITIONS

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Abstract: The experiment was conducted at horticulture research farm Dhampur Bijnor during winter season 2019-2020. In the present investigation 21 genotypes of garlic (*Allium sativum* L.) were evaluated in RBD with the objective of estimating the genetic variability and determination of association among different attributes with each other and with bulb yield. On the basis of mean performance, the genotype G-41 was the highest yielder followed by G-384, Bareilly local and minimum was found in G-282. Based on mean performance G-189, G-323, G-01 and NG-3181 were identified as high yielders for bulb yield per plant. These genotypes may further be utilized in breeding programme aimed at improving bulb yield in garlic. Analysis of variance indicated presence of considerable variability for all the twelve characters. The estimates of phenotypic co-efficient of variation (PCV) were higher than the genotypic co-efficient of variation (GCV) for all the characters. High GCV and PCV were observed for Number of cloves per bulb, Polar diameter, weight of dry bulb, and weight of fresh bulb, width of leaf and length of leaves.

Keywords: Garlic, Variability, Yield, GCV and PCV

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Introduction

Garlic (*Allium sativum* L.) belongs to the family Alliaceae [1]. It is an apomictic diploid species ($2n=2x=16$). The origin of garlic is thought to be in central Asia (India, Afghanistan, West China, Russia) and spread to other parts of the world through trade and colonization (Tindal, 1986). Garlic has been used in China and India for more than 500 years, and Egypt since 2000 B.C [2]. Garlic is the most important *Allium* crops and ranks second next to onion in the world [3].

With respect to its production and economic value, garlic is one of the main *Allium* vegetable crops in the world and used as a seasoning in many foods throughout the globe. Garlic has also medicinal value which is well recognized in the control and treatment of hypertension, worms, germ, bacterial and fungal diseases diabetes, cancer, ulcer, rheumatism etc [4-6]. Many people perceived and appreciated garlic for its many medicinal attributes [7].

Materials and Methods

The field experiment was conducted at the horticulture research centre (HRC) at R.S.M (PG) College Dhampur Bijnor Uttar Pradesh India. Geographically it is situated between 29°15' 27.5328" latitude in the north and 78°30' 0.2196" longitudes in the eastern elevation of about 235 m above mean sea level. Geographically, it falls in the north east Gangetic alluvial plains of eastern U.P. region. The experimental field had sandy loam soil, low in organic carbon, nitrogen, medium in phosphorous, potash and slightly alkaline (pH-8.0) in nature. The mechanical mixture of soil was 30.7 (%) Coarse sand, 35.5 (%) Fine sand, 20.6 % silt and 13.2 % clay. The experimental material of garlic used in the present study were, the collections from different places of India. Twenty-one genotypes have been used in the present study. The experiment was laid out in (RBD) Randomize block design.

These 21 genotypes were evaluated and studied for their growth, yield and quality performance based on morphological and agronomical measurements. The following observations were recorded during the course of experimentation on following characters-Plant height (cm), Number of leaves per plant, Length of leaf (cm), Width of leaf (cm), Plant pseudo stem height(cm), Plant pseudo stem diameter (mm), Equatorial Diameter of bulbs (mm), Polar diameter of bulbs (mm), Weight of fresh bulbs (gm), Weight of dry bulbs (gm), Number of cloves per bulb, Yield q/ha, Total soluble solids (%). Protein %, Sulphur contain (%). The observations were recorded on five randomly selected plants of each row. Average of data from the sampled plant of each treatment was used for statistical analyses in order to draw valid conclusions. The statistical parameters like mean, range were calculated as per the standard methods of analysis.

Results and Discussion

The analysis of variance for the design of experiment indicated that the mean squares due to genotypes were highly significant for most of the characters indicating a wide genetic variability among the genotypes [Table-1]. The variation due to checks were also highly significant for are the characters like plant height (58.91 cm), Plant pseudostem height (3.87 cm), number of leaves per plant (1.06), length of leaf (15.68 cm), width of leaf (6.72 mm), Plant pseudostem diameter (3.97 mm), Equatorial diameter of bulbs (25.71 mm), Polar diameter of bulbs (20.07 mm), number of cloves per bulb (22.96), weight of fresh bulbs (152.72 g), weight of dry bulbs (122.57 g), Yield quantal/ha (1573.66), total soluble solids (9.25%), Sulphur contain (0.0005 %), Protein (0.30 %). Mean performance serves as an important criterion in eliminating the undesirable types in a selection programme [8].

