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Genotypic Response of Garlic (*Allium sativum* L.) to Different Dates of Sowing under Ecology of Bihar

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A B S T R A C T

The present experiment was conducted during winter (*Rabi*) season of 2018-19 at the research farm and the laboratory at Bihar Agricultural University, Sabour, Bhagalpur, and Bihar. The experiment comprised of five genotypes of garlic namely, BRG-13, BRG-14, BRG-1, G-1 and G-323 sown on three different dates of sowing10-10-2019, 25-10-2019 and 10-11-2011. Thus total numbers of treatment combinations were 15. The design of experiment was Split Plot Design and there were three replications. Observations were recorded treatment wise on growth and yield parameters like plant height, length of leaves, number of leaves per plant, width of leaf, shaft length, yield of bulb per plant, neck thickness, diameter of bulb, length of bulb, length of clove, weight of clove, width of clove and number of cloves and quality parameters like TSS and total phenol content. The data were analyzed statistically according to the method outlined by (Gomez and Gomez, 1984). Results showed that most of the treatments varied significantly with respect to different dates of planting and genotypes and also due to their interaction effect for growth, yield and quality parameters and that the genotype, BRG-13 was the best performer with respect to growth yield and quality when sown on first date of sowing.

Introduction

Garlic (*Allium sativum* L., 2n=16) belongs to the family Amaryllidaceae and is the second most widely used Allium next to onion. It had originated from Central Asia and Southern Europe especially the Mediterranean region. Garlic enjoys almost universal cultivation for its valuable bulb. Garlic has been found to have antibacterial, antiviral and antifungal activities. It also has several medicinal properties. The economic importance of the garlic crop has increased considerably in the entire world in recent years. They have a characteristic pungent and spicy flavour. The characteristic odour and pungent principle of garlic is due to diallyl disulphide. This is one of the important foreign exchange earner crops of India because of the good quality and quantity of garlic exported every year from the country.

Growth and development of garlic is greatly influenced by agricultural practices i.e.,

planting date; cultivar, fertilizer application and irrigation which in turn affect yield and bulb quality of garlic and at the same time garlic is known to be thermo and photo-sensitive crop (Jones and Mann, 1963) and its vegetative growth and bulb formation are greatly influenced by growing environment (Rahim and Fordham, 1988). The performance of garlic largely depends on the time of planting as the vegetative growth is encouraged under short day and cool temperature, while long day and high temperature is favourable for better bulb development (Subrata *et al.,* 2010). Therefore, planting time plays an important role on the growth and yield of garlic and this warrants systematic study in the area. The production of garlic can be greatly increased by identifying and adopting suitable genotypes for different dates of sowing Therefore the present study was planned with the objectives to study the effect of planting dates on growth, yield and quality performance of genotypes under the agro climatic zone of Bihar.

Materials and Methods

The field experiment on "Genotypic response of garlic to dates of planting and fertilizer levels" was conducted during winter (*Rabi*) season of 2018-19 at the research farm and the laboratory at Bihar Agricultural University, Sabour, Bhagalpur, Bihar. The weather condition prevailing during the period of investigation was close to normal for the place and could be termed congenial for growth and development of garlic. The soil of experimental plot was typically gangetic alluvial in origin. The plant materials comprised of five genotypes of garlic namely, BRG-13, BRG-14, BRG-1, G-1 and G-323 denoted as (V1, V2, V3, V4 and V5 respectively in the treatment combination in the experiment). These genotypes were selected out of the germplasm collection being maintained at the Department of Horticulture (Vegetable and Floriculture) BAU, Sabour. The garlic genotypes were sown on three different dates of sowing, viz., D1- 1st date of sowing (10-10-2019), D2-2nd date of sowing (25-10-2019) and D3-3rd date of sowing (10-11-2019). Thus total numbers of treatment combinations were 15. The design of experiment was Split Plot Design and there were three replications. Planting was done at spacing of 15 cm from row to row and 10 cm from plant to plant. Recommended package of practice was followed to raise the crop. Observations were recorded treatment wise on five randomly selected plants for growth and yield parameters like plant height (cm), neck thickness (cm), number of leaves per plant, length of leaves (cm), width of leaves (cm), yield per plant or average weight of bulb (g), diameter of bulb (cm), number of cloves per bulb, length of clove (cm), diameter of clove (cm) and average weight of clove (g). and quality parameters like TSS(^{o} Brix) and total phenol content (mg GAE /100g). The data were analyzed statistically according to the method outlined by Panse and Sukhatme (1984).

