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Evaluation of some garlic (*Allium sativum* L.) germplasm for their suitability in north Bihar condition

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Abstract
The present investigation was carried out to screen the 21 genotypes of garlic for plant growth, yield and yield contributing parameter under field condition for two consecutive years. Attempt has been made to assess the genetic variation for plant architecture, yield traits of garlic germplasm. Results of two years pooled data revealed that genotypes had a great extent of influence on plant growth behavior and yield attributing traits. Among the 21 genotypes, RAUG-4 observed as the tallest plant having maximum number of leaves, however, RAUG-5 had the ability to complete their life cycle at a shortest period and potent to produce larger size of bulb along with maximum marketable as well as total yield. The plants with medium height bearing sizeable number of leaves with a rapid growth, quickly to harvest photo radiation and accumulated photosynthates into the economic part (cloves) at a better way. Besides the superior genotypes, RAUG-5 and RAUG-16 pertaining to yield accessions RAUG-12, RAUG-7, RAUG-15 and RAUG-4 were moderate yielder and might be considered as a promising candidates. However, the genotype RAUG-1, RAUG-2, RAUG-3, RAUG-6 RAUG-10, RAUG-14 RAUG-17 exhibited somewhat lower performance (45- 70 q/ha) while accession RAUG-8, RAUG-9, RAUG-11, RAUG-18 RAUG-19 and RAUG-20 depicted as poor yielder.

Keywords: garlic, germplasm, north Bihar

Introduction

Garlic (*Allium sativum* L) is considered as one of the most important species in the family Alliaceae and as an important bulb crop next to onion. *A. sativum* is a diploid species (2n=2X=16) cultivated since 3000 years B.C. (McCollum, 1987) [15]. It is generally not fertile and thus propagated by cloves. A wide range of adaptability to soil types, temperatures and day length, makes its farming possible from tropics to temperate region. The flavor in garlic is easily diagnosed and has anti-infective properties such as power suppliers, insecticidal, anti-bacterial, antifungal, anti-cancer, lowering of blood sugar, blood lipids, and reduction of blood platelet aggregation (Agusti, 1990) [3]. It is a winter perennial crop having more nutrient and water exhaustive in nature. The selection of the genotype/genotypes should take into consideration several different factors and characteristics, some of which include the adaptability of the cultivar to the climate of the growing area, the market demand of the particular cultivar and the resistance or tolerance of the cultivar to various diseases and pests. Clones of garlic are variable for morphophysiologic traits (Avato *et al*., 1998) [6], and commercial cultivars can be selected and identified on the basis of canopy structure and yield related traits (Zepeda, 1997) [22]. Genotypes may also differ in pungency, length of storage, colour, size, number of cloves per bulb, hardiness, and suitability for cooking. Some even store longer, some are more gourmets in flavor and some mature earlier and others later (Immelman, 2006) [10]. Genetic variation among populations of cultivated garlic is precious for an economic use of genes and genomes. The collection of cultivated garlic germplasms and its genetic evaluation will identify accessions that could be useful to obtain cultivars using clonal selection to be used in breeding programmes. The objectives of this research work have to assess genetic variation for plant architecture and yield traits of garlic germplasms.

Materials and Method

Field evaluation of 21 accessions obtained from different parts of Bihar and Jharkhand was carried out at the experimental farm of Dr. Rajendra Prasad Central Agricultural University, Pusa Bihar, India during the Rabi season of 2017-18 and 2018-19. The material used for the present experiment comprised of 21 genotypes of garlic *viz.* RAUG-1 to RAUG-20 along with one prominent check variety (G-323) was grown in randomized block design with 3 replications in two successive years. The crop was planted in the second week of October at a spacing of 15 (row to row) × 10 cm (plant to plant). Fertilizer application of 120:80:80 kg NPK/ha in the form of urea, diammonium phosphate and muriate of potash, respectively was applied. Total phosphorus and potassium and half of the nitrogen was applied before planting and rest amount of nitrogen was top dressed in two equal splits 30 and 45 days after planting when hand weeding was carried out in the experimental plots. All other agricultural practices (weeds control and irrigation, etc.), were performed when they were required and as recommended for commercial garlic production. A random sample of ten plants of each accession was collected from each plot to estimate the plant height (cm) and number of leaves per plant at 75 days after planting. However, polar and equatorial diameter (cm), number of cloves per bulb, bulb weight (g), weight of 10 cloves (g), marketable and total yield (q/ha) were recorded from randomly selected of 10 plant/bulb at the time of harvesting of individual accessions. The marketable and total bulb yield (q/ha) for each genotypes was recorded and two consecutive years data were pooled and statistically analyzed as per the standard procedure (Sukhatme and Amble, 1995) [19].