Table-1 ANOVA for 15 important traits in 21 genotypes of garlic

Source of variation	d.f.	Plant Height	Plant pseudostem height	Number of leaf	Leaf length	Leaf Width (mm)	Plant pseudostem diameter	Equatorial Diameter of bulbs	Polar Diameter
Replication	2	2.22	1.14	0.32	8.20	0.02	1.57	5.70	0.74
Treatment	20	58.91**	3.87**	1.06**	15.68**	6.72**	3.97**	25.71**	20.07**
Error	40	6.28	0.87	0.15	4.34	2.08	0.46	3.81	2.20

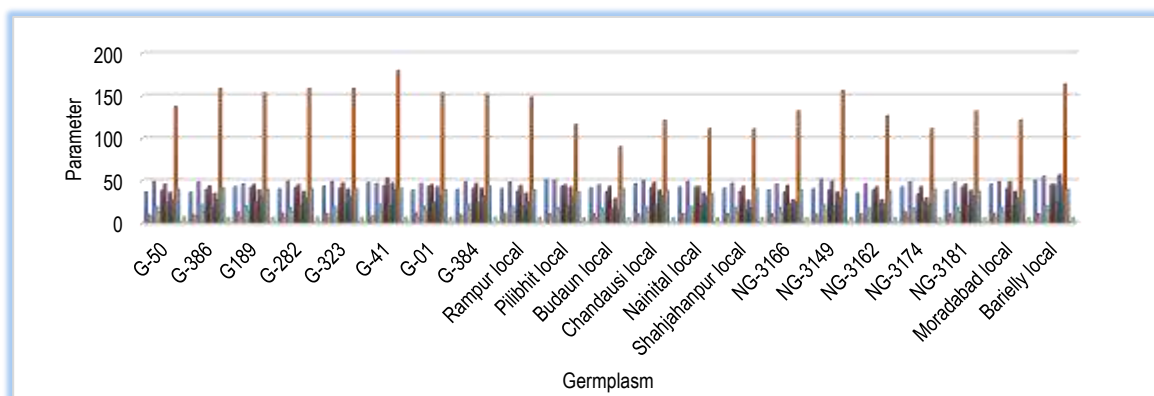
Source of variation	d.f.	Number of cloves per bulb	Weight of fresh bulbs	Weight of Dry bulbs	Yield quantal/ha	Total soluble solids %	Sulphur content %	Protein %
Replication	2	4.06	35.27	42.67	232.21	4.55	0.0000	0.11
Treatment	20	22.96**	152.72**	122.15**	1573.66**	9.25**	0.0005**	0.30**
Error	40	2.17	22.71	16.96	298.23	2.65	0.0001	0.16

