Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(1): 1054-1056
Received: 14-11-2018
Accepted: 17-12-2018

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Influence of planting time and spacing for growth and yield of garlic (*Allium sativum* L.)

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Abstract
The planting time and spacing between rows of plants is the important factor that affects the growth and yield of garlic. For the experiment treatments was consisted five levels of intra spacing (10x10, 4x10, 8x10, 12x10, 16x10 cm) at three different date of planting (7th December, 14th December and 21th December in 2016) following randomized complete block design in a factorial arrangement with three replications of garlic viz. Gangajali. The early 12th December of planting with spacing 12 x 10 cm was found for increase bulb weight, bulb diameter in respect of higher bulb yield. Early planting of garlic produced large sized bulbs resulting in the increased weight. Yield in garlic decreased significantly with delay in planting with closes spacing.

Keywords: Garlic, spacing, planting date, yield

Introduction
Garlic is one of the most ancient cultivated herbs and it is vegetative propagated by cloves and widely cultivated spice crops used for food as well as medicinal purposes (Diriba *et al.*, 2013) [1]. It has a characteristic of pungency. It adds to taste of foods as well as it helps to make them digestible. Garlic contains different essential minerals, vitamins and many other substances used for health of human beings. It is rich in sugar, protein, fat, calcium, potassium, phosphorous, sulfur, iodine fiber and silicon in addition to vitamins. Furthermore, garlic has miracle pharmaceutical effects and used to cure an enormous disease including blood pressure and cholesterol, cancer, hepatoprotective, antihelmentics, antiinflammatory, antioxidant, antifungal and wound healing, asthma, arthritis, sciatica, lumbago, backache, bronchitis, chronic fever, tuberculosis, rhinitis, malaria, obstinate skin disease including leprosy, leucoderma, discoloration of the skin and itches, indigestion, colic pain, enlargement of spleen, piles, fistula, fracture of bone, gout, urinary diseases, diabetes, kidney stone, anemia, jaundice, epilepsy, cataract and night blindness as mentioned by (Azene and Mengesha, 2015) [8]. Planting larger cloves of garlic will produce larger bulbs than planting smaller cloves. The size bulbs harvested is directly related to the size of cloves planted and the spacing of plants. Spacing between rows of plants is another factor that affects the growth and yield of the crop. Among different factors influencing production of the crop, date of planting and plant densities are considered important, which can be manipulated to boost up the productivity. A number of studies in various parts of the world have shown that garlic production can be improved through proper spacing. It is known that among yield influencing factors under normal conditions, date of planting and plant density are the main factors which greatly influence the growth, yield and quality of garlic crop (Kilgori *et al.*, 2007) [2]. The present study was an attempt to identify suitable planting date and optimum intra row spacing of garlic for maximum growth and yield performance.

Materials and Methods
The experiment was conducted at Instructional farm, RRS, UBKV, Majhian, Dakshin Dinajpur, W.B, India. The treatments consisted of five levels of intra spacing (10x10, 4x10, 8x10, 12x10, 16x10 cm) at three different date of planting (7th December, 14th December and 21th December in 2016) with plot size- 2m x 1.5m. The experiment was laid out as a randomized complete block design in a factorial arrangement with three replications using variety (Gangajali) of garlic. The experimental plot was ploughed, well prepared and used recommended dose of fertilizers. Irrigation and weeding were done whenever necessary. The experimental plot was regularly observed and the data were recorded on growth and yield attributing traits. The statistical analysis of experimental data utilized the ANOVA program was done on SPSS 16.0 software.

Results and discussion

Analysis of variance showed significant difference with different dates of planting with different spacing and interaction between these for all the yield characteristics except plant height and leaf length of garlic variety viz. Gangajali (Table 1). The interaction of dates of planting and plant spacing significantly influenced the plant height of garlic. Maximum plant height (25.17 cm) was recorded in planting of 14th December with normal spacing 10×10 cm, while minimum plant height (19.16 cm) in 21th December of planting with spaced 16×10 cm. The growth parameter such as leaf number (4.74), leaf length (21.62 cm) and leaf breadth (1.18 cm) was recorded better in early planting with normal spacing of 10×10 cm. On the other hand, yield parameter such as maximum bulb weight (11.60 g) and bulb size (3.50 cm) was recorded in 14th December of planting with spaced 12×10 cm, while crop spacing maintain with 4×10 cm significantly reduce their weight and size of bulb. Therefore, early planting of garlic produced large sized bulbs resulting in the increased weight. These findings are also supported with the reports of (Rahim *et al.*, 1984; Sultana *et al.*, 1997; Islam *et al.*, 1998) [4, 10, 9]. The interaction of dates of planting and plant spacing significantly influenced the yield of garlic. Crop planted on 14th December recorded maximum bulb yield (1.13 kg plot^{-1}) when compared to other dates of planting with 12×10 cm spacing. Bulb diameter and bulb weight also might have influenced the bulb yield. The plant spacing significantly increase bulb size, bulb weight and yield (Mohammad *et al.*, 2001; Singh *et al.*, 2010; Alam *et al.*, 2010; Naruka and Dhaka, 2001) [3, 5, 6, 7]. Maximum yield in early planting could be attributed to better growth of plants and large sized bulb and also the enhanced crop growth rate which might have resulted in efficient metabolism, there by increased the sink capacity.