Result and Discussion

The pooled data of two consecutive years 2017-18 and 2018-19 presented in Table 1 indicated significant variations among the germplasms of garlic with respect to vegetative growth and yield parameters. The results depicted a handsome amount of deviation with respect to plant height and the plant height varies from 42.47 cm to 75.62 cm with a mean value of 55.31 cm. The germplasm, RAUG-4 had produced significantly highest plant height of 75.62 cm over the tested germplasm. However the significantly lowest plant height (42.47 cm) was observed for RAUG-14 followed by RAUG-19 (43.22 cm). The number of leaves per plant varies significantly and value ranged from 5.06 to 7.87 with general mean of 6.33. The maximum number of leaves per plant (7.87) was also found for the genotypes RAUG-4 and leaves number did not statistically variate with genotype RAUG-1, RAUG-2, RAUG-18, while significantly least number of leaves per plant was noted for the germplasm RAUG-19 (5.06) and result have not been differed with the genotype RAUG-20, RAUG-13, RAUG -7. Days to harvesting is an important parameter that decides the crop length and fitted well in a particular cropping sequence at a particular location. The earliness or late in maturity traits are utilized in the breeding programme for crop improvement. The data presented in Table-1 depicted significant variation for days to harvesting among the accessions that differ from 139.67 days (RAUG-5 and G-323) to 148.00 days (RAUG-13) and grand mean was 145.01 days. Result also exhibited that there was no one accessions have been found earlier to harvest over the control cultivar (G-323) but similar result with RAUG-5 and at par with RAUG-12. Variation in the plant height, number of leaves per plant and crop duration is an important trait that may be utilized in the crossing programme by the plant breeders to transfer the characters from one genotype into others ones. Variation in these plant growth parameters have already been attributed by Hariom and Srivastava (1976) [9], Ahmed and Hoque (1986) [4], and Islam *et al*. (2004) [11] in garlic genotypes. Tripathy *et al.* (2013) [21] have also reported a handsome amount of variation among genotype of onion for plant height and number of leaves per plant.

Significant deviations were noticed among the lines pertaining to the polar and equatorial diameter of the individual bulbs (Table-1) which varied from 4.02-4.64 and 4.19-4.89 cm respectively. In both the cases the accession RAUG-5 performed better as compared to other lines and results at par with the control cultivar G-323 for both polar as well as equatorial diameter. The bulb diameter with respect to polar side was lowest (4.02 cm) in case of RAUG-15 and in case of equatorial was for RAUG-1 (4.19 cm). The length and width of the garlic bulb as provisionally indicated as polar and equatorial diameter of the bulb decides the economic size and an important parameter to study for various genotypes in garlic pertaining to crop improvement. Variation in bulb size have also been confirmation with the studied of Korla and Rastogy (1979) [14], Ahmed and Hoque (1686) [4] and Islam *et al.* (2004) [11] in garlic.

The accession of evaluated garlic lines under investigation produced bulbs in which the number of cloves per bulb and 10 cloves weight were observed to vary in a great extent from 17.00-36.80 and 3.55-7.80 g respectively. The greatest number of cloves per bulb (36.80) was counted for RAUG-18 and results parity with RAUG-5 (35.60) followed by RAUG-10 (33.00), however, lowest value was recorded for RAUG-8 with grand mean of 26.47. While significantly maximum weight with respect to average 10 cloves (7.80 g) was found also for RAUG-5 overall other germplasm investigated along with established variety G-323 (7.14 g). The least weight of 10 cloves (3.55 g) was weighed in case of RAUG-11. The number of cloves per bulb and average 10 cloves weight attributed to the yield potential of the accessions and varied from each other might be due to their differences in genetic configuration which was supported by Hariom and Srivastava (1976) [9], Korla and Rastogy (1979) [14], Moenir (1979) [16] and Andrade *et al.* (1982) [5] during comparing some selected variety/genotype of garlic. Regarding the average weight of bulb (Table-1) for different genotypes showed different from as low as 10.55 g (RAUG-3) results at par with RAUG-11 (10.56 g) and RAUG-14 (10.65 g) to as high as 20.78 g for RAUG-4 genotype while performance did not differed significantly with RAUG-5 (20.45 g), RAUG-16 (20.54 g) and RAUG-20 (20.52 g) followed by the control variety G-323 (19.64 g)used for standard check. Variations in bulb weight of garlic for different lines are in accordance with the finding of Agarwal and Tiwari (2013) [2] and Tripathy *et al.* (2013) [21]. It is also worthwhile to mention the report of Thompson and Kelly (1976) [20].