Table-2 Mean performance of 15 important traits in 21 garlic genotypes

SN	Genotypes	Plant Height (cm)	Plant pseudostem height (cm)	Number of leaf	Leaf length (cm)	Leaf Width (mm)	Plant pseudostem diameter (mm)	Equatorial Diameter of bulbs (mm)	Polar Diameter (cm)	No of cloves /bulb	Weight of fresh bulbs	Weight of Dry bulbs	Yield quantal/ ha	Total soluble solids %	Sulphur content %	Protein %
1	G-50	36.70	9.67	7.40	48.83	18.93	13.10	38.33	45.80	24.07	35.87	26.40	137.56	40.00	0.337	7.27
2	G-386	36.27	9.53	7.60	48.73	21.60	13.11	39.67	43.73	18.40	34.93	27.47	158.73	41.27	0.330	6.63
3	G189	42.97	12.63	7.07	46.10	20.10	14.06	42.07	45.07	25.60	38.67	30.80	153.43	39.33	0.333	6.67
4	G-282	40.23	11.63	6.27	49.30	18.20	13.35	41.73	45.27	21.60	37.07	29.13	158.72	40.13	0.353	7.30
5	G-323	43.73	11.10	6.80	48.93	19.27	14.14	41.20	47.07	23.87	39.87	31.20	158.73	40.30	0.330	6.67
6	G-41	47.97	7.50	8.67	46.57	22.67	13.85	44.00	53.13	20.33	47.33	39.33	179.89	41.17	0.323	7.00
7	G-01	39.13	11.83	6.80	46.63	19.33	14.42	43.40	45.13	23.93	42.93	32.47	153.43	39.00	0.327	6.80
8	G-384	39.47	9.80	7.40	48.73	21.93	15.31	40.60	46.73	24.33	40.80	31.53	152.06	43.00	0.350	7.10
9	Rampur local	40.40	11.70	7.00	48.43	19.00	12.81	37.67	44.20	19.76	35.20	24.93	148.14	38.93	0.323	6.37
10	Pilibhit local	51.47	10.87	6.93	50.79	18.07	12.30	43.73	44.93	18.93	42.13	30.80	116.40	36.87	0.323	6.23
11	Budaun local	41.57	10.63	5.80	45.20	17.07	11.69	36.93	43.07	16.67	28.80	16.80	89.94	40.20	0.320	6.40
12	Chandausi local	46.33	10.50	7.07	50.20	19.13	13.41	42.00	47.87	22.40	38.80	31.87	121.48	37.73	0.320	6.40
13	Nainital local	42.40	11.20	7.03	49.17	19.53	13.40	42.73	42.87	21.00	35.47	31.33	111.44	35.00	0.357	6.27
14	Shahjahanpur local	41.00	10.87	6.87	47.00	18.13	11.87	36.87	43.33	14.80	26.73	18.00	111.11	40.33	0.323	6.33
15	NG-3166	39.13	10.67	6.73	45.73	18.33	11.72	36.33	44.20	22.33	27.13	24.93	132.27	38.63	0.327	6.50
16	NG-3149	40.13	9.93	7.67	52.00	21.33	14.58	38.87	49.33	19.87	36.40	30.13	156.42	39.97	0.327	6.37
17	NG-3162	35.53	11.03	6.60	46.40	18.47	11.70	38.80	42.67	21.73	27.67	22.53	126.75	37.73	0.353	6.47
18	NG-3174	42.53	12.63	6.20	48.80	17.53	12.24	34.40	42.47	24.47	29.73	21.60	111.11	39.83	0.350	6.43
19	NG-3181	38.27	10.43	6.80	47.87	18.73	12.76	42.33	45.73	20.47	38.53	32.00	132.07	37.30	0.327	6.50
20	Moradabad local	45.67	11.43	6.53	48.67	18.47	12.03	40.73	48.53	19.27	37.33	28.93	121.69	37.97	0.323	6.57
21	Barielly local	51.00	10.90	6.93	55.13	20.47	15.33	45.60	45.40	23.20	56.93	44.67	163.88	39.67	0.330	6.87
	Mean	42.00	10.79	6.96	48.53	19.35	13.20	40.38	45.55	21.29	37.06	28.90	137.87	39.26	0.333	6.63
	Max	51.47	12.63	8.67	55.13	22.67	15.33	45.60	53.13	25.60	56.93	44.67	179.89	43.00	0.357	7.30
	Min	35.53	7.50	5.80	45.20	17.07	11.69	34.40	42.47	14.80	26.73	16.80	89.94	35.00	0.320	6.23
	SE(d)	2.05	0.76	0.32	1.70	1.18	0.55	1.59	1.21	1.20	3.89	3.36	14.10	1.33	0.007	0.33
	C.D. at 5%	4.15	1.55	0.64	3.45	2.39	1.12	3.23	2.46	2.44	7.89	6.82	28.60	2.70	0.014	0.67
	C.V. (%)	5.97	8.65	5.57	4.29	7.45	5.14	4.83	3.26	6.92	12.86	14.25	12.53	4.15	2.630	6.11

