Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(5): 1794-1797
Received: 25-07-2018
Accepted: 26-08-2018

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Studies genetic variability, heritability and genetic advance for various yield contributing traits in garlic (*Allium Sativum* L.)

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Abstract
The experiment was conducted during rabi season, 2016-2017 in Augmented Randomized Block Design at Vegetable Research Station, Junagadh Agricultural University, Junagadh. Genotypic variability, heritability and genetic advance for bulb yield and bulb yield contributing characters were studied on 126 garlic genotypes and 4 checks. The observation were recorded on 14 characters viz., plant height (cm), pseudostem height (cm), number of leaves per plant, leaf length (cm), leaf width at middle portion (cm), bulb equatorial diameter (cm), bulb polar diameter (cm), bulb weight (g), number of cloves per bulb, clove weight (g), clove length (cm), days to maturity (days), bulb yield (kg/ha) and total soluble solid (%). The analysis of variance revealed that mean square due to genotypes were highly significant for all the characters except plant height, pseudostem height and days to maturity, implies the presence of sufficient amount of genetic variability among the genotypes. The phenotypic coefficient of variation were higher than the corresponding genotypic coefficient of variation for all the characters studied, however, the differences was narrow which implied less environmental influences. High heritability estimates were obtained for bulb yield and number of leaves per plant, while high genetic advance as percent of mean were obtained for bulb yield followed by pseudostem height and clove weight indicating wide scope for improvement through selection of these traits.

Keywords: GCV, PCV, heritability, genetic advance

Introduction
Garlic (*Allium Sativum* L.) is the second most widely cultivated bulb crop after onion and belongs to the family Amaryllidaceae (alliaceae). It has long been recoginsed as a valuable spice and condiment throughout India. It is a frost hardy bulbous, erect annual herb of 30-100 cm in height narrow flat leaves and bears small white flowers and bulbils. The seed stalk bears a terminal inflorescence, which in term bear bulbis instead of flowers. The shoot of garlic become flat and finally aborts after the development of bulbils in the inflorescence. Garlic has higher nutritive values than other bulb crops. The fresh peeled garlic cloves contain 62.8% moisture, 29% carbohydrate, 6.3% protein, 1% mineral matter, 0.8% fiber, 0.1% fat, 1% total ash, 0.03% calcium, 0.31% phosphorous, 0.0001% iron, 0.4 mg/100 g nicotinic acid and 13 mg/100 g vitamin 'C'. Alliums are mostly popular for their flavour and these are having sulphur containing compound, formed directly by crushing followed by a chemical reaction. Allinase is an enzyme present in most of the members of *Allium* genus and product is chemically called as thiosulfinates. These thiosulfinates are pungent, unstable and directly responsible for characteristic flavour. Pungent and spicy flavour mellows and sweetens considerably with cooking. Oils are often flavoured with garlic cloves. A colourless, odourless, water soluble amino acid allin is present in uninjured garlic. Diallyl disulphide is said to possess true garlic odour. Garlic has some antifungal, antimicrobial, insecticidal and other medicinal properties. It has capable of lowering blood sugar. Garlic therapy has also been suggested in flatulence, constipation, faulty digestion, inadequate food intake, chronic coughs, leprosy and many other diseases.

Materials and Methods
The present research was carried out at Vegetable Research Station, Junagadh Agricultural University, Junagadh (Gujarat), India during "*Rabi"* 2016-17. Geographically, Junagadh is situated at 210 N Latitude and 70.50 E Longitude with an altitude of 60 meters above the mean sea level. The soil of experimental site was medium black, alluvial in origin and poor in organic matter. The climate of the area represents tropical and semi-arid. The experimental material used in the present study consisted of 126 genotypes and 4 checks of garlic were obtained from the Vegetable Research Station, Junagadh Agricultural University, and Junagadh.

The experiment was conducted in Augmented Randomized Block Design. In single plot sized 1.00 x 1.00 m2 with the distance of 15 cm row to row and 10 cm plant to plant. Recommended cultural and plant protection measures were followed to raise a healthy crop and good expression of the characters. Observations were recorded on randomly selected plants from each plot for fourteen characters namely on plant height, pseudostem height, number of leaves per plant, leaf length , leaf width at middle portion, bulb equatorial diameter, bulb polar diameter, bulb weight, number of cloves per bulb, clove weight, clove length, days to maturity, bulb yield and total soluble solid (%).