Results and Discussion

Results showed that most of the treatments varied significantly with respect to different dates of planting and genotypes and also due to their interaction effect for growth and yield parameters like plant height, length of leaves, number of leaves per plant, width of leaf, shaft length, yield of bulb per plant, neck thickness, diameter of bulb, length of bulb, length of clove, weight of clove, width of clove and number of cloves and quality parameters like TSS and total phenol content (Table 1-15).

The maximum plant height was recorded in genotype BRG-13 (48.76 cm) when sown on

the first date of sowing, i.e.,10th October (D1) and the minimum was observed in genotype G1 (33.86 cm) on the last date of sowing, i.e., on the 10th November (D3). Similar finding for plant height was also observed Alam *et al.,* (2010), Shuvra et.al (2017) in garlic. The beneficial influence on plant height due to early planting has also been reported by Qaryouts and Kasarawi (1995). The maximum leaf width was observed in genotype BRG-13 (1.70 cm) sown on the first date of sowing, i.e., 10th October (D1) and narrow in genotype G1 (0.99 cm) on the last date of sowing, i.e., D3. Similar variability trend for leaf width was also observed by Kowser *et al.,* (2019) in garlic. The maximum shaft length was observed in genotype genotype BRG-13 (3.19 cm) sown on the first date of sowing, i.e., 10th October (D1) and minimum in genotype BRG1 (2.29 cm) on the second date of sowing, 25th October i.e., D2. The highest length of leaf was observed in BRG-13 (42.78 cm) when sown on the first date of sowing, i.e., 10th October (D1) and the minimum was observed in genotype G1 (31.89 cm) on the last date of sowing, i.e., on the 10th November (D3). These results are in agreement with the works of Murmu *et al.,* (2018), Shuvra *et al.,* (2017) in garlic.

The maximum number of leaf was observed in BRG-14 (10.69 cm) when sown on the first date of sowing, i.e.,10th October (D1) and the minimum was observed in genotype G323 (6.57 cm) on the last date of sowing, i.e., on the 10th November (D3). The results of present study are similar to research of Alam *et al.,* (2010), EL-Zohiri *et al.,* (2014), in garlic. The highest neck thickness was observed in BRG-14 (0.81 cm) when sown on the first date of sowing, i.e.,10th October (D1) and the minimum was observed in genotype GBR1 (0.62 cm) on the last date of sowing, i.e., on the 10th November (D3). Similar results have been observed by Mishra *et al.,* (2013), EL-Zohiri *et al.,* (2014), Ahmad *et al.,* (2018) in garlic. Such results may be due to the fact that earliest plantation encourage meristimatic elongation and cell division which encourage the vegetative growth of the plants that received low temperature and short day length. The results are in agreement with those reported by Sultana *et al.,* (1997) and Rahim *et al.,* (1984). This result may also be due to genetic variation of garlic genotype. More favorable temperature conditions when growing garlic in the planting date of 10th October gave adequate vegetative growth of plants

The genotype, BRG-233 was recorded maximum equilateral diameter of bulb (5.64 cm) when sown on the first date of sowing, i.e., 10th October (D1) and the minimum was observed in genotype G1 (4.11 cm) on the last date of sowing, i.e., on the 10th November (D3). The results of present study are quite similar with research of Lammerink (1989, Alam *et al.,* (2010), Shuvra *et al.,* (2017), Ahmad *et al.,* (2018) are in close approximation with the result of the present investigation in garlic crop. The maximum polar diameter of bulb was observed in genotype BRG-13 (3.84cm) when sown on the first date of sowing, i.e., 10th October (D1) while the same genotype performed the minimum when (2.70 cm) when sown on the on the last date i.e., on the 10th November (D3). These results are in close approximation with the result of Alam *et al.,* (2010), Shuvra *et al.,* (2017) in garlic.

The highest weight of bulb yield per plant was observed in BRG-13(34.40 g) when sown on the first date of sowing, i.e., 10th October (D1) and the minimum was observed in genotype G1 (20.85 cm) on the last date of sowing, i.e., on the 10th November (D3).The results of present study are quite similar with research of EL- Zohiri et.al (2014), Shuvra *et.al* (2017), Ahmad *et al.,* (2018) in garlic.