Table-3 Genetic variability Please mention the units for all the traits

Genotypes	Mean	Min	Max	Heritability (%)	Genic advance	Ga as % mean	GCV (%)	PCV (%)	% cont
Plant Height (cm)	42.00	35.53	51.47	73.63	7.40	17.63	9.97	11.62	5.69
Plant pseudostem height (cm)	10.79	7.50	12.63	53.48	1.51	13.97	9.27	12.68	7.16
Number of leaf	6.96	5.80	8.67	67.00	0.93	13.37	7.93	9.69	6.12
Leaf length (cm)	48.53	45.20	55.13	46.55	2.73	5.63	4.01	5.87	7.68
Leaf Width (mm)	19.35	17.07	22.67	42.71	1.68	8.66	6.43	9.84	8.35
Plant pseudostem dia. (mm)	13.20	11.69	15.33	71.75	1.89	14.29	8.19	9.67	6.24
Equatorial Dia. of bulbs (mm)	40.38	34.40	45.60	65.74	4.51	11.18	6.69	8.25	6.17
Polar Diameter (mm)	45.55	42.47	53.13	73.02	4.30	9.43	5.36	6.27	6.60
No of cloves /bulb	21.29	14.80	25.60	76.15	4.73	22.23	12.37	14.17	4.81
Weight of fresh bulbs (g)	37.06	26.73	56.93	65.62	10.99	29.64	17.76	21.93	8.50
Weight of Dry bulbs (g)	28.90	16.80	44.67	67.40	10.01	34.65	20.49	24.96	6.88
Yield quantal/ha	137.87	89.94	179.89	58.77	32.56	23.62	14.96	19.51	5.81
Total soluble solids %	39.26	35.00	43.00	45.40	2.06	5.25	3.78	5.61	4.64
Sulphur content %	0.33	0.32	0.36	61.62	0.02	5.39	3.33	4.25	6.33
Protein %	6.63	6.23	7.30	22.10	0.21	3.15	3.26	6.93	9.00

Fig-1 Germplasm parameter of Garlic (*Allium sativum* L.)

The result of the present investigation revealed that there exist significant variations for different characters. The mean performance and range of the 21 genotypes for all the twelve characters are presented in the [Table-2].

A perusal of [Table-2] revealed that a large amount of variability was present in plant height. The maximum plant height was observed in G-41 (51.74 cm). The shortest plant height was observed in NG- 3162 (35.53 cm) against the population mean of (42.0 cm).

Nine genotypes namely Barielly local, Pilibhit local, Chanduas local, Moradabad local, G-323, G-189, NG- 3174, Nanital local and Budaun local. Exhibited higher mean values as compared to general mean (42.0), while Shahjahanpur local, Rampur local, G-282, NG-3149, G-384, G-01, NG-3166, NG-3181, G-50, G-386, NG-3162. Showed lower mean values.

The Number of leaves per plant ranged between 5.8 to 8.67. The maximum Number of leaves per plant was recorded in G-41 (8.67) followed by NG-3149 (7.67) and G-386 (7.60), while the minimum value in Budaun local (5.8) against the population mean of (6.96). The length of leaf exhibited sufficient variability ranged from 45.2 cm to 55.13 cm. The maximum length of leaf was recorded in Bareilly local (55.13 cm) followed by NG-3149 (52 cm) and Pilibhit local (50.79 cm) while the minimum in Budaun local (45.2 cm) against the population mean of 48.53 cm. The maximum width of leaf was recorded in G-41 (22.67 mm) followed by G-384 (21.93 mm) while, minimum in Budaun local (17.07 mm) against the population mean of (19.35 mm). The plant pseudo stem diameter exhibited sufficient variability ranged from 11.70 to 15.33 mm. The maximum plant pseudo stem diameter was recorded in Bareilly local (15.33 mm) which statistically was at par with genotype Rampur local (15.31 mm) and NG-3149 (14.58 mm) while the minimum in NG-3162 (11.07 mm), against the population mean of 13.20 mm. The maximum equatorial diameter was recorded in Moradabad local (45.40 mm) followed by NG-3149 (44.0 mm) and G-01 (43.40 mm). While, minimum in NG-3174 (34.40 mm). Against the population mean of (40.38 mm). The genotypes exhibited considerable variation for the plant polar diameter. It ranged between 42.47 to 53.13 mm. The maximum polar diameter was recorded in G-282 (53.13 mm) followed by NG-3149 (49.33 mm) and Chandausi local (47.87 mm). While the minimum value was observed in NG-3174 (42.47 mm), against the population mean of (45.55mm). The number of cloves per bulbs ranged from 14.80 to 24.47 against the population mean of 21.29. The maximum number of cloves per bulbs was recorded in G-189 (25.60) followed by NG-3174 (24.47), G-384 (24.33) and G-50 (24.07). The minimum number of cloves per bulbs was observed in Shahjahanpur local (14.80). The weight of fresh bulb ranged between 26.73 to 56.93. The maximum weight of fresh bulb was recorded in Bareilly local (56.93 gm) followed by G-41 (47.33 gm), G-01 (42.93 gm), while the minimum value in Budaun local Shahjahanpur local (26.73 gm) against the population mean of (37.06 gm). The weight of dry bulbs exhibited sufficient variability ranged from 16.80 to 44.67. The maximum weight of dry bulbs was recorded in Bareilly local (44.67 gm) which was statistically at par with genotype G-41 (39.33 gm) and Pilibhit local (38.80 gm), while the minimum in Budaun local (16.80 gm), against the population mean of 28.90. The bulb yield per hectare exhibited significant variation among the genotype ranging from 89.94 to 179.89. The maximum bulb yield per hectare was recorded in the germplasm G-189 (179.89 q/ha) which was statistically at par with genotype Bareilly local (163.88 q/ha), and G-386 (158.73 q/ha), while minimum value was in Budaun local (89.94 q/ha). The mean of bulb yield per hectare was 137.87 q/ha. The total soluble solids ranged between 35.0 to 43.0 °B. The maximum total soluble solids were recorded in G-384 (43.0 °B) followed by G-386 (41.27 °B), G-41 (41.17 °B), while the minimum value in Nainital local (35.0 °B), against the population mean of 39.26 °B. The sulphur content exhibited significant variation among the genotype ranging from 0.320 to 0.357%. Maximum total soluble solids were recorded in the germplasm Nainital local (0.357%) statistically at par with genotype G-282 (0.353%), and G-384 (0.350%), while minimum in Badaun local (0.320%), The mean of sulphur content was 0.333%. The maximum protein content was recorded in the germplasm G-282 (7.30%). The minimum was in Pilibhit local (6.23%) against the population mean of (6.63%). The higher TSS value in these genotypes may be due to its inherent characteristics. Similar results were observed by Azuara *et al.* (2008) [9] and Usman *et al.* (2015) [10]. Present findings are in accordance with reports of