Results and Discussion

Based on the highest mean values with respect to characters (Table 2) the genotype JGP-41 (7123.00 kg/ha) was the higher in bulb yield. The genotype to JGP-113 (55.94) had highest plant height. Highest pseudostem height was showed by genotype RGP-391 (8.80 cm). The genotype JGP-59 (12.10) had highest number of leaves per plant. JGP-145 (34.11 cm) genotype had highest leaf length. The genotype RGP-376 (1.62 cm) had highest leaf width at middle portion. Highest bulb equatorial diameters were showed by genotype JGP-2 &JGP-21 (3.80). The genotype RGP-391 (3.20 cm) had highest bulb polar diameter. JGP- 191 (13.40 g) genotype had highest bulb weight. The genotypes JGP-155 (13.00) had highest number of cloves per bulb. RGP-187 (1.553 g) genotype showed highest clove weight. The genotype JGP-41 (2.65 cm) had highest clove length. JGP-21 (92.00 days) genotype was early maturity than other genotypes. The genotype RGP-420 (39.70%) had highest total soluble solid.

Table 1: Analysis of variance for bulb yield and bulb yield contributing traits.

Source of variation	Block (B)	Entries (E) Germplasm accessions + Check entries	Check entries (c)	Germplasm accessions (G)	Accessions Vs Check varieties	Error
d.f	5	129	3	125	1	15
Plant height (cm)	2.337	21.883*	8.071	12.718	83.988*	8.279
Pseudostem height (cm)	15.311*	0.903	0.243	1.330	50.461*	0.770
Number of leaves per plant	10.269*	1.938*	1.084	1.968*	0.676	0.467
Leaf length (cm)	124.309*	9.866*	27.317*	14.197*	83.931*	2.864
Leaf width at middle portion (cm)	0.071*	0.030*	0.045*	0.024*	0.746*	0.010
Bulb equatorial diameter (cm)	0.056	0.102*	0.078	0.099*	0.505*	0.043
Bulb polar diameter (cm)	0.363*	0.093	0.071	0.102*	0.958*	0.046
Bulb weight (g)	5.521	6.330*	1.895	6.318*	21.114*	2.765
Number of cloves per bulb	6.853*	2.622	0.237	2.849*	18.599*	1.340
Clove weight (g)	0.254*	0.067*	0.003	0.071*	0.320*	0.013
Clove length (cm)	0.106*	0.043*	0.005	0.046*	0.263*	0.011
Days to maturity (days)	5.175	9.677*	3.546	8.202	212.458*	4.189
Bulb yield (kg/ha)	508017.3*	1635076.0*	401145.3*	1676056.0*	214317.9	77468.23
Total soluble solid (TSS) (%)	2.318	5.557*	2.777	5.412*	32.029*	1.236

Table 2: Estimates of genetic parameters of variation for the fourteen characters of garlic genotypes.

Characters	Mean	Range MIN.	Range MAX.	Genotypic Variance	Phenotypic Variance	GCV %	PCV %	Heritability (%)	Genetic Advance	Genetic Advance as percent of mean (%)
Plant height (cm)	44.99	32.50	55.94	2.68778	10.96698	3.66	7.39	24.50	1.671	3.73
Pseudostem height (cm)	5.41	3.40	8.80	1.03515	1.80026	16.23	24.03	57.50	1.581	29.16
Number of leaves per plant	8.06	5.20	12.10	0.70017	0.96803	10.38	12.20	72.32	1.465	18.18
Leaf length (cm)	27.35	17.55	34.11	5.26656	8.76407	8.39	10.96	60.09	3.664	13.39
Leaf width at middle portion (cm)	1.14	0.82	1.62	0.02899	0.13175	13.10	18.83	22.00	0.164	14.47
Bulb equatorial diameter (cm)	2.75	2.12	3.80	0.11226	0.43897	12.18	24.09	25.57	0.349	12.69
Bulb polar diameter (cm)	2.40	1.56	3.20	0.05112	0.09772	9.42	13.02	52.31	0.336	14.03
Bulb weight (g)	6.10	1.80	13.40	0.71073	1.47604	13.82	19.91	48.15	1.204	19.73
Number of cloves per bulb	8.50	5.00	13.00	0.30183	1.64227	6.46	15.07	18.37	0.485	5.59
Clove weight (g)	0.750	0.255	1.553	0.01167	0.02501	14.40	21.08	46.66	0.152	20.27
Clove length (cm)	1.89	1.42	2.65	0.00689	0.01881	4.39	7.25	36.65	0.103	5.38
Days to maturity (days)	96.74	92.00	103.50	0.80254	4.99192	0.92	2.30	16.07	0.739	0.76
Bulb yield (kg/ha)	3323.33	578.00	7123.00	319717.6	397185.8	17.01	18.96	80.49	1043.05	31.40
Total soluble solid (TSS) (%)	35.76	31	39.7	0.83517	2.07206	2.55	4.02	40.30	2.960	8.29