Table1 Effect of different date and variety on plant height (cm)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG-13	48.76	47.40	46.93	**47.70**
V2- BRG-14	48.01	46.24	43.63	**45.96**
V3- BRG-1	47.16	42.65	43.18	**44.33**
V4- G1	44.25	37.37	33.86	**38.49**
V5- G-323	47.22	39.93	37.82	**41.66**
Mean	**47.08**	**42.72**	**41.08**	**43.63**
	Sem(±)	**CD**		
D(date of planting)	0.5822	2.2856		
V(variety)	0.7487	2.1849		
V at same D	1.2968	4.0473		
D at same V	1.2978	4.0505		
C.V (%)	**(a)** 5.17	(b)5.15		

Table.2 Effect of different date and variety on leaf width (cm)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	1.70	1.29	1.18	**1.39**
V2- BRG-14	1.49	1.22	1.11	**1.28**
V3- BRG-1	1.35	1.22	1.02	**1.20**
V4- G1	1.31	1.11	0.99	**1.14**
V5- G-323	1.33	1.20	1.02	**1.18**
Mean	**1.44**	**1.21**	**1.07**	**1.24**
	Sem(±)	**CD**		
D(date of planting)	0.0274	0.1077		
V(variety)	0.0221	0.0645		
V at same D	0.0383	0.1267		
D at same V	0.0439	0.1453		
C.V (%)	(a)8.59	(b)5.36		

Table.3 Effect of different date and variety on shaft length (cm)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	3.19	2.50	2.54	**2.74**
V2- BRG-14	2.75	2.58	2.61	**2.65**
V3- BRG-1	2.57	2.29	2.89	**2.58**
V4- G1	2.47	2.38	2.45	**2.43**
V5- G-323	2.35	2.63	2.87	**2.62**
Mean	**2.67**	**2.48**	**2.67**	**2.60**
	Sem(±)	**CD**		
D(date of planting)	0.0379	0.1489		
V(variety)	0.0621	0.1814		
V at same D	0.1076	0.3287		
D at same V	0.1035	0.3160		
C.V (%)	(a)5.64	(b)7.16		

Table.4 Effect of different date and variety on leaf length (cm)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	42.78	41.73	39.95	**41.49**
V2- BRG-14	40.70	40.69	38.25	**39.88**
V3- BRG-1	39.14	39.14	35.69	**37.99**
V4- G1	36.87	36.80	31.89	**35.19**
V5- G-323	39.09	39.09	34.30	**37.49**
Mean	**39.72**	**39.49**	**36.02**	**38.41**
	Sem(±)	**CD**		
D(date of planting)	0.7711	3.0272		
V(variety)	0.8339	2.4336		
V at same D	1.4444	NS		
D at same V	1.5045	NS		
C.V (%)	(a)7.77	(b)6.51		

Table5 Effect of different date and variety on number of leaf

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	9.95	9.89	10.06	**9.97**
V2- BRG-14	10.69	9.65	9.75	**10.03**
V3- BRG-1	9.04	7.66	8.62	**8.44**
V4- G1	9.98	8.06	7.20	**8.41**
V5- G-323	9.72	7.89	6.57	**8.06**
Mean	**9.88**	**8.63**	**8.44**	**8.98**
	Sem(±)	**CD**		
D(date of planting)	0.2514	0.9869		
V(variety)	0.2595	0.7574		
V at same D	0.4495	1.4391		
D at same V	0.4742	1.5181		
C.V (%)	(a)10.84	(b)8.67		

Table.6 Effect of different date and variety on neck thickness (cm)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	0.81	0.77	0.74	**0.77**
V2- BRG-14	0.79	0.78	0.72	**0.76**
V3- BRG-1	0.73	0.71	0.62	**0.69**
V4- G1	0.76	0.69	0.63	**0.69**
V5- G-323	0.76	0.67	0.63	**0.69**
Mean	**0.77**	**0.72**	**0.67**	**0.72**
	Se m(±)	**CD**		
D(date of planting)	0.0087	0.0343		
V(variety)	0.0122	0.0357		
V at same D	0.0212	NS		
D at same V	0.0209	NS		
C.V (%)	(a)4.70	(b)5.10		

Table.7 Effect of different date and variety on equilateral diameter of bulb (cm)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	4.92	4.81	4.72	**4.82**
V2- BRG-14	4.76	4.49	4.36	**4.54**
V3- BRG-1	4.68	4.35	4.36	**4.46**
V4- G1	4.60	4.13	4.11	**4.28**
V5- G-323	5.64	4.34	4.37	**4.78**
Mean	**4.92**	**4.42**	**4.38**	**4.58**
	Sem(±)	**CD**		
D(date of planting)	0.1159	0.4552		
V(variety)	0.1346	**NS**		
V at same D	0.2331	**NS**		
D at same V	0.2385	**NS**		
C.V (%)	(a)9.81	(b)8.82		