Dubey *et al.* (2010) [11] and Jabeen *et al.* (2010) [12]. These results are also accordance with the findings of Raju *et al.* (2013) [13] and Pervin *et al.* (2014) [14] who reported significant differences for bulb yield in different garlic varieties. The estimate of phenotypic and genotypic coefficients of variability gives a clear picture of amount of variations present in the available germplasm. For all the traits studied, we recorded a higher PCV over the GCV indicating towards the major role of environment the expression of traits. The estimates of phenotypic coefficient of variation (PCV) were higher than the genotypic coefficient of variation (GCV) for all the characters. Coefficients of variability varied in Magnitude from trait to trait, either low or moderate or high. Therefore, it indicated the presence of high diversity Among all the characters high GCV and PCV were high for Weight of dry bulb, Weight of fresh bulb, bulb yield/ha, number of cloves/bulbs, plant pseudostem height, plant height and lowest protein, sulphur content, total soluble solids, in the genotypes. Similar results were reported by, Chattoo *et al.* (2015) [15], Hussien *et al.* (2019) [16] and Sandhu *et al.* (2015) [17]. Singh *et al.* (2013).

Conclusion

Based on the present results, it can be concluded that Analysis of variance revealed highly significant differences among the genotypes for all the characters showing thereby considerable amount of genetic variability for all the characters and were amenable to improvement. The estimates of phenotypic coefficient of variation (PCV) were higher than the genotypic co-efficient of variation (GCV) for all the characters. Both PCV and GCV were high for Weight of dry bulb, Weight of fresh bulb, bulb yield/ha, number of cloves/bulbs, plant pseudo stem height, plant height and lowest protein, sulphur content, total soluble solids in the genotypes. The weight of dry bulb had positive and desirable association with bulb yield and selection of these traits would be effective for yield improvement in garlic. It was observed that genotypes G-41, G-189, Bareilly local, G-386, G-323, G-282 produced highest bulb yield per plant which indicated that these genotypes may be considered in breeding programme and recommended as a potential replacement to the low yielding variety under field conditions.

Application of research

The results obtained in the present study may be used by the breeders and biologists working on the improvement of the garlic crop.

Research Category: Horticulture

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Study area / Sample Collection: Dhampur Conditions

Cultivar / Variety / Breed name: Garlic (*Allium sativum* L.)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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