Yield, being complex quantitative traits depending upon various plant characteristics. It is the most important economic viable attribute that decide the acceptability of the variety on farmers' field with a sustainable manner for longer times. The different genotypes of garlic under studied had different yield potential pertaining to marketing yield as well as total yield (q/ha^{-1}) and were observed to vary from 20.10-76.05 and 24.60-82.80 qha^{-1}respectively, while the general mean was 48.24 and 52.90 qha^{-1}for marketable and total yield. In both the parameters i.e. marketable yield and total yield the genotype RAUG-5 performed better 76.05 and 82.80 qha^{-1} respectively over other accessions and results at par with RAUG-16 (75.90 qha^{-1}) and G-323 (74.90qha^{-1}) for marketable yield (Table 1). However, the significantly lowest value for both the traits 20.10 and 24.60 qha^{-1}respectively was observed for genotype RAUG-13 and similar digits had reflected for genotypes RAUG-11 for marketable yield. Variation in bulb yield among different genotypes might be attributed to their genetic makeup and ability for different in net assimilation rate resulting into production of photosynthates. The variations in the bulb yield of different genotypes of garlic have also been reported from several places (Bisht and Agarwal, 1996; Kaur *et al.* 1994; Agarwal and Tiwari, 2005; 2013) [8, 12, 2]. These finding were also close confirmation with the output of (Patil *et al.,* 1991; Bhonde *et al*., 1992, Khan, 1997; Mohanty and Prusty, 2002 and Tripathy *et al.,* 2013) [18, 7, 13, 17, 21] for different varieties of onion. Superiority of RAUG-5 garlic genotype has also been reported by Agarwal and Tiwari (2013) [2].

Conclusion

In the present scenario earliness and yield potential, a complex quantitative trait is the ultimate and prime object of most of the breeding programmes. Earliness in vegetable is highly desirable characters in any situation i. e. in terms of market price and in scarcity. Bulb and clove weight were positively correlated with yield. Thus in the light of experiment result and available literature the genotypes have significant influence on plant growth as well as yield, and its attributing characters. Among the twenty genotypes, RAUG-5 has greater ability to earliness and has capable to produce the bulb having more polar and equatorial diameter, average weight of 10 cloves and ultimately greater marketable and total yield. Considering yield potential and other desirable traits other than the superior genotypes RAUG-5, accessions RAUG-16, RAUG-12, RAUG-7and RAUG-4 are considered as a promising and can be selected preliminarily and might be used for further breeding trial for further crop improvement with a view to develop new varieties.

Table 1: Performance of garlic genotypes for growth, yield and yield contributing characters (Pooled of 2yrs)

Entry	PH (cm)	NOL	DTH	P (cm)	E (cm)	NOC	ABW (g)	AWC (g)	MY (q/ha)	TY (q/ha)
RAUG1	58.6	7.0	144.33	4.11	4.19	31.2	14	4.49	42.10	45.20
RAUG2	57.2	7.0	147.67	4.25	4.42	23.80	16	6.72	49.19	50.80
RAUG3	52.2	6.8	144.67	4.14	4.27	25.20	10	3.97	48.40	52.85
RAUG4	75.6	7.8	143.67	4.18	4.45	28.60	20	6.99	72.15	75.00
RAUG5	72.4	6.8	139.67	4.39	4.59	25.60	20	7.80	76.05	82.30
RAUG6	64.6	6.6	146.67	4.40	4.49	28.40	18	6.33	45.15	52.20
RAUG7	49.0	5.8	145.00	4.77	4.94	20.80	16	7.69	72.90	75.90
RAUG8	48.6	7.2	145.33	4.20	4.31	17.00	16	6.27	35.05	39.60
RAUG9	55.6	6.2	145.00	4.44	4.58	24.40	14	5.73	35.10	39.35
RAUG10	51.6	6.0	146.00	4.50	4.64	33.00	18	5.45	42.95	45.15
RAUG11	63.0	6.2	147.00	4.50	4.63	28.20	10	3.55	20.10	25.10
RAUG12	68.2	6.8	141.00	4.50	4.60	33.20	18	5.42	77.10	82.15
RAUG13	47.2	5.8	148.00	4.31	4.43	21.20	16	5.12	20.10	24.60
RAUG14	42.4	5.8	147.00	4.29	4.42	15.20	10	6.57	45.16	52.50
RAUG15	54.2	6.8	147.00	4.02	4.20	20.60	12	5.82	65.10	70.16
RAUG16	52.0	5.6	143.67	4.15	4.26	27.80	20	7.19	75.90	80.21
RAUG17	44.0	5.2	143.00	4.26	4.35	25.00	14	5.60	40.65	45.50
RAUG18	64.4	7.0	146.67	4.42	4.56	36.80	14	3.80	25.50	30.15
RAUG19	43.2	5.0	147.33	4.39	4.54	29.80	14	4.70	25.10	30.90
RAUG20	44.0	5.2	147.00	4.29	4.43	29.20	20	6.85	24.40	30.60
G-323(C)	57.7	6.4	139.67	4.62	4.80	30.71	19.64	7.14	74.90	80.87
SEM	0.64	0.32	0.85	0.10	0.09	0.43	0.33	0.08	0.58	0.55
CD (5%)	1.77	0.89	2.38	0.30	0.26	1.20	0.92	0.23	1.61	1.53
CV (%)	1.99	8.86	1.04	4.34	3.76	2.84	3.67	2.51	2.08	1.80

PH = Plant height, NOL = Number of leaves, DTH = Days to harvesting P = Polar diameter; E = Equatorial diameter, NOC = Number of cloves, ABW = Average bulb weight, AWC = Average Weight of 10 cloves MY = Marketable yield, TY = Total yield.

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