The analysis of variance revealed that mean square due to genotypes were highly significant for all the characters except plant height, pseudostem height and days to maturity, implies the presence of sufficient amount of genetic variability among the genotypes (Table 1). The phenotypic and genotypic coefficients of variation were computed to assess the nature and magnitude of existing variability in the germplasm.. The phenotypic coefficients of variation were higher than the corresponding genotypic coefficient of variation for all the characters (Table 2). High PCV were observed for bulb equatorial diameter followed by pseudostem height and clove weight. Moderate GCV were observed for bulb yield followed by pseudostem height, clove weight, bulb weight, leaf width at middle portion, bulb equatorial diameter and number of leaves per plant. Whereas, moderate PCV were displayed by bulb weight, bulb yield, leaf width at middle portion, number of cloves per bulb, bulb polar diameter, number of leaves per plant and leaf length. These result are in broad conformity to earlier researcher Vijay (1990) [12], Tsega *et al*., (2010) [11], Singh *et al*., (2012) [10], Dhall and Brar (2013) [13], Panse *et at.*,(2013) [8], Kar *et al.,* (2014) [6], Agrawal and Tiwari (2004) [2], Pervin *et al.,* (2014) [9] and Bhatt *et al*., (2017) [3], and The characters exhibiting high PCV and GCV values, as mentioned above, are likely to allow reasonable scope of improvement through selection in respective environment owing to moderate genetic variability available in the germplasm collections evaluated.