Table.8 Effect of different date and variety on polar diameter of bulb (cm)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	3.84	3.12	2.70	**3.22**
V2- BRG-14	3.52	3.15	3.02	**3.23**
V3- BRG-1	3.33	2.99	2.92	**3.08**
V4- G1	3.22	2.98	2.76	**2.99**
V5- G-323	3.15	3.04	2.75	**2.98**
Mean	**3.41**	**3.06**	**2.83**	**3.10**
	Sem(±)	**CD**		
D(date of planting)	0.0660	0.2590		
V(variety)	0.0590	0.1721		
V at same D	0.1021	**NS**		
D at same V	0.1127	**NS**		
C.V (%)	(a)8.24	(b)5.71		

Table.9 Effect of different date and variety on weight of bulb (g)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	34.40	31.61	30.45	**32.15**
V2- BRG-14	33.44	31.14	29.87	**31.48**
V3- BRG-1	31.43	29.93	27.57	**29.64**
V4- G1	31.03	26.74	20.85	**26.21**
V5- G-323	31.83	29.61	25.78	**29.07**
Mean	**32.43**	**29.81**	**26.90**	**29.71**
	Sem(±)	**CD**		
D(date of planting)	1.0246	4.0223		
V(variety)	0.5062	1.4773		
V at same D	0.8768	3.1158		
D at same V	1.2902	4.5851		
C.V (%)	(a)13.35	(b)5.11		

Table.10 Effect of different date and variety on weight of cloves (g)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	0.95	0.77	0.81	**0.85**
V2- BRG-14	0.84	0.81	0.78	**0.81**
V3- BRG-1	0.81	0.78	0.78	**0.79**
V4- G1	0.78	0.74	0.74	**0.75**
V5- G-323	0.78	0.77	0.77	**0.77**
Mean	**0.83**	**0.78**	**0.77**	**0.79**
	Sem(±)	**CD**		
D(date of planting)	0.0125	0.0489		
V(variety)	0.0169	0.0492		
V at same D	0.0292	**NS**		
D at same V	0.0289	**NS**		
C.V (%)	(a) 6.07	(b) 6.37		

Table.11 Effect of different date and variety on clove length (cm)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	3.87	3.10	2.41	**3.13**
V2- BRG-14	3.83	3.36	2.36	**3.18**
V3- BRG-1	3.51	2.74	2.35	**2.86**
V4- G1	2.98	2.36	2.20	**2.51**
V5- G-323	3.36	2.63	2.31	**2.76**
Mean	**3.51**	**2.84**	**2.32**	**2.89**
	Sem(±)	**CD**		
D(date of planting)	0.0662	0.2598		
V(variety)	0.0664	0.1939		
V at same D	0.1151	0.3697		
D at same V	0.1223	0.3931		
C.V (%)	(a) 8.87	(b) 6.90		

Table.12 Effect of different date and variety on clove width (cm)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	1.07	0.82	0.81	**0.90**
V2- BRG-14	0.96	0.91	0.81	**0.89**
V3- BRG-1	0.92	0.85	0.78	**0.85**
V4- G1	0.90	0.85	0.79	**0.85**
V5- G-323	0.90	0.87	0.79	**0.85**
Mean	**0.95**	**0.86**	**0.80**	**0.87**
	Sem(±)	**CD**		
D(date of planting)	0.0091	0.0358		
V(variety)	0.0151	0.0441		
V at same D	0.0262	**NS**		
D at same V	0.0251	**NS**		
C.V (%)	(a) 4.07	(b) 5.22		

Table.13 Effect of different date and variety on number of clove

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	47.15	45.15	45.02	**45.77**
V2- BRG-14	45.72	44.90	43.94	**44.85**
V3- BRG-1	44.89	43.57	41.15	**43.21**
V4- G1	39.72	43.79	37.08	**40.20**
V5- G-323	43.92	43.80	38.87	**42.20**
Mean	**44.28**	**44.24**	**41.21**	**43.25**
	Sem(±)	**CD**		
D(date of planting)	0.6474	2.5417		
V(variety)	0.8135	2.3742		
V at same D	1.4091	NS		
D at same V	1.4169	NS		
C.V (%)	(a) 5.80	(b) 5.64		

Table.14 Effect of different date and variety on total soluble solids (degree Brix)

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019	Mean
V1- BRG13	38.94	38.43	36.60	**37.99**
V2- BRG-14	37.22	36.46	36.49	**36.72**
V3- BRG-1	37.15	36.19	36.25	**36.53**
V4- G1	36.96	36.90	29.13	**34.33**
V5- G-323	38.02	36.29	33.58	**35.96**
Mean	**37.66**	**36.85**	**34.41**	**36.31**
	Sem(±)	**CD**		
D(date of planting)	0.6076	2.3853		
V(variety)	0.6997	2.0420		
V at same D	1.2120	NS		
D at same V	1.2427	NS		
C.V (%)	(a) 6.48	(b) 5.78		

Table.15 Effect of different date and variety on total phenol (µg GAE/g) in bulb

	D1: 10-10-2019	D2: 25-10-2019	D3: 10-11-2019
V1- BRG13	0.64	0.62	0.63
V2- BRG-14	0.64	0.63	0.63
V3- BRG-1	0.62	0.61	0.61
V4- G1	0.61	0.60	0.58
V5- G-323	0.62	0.63	0.59
Mean	**0.63**	**0.62**	**0.61**
	Sem(±)	**CD**	
D(date of planting)	0.0058	NS	
V(variety)	0.0097	0.0284	
V at same D	0.0169	NS	
D at same V	0.0162	NS	
C.V (%)	(a) 3.66	(b) 4.74	

The maximum average weight of cloves was obtained in BRG-13 (0.95 g), when sown on the first date of sowing, i.e.,10th October (D1) and the minimum was observed in genotype G1 (0.74 cm) on the last date of sowing, i.e., on the 10th November (D3). Variation in yield amongst the varieties was also reported by Ahmad *et al.,* (2018), Lammerink (1989) in garlic crop.

The maximum clove length was exhibited in BRG-14 (3.87cm), when sown on the first date of sowing, i.e.,10th October (D1) and the minimum was observed in genotype G1 (2.20 cm) on the last date of sowing, i.e., on the 10th November (D3). The results are in close approximation of results of Ahmad *et al.,* (2018) in garlic crop.

The maximum clove width was recorded in BRG-13 (1.07cm), when sown on the first date of sowing, i.e.,10th October (D1) and the minimum was noticed in genotype BRG1 (0.78 cm) on the last date of sowing, i.e., on the 10th November (D3). The results of present study are quite similar with research of width of clove of garlic was also observed Ahmad *et al.,* (2018) in garlic crop.

The maximum number of clove per bulb was observed in genotype BRG-13(47.15) when sown on the first date of sowing, i.e.,10th October (D1) and the minimum was noticed in genotype G1 (37.08 cm) on the last date of sowing, i.e., on the 10th November (D3). This conclusions are similar with Ahmad *et al.,* (2018), Shuvra *et al.,* (2017), Alam *et al.,* (2010) in garlic.

The maximum amount of total soluble solid was noticed in genotype BRG-13 (38.94°Brix), when sown on the first date of sowing, i.e.,10th October (D1) and the minimum was noticed in genotype G1 (29.13cm) on the last date of sowing, i.e., on the 10th (D3). The results of present study are quite similar with research of Chen *et al.,* (2013) in garlic.

The maximum amount of total phenol in cloves was obtained in BRG-13 and BRG-14 (0.64µgGAE /g), when sown on the first date of sowing, i.e., 10th October (D1) and the minimum was noticed in genotype G1 (0.58µg GAEacid/g) sown on the last date of i.e., on the 10th November (D3). This finding is similar research of Ahmad *et al.,* (2018), Chen *et al.,* (2013) in garlic.

Thus it was observed that time of planting had significant effect on bulb diameter, bulb yield, clove weight and length and width of cloves, number of cloves per bulb. Early planting i.e., 10th October produced highest values of all yield related traits. Late planting (November, 10th) gave the lowest values for most yield traits. Bulb size and yield influenced by growth environment, cultivar and production year has also been reported. The results of this study are in agreement with Rahim, (1988) who showed that delay planting time reduced significantly the number of cloves and clove size. It may be due to that plant did not receive a long cool growing period which was essential for the development of the bulb (Swati *et al.,* 2013). This result may also be due to genetic variation of garlic genotypes and their interaction effect due to environment.

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