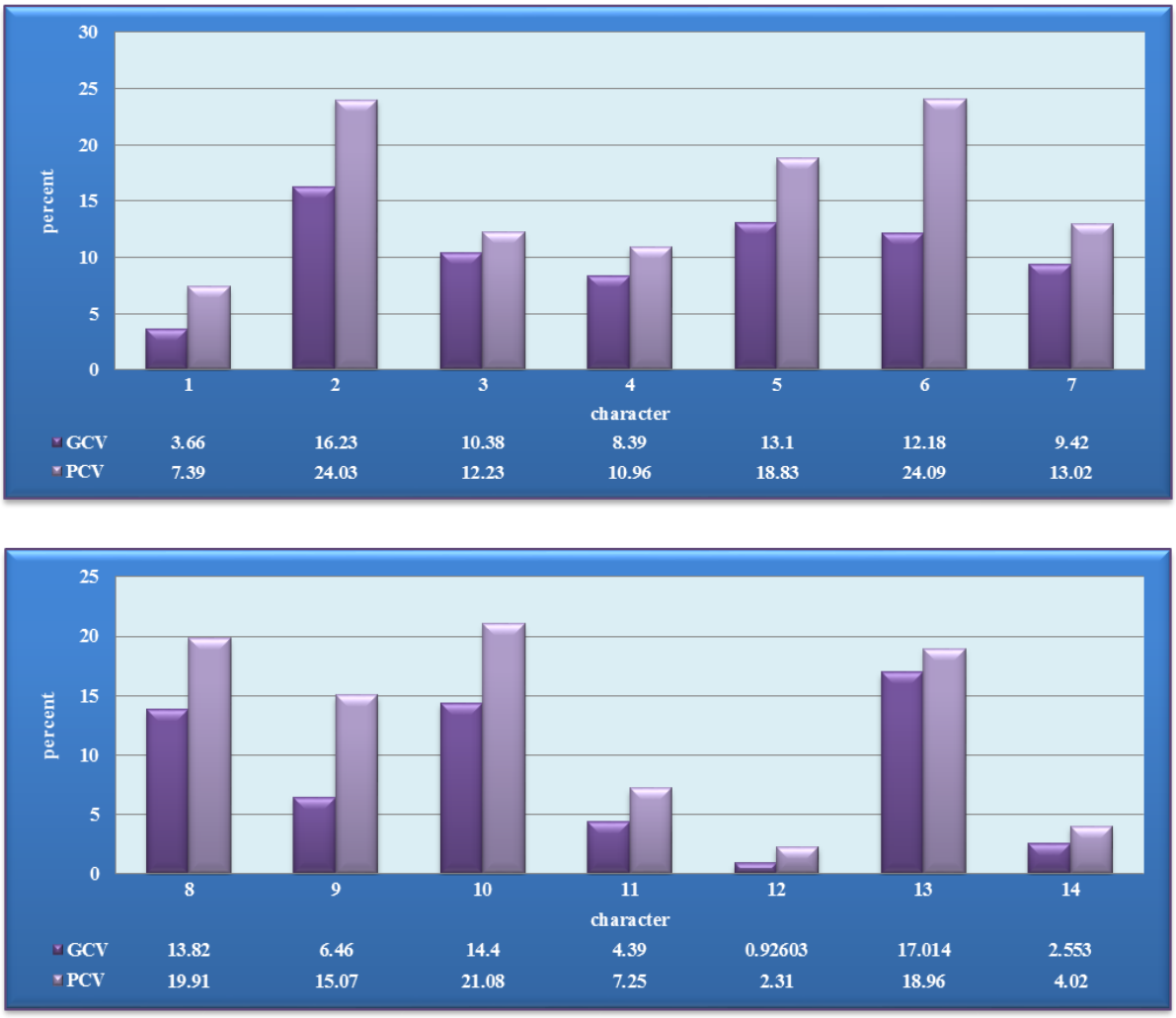

Fig 1: Genotypic coefficient of variation and phenotypic coefficient of variation of fourteen characters. (1) Plant height (2) pseudostem height (3) no. of leaves per plant (4) leaf length (5) leaf width at middle portion (6) bulb equatorial diameter (7) bulb polar diameter (8) bulb weight (9) no. of cloves per bulb (10) clove weight (11) clove length (12) days to maturity (13) bulb yield (14) total soluble solid.

High heritability were displayed by bulb yield followed by number of leaves per plant. High values of broad sense heritability for these characters expressed that they were least influenced by environmental modification. It reflected that the phenotypes were the true representative of their genotypes and selection based on phenotypic performance would be reliable. The high genetic advance as percent of mean found for bulb yield, followed by pseudostem height and clove weight. Similar result was found by Vijay (1990), Agrawal and Tiwari (2004) [2], Tsega *et al.*, (2010) [11] and Yadav *et al.*, (2012) [13]. This suggesting that all these traits are genetically controlled by additive gene action and they can be further improved through mass selection.

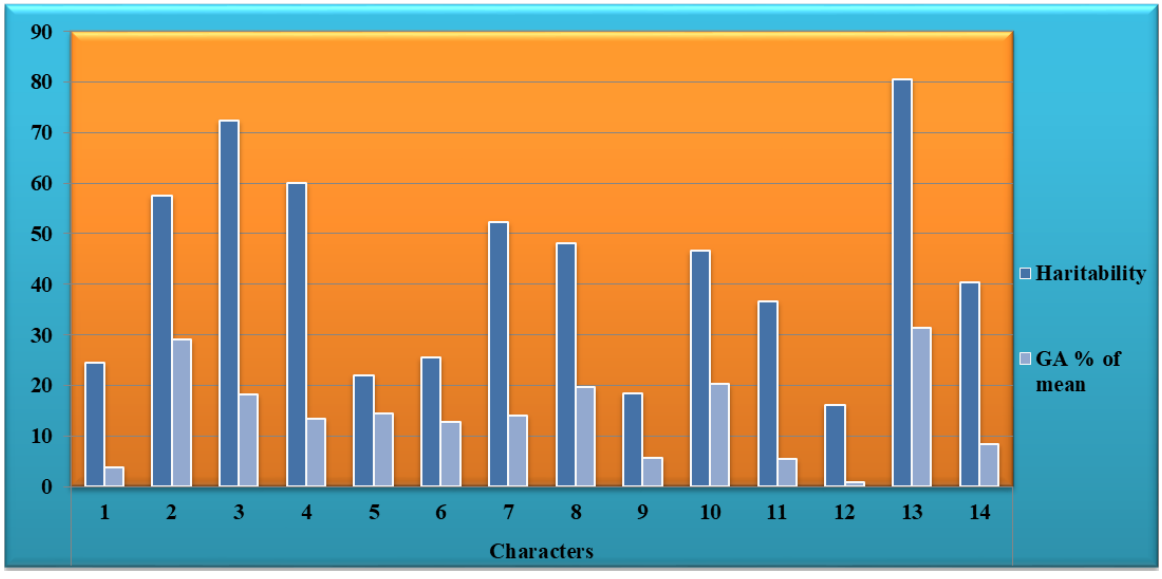

Fig 2: Heritability and genetic advance as percent of mean of fourteen traits of garlic

(1) Plant height (2) pseudostem height (3) no. of leaves per plant (4) leaf length (5) leaf width at middle portion (6) bulb equatorial diameter (7) bulb polar diameter (8) bulb weight (9) no. of cloves per bulb (10) clove weight (11) clove length (12) days to maturity (13) bulb yield (14) total soluble solid.

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