Table 1: Effect of different spacing on different dates of planting in garlic var. Gangajali ANOVA

Source of Variation	DF	Plant height (cm)	Leaf no.	Leaf length (cm)	Leaf breadth (cm)	Bulb weight (gm)	Bulb diameter (cm)	Yield plot^{-1} (kg)	Yield ha^{-1} (t)
Factor A	2	32.472	0.523	3.834	0.168	4.849	0.502	0.025	0.342
Factor B	4	10.608	0.153	9.405	0.431	15.389	0.267	0.087	1.016
Interaction A X B	8	4.717	0.086	2.922	0.098	1.481	0.049	0.009	0.105
Error	28	8.635	0.180	5.614	0.004	0.114	0.026	0.002	0.027

Table 2: Two ways mean of growth and yield of garlic

	Plant height (cm)						Leaf number plant^{-1}					
Date of planting	**4 ×10 cm**	**8×10 cm**	**12×10 cm**	**16 ×10 cm**	**10 ×10 cm (normal)**	**Mean A**	**4 ×10 cm**	**8×10 cm**	**12×10 cm**	**16 ×10 cm**	**10 ×10 cm**	**Mean A**
7 Dec	23.22	22.11	22.46	22.89	24.00	22.94	4.73	4.20	4.67	4.47	4.47	4.51
14 Dec	20.93	22.08	22.23	20.45	25.17	22.17	4.73	4.40	4.67	4.50	4.74	4.61
21 Dec	20.93	20.24	19.52	19.16	20.63	20.09	4.47	4.40	4.20	4.27	3.90	4.25
Mean B	21.36	21.14	21.41	20.50	23.26		4.64	4.33	4.51	4.44	4.34	
Factors	**C.D.**		**SE(d)**		**SE(m)**		**C.D.**		**SE(d)**		**SE(m)**	
Factor (A)	2.209		1.073		0.759		N/A		0.155		0.109	
Factor (B)	N/A		1.385		0.979		N/A		0.200		0.141	
Factor (AX B)	N/A		2.399		1.697		N/A		0.346		0.245	

	Leaf length						Leaf breadth					
Date of planting	**4 ×10 cm**	**8×10 cm**	**12×10 cm**	**16 ×10 cm**	**10 ×10 cm**	**Mean A**	**4 ×10 cm**	**8×10 cm**	**12×10 cm**	**16 ×10 cm**	**10 ×10 cm**	**Mean A**
7 Dec	18.80	16.27	18.32	17.82	18.33	17.91	0.57	0.82	1.24	1.23	1.28	1.02
14 Dec	17.73	17.61	18.57	17.65	21.62	18.64	0.71	0.84	0.95	1.15	1.40	1.08
21 Dec	18.38	17.50	16.95	16.39	19.10	17.66	0.76	0.85	0.86	0.89	0.98	0.87
Mean B	18.31	17.13	17.94	17.29	19.69		0.68	0.84	1.02	1.09	1.19	
Factors	**C.D.**		**SE(d)**	**SE(m)**		**C.D.**	**SE(d)**			**SE(m)**		
Factor (A)	N/A		0.865	0.612		0.048	0.023			0.017		
Factor (B)	N/A		1.117	0.790		0.062	0.030			0.021		
Factor (AX B)	N/A		1.935	1.368		0.108	0.052			0.037		

	Bulb weight (gm)						Bulb diameter					
Date of planting	**4 ×10 cm**	**8×10 cm**	**12×10 cm**	**16 ×10 cm**	**10 ×10 cm**	**Mean A**	**4 ×10 cm**	**8×10 cm**	**12×10 cm**	**16 ×10 cm**	**10 ×10 cm**	**Mean A**
7 Dec	7.83	8.81	11.46	10.80	11.40	10.06	2.84	3.04	3.20	3.23	3.27	3.12
14 Dec	9.90	10.10	11.60	11.50	10.50	10.72	3.00	3.10	3.50	3.50	3.10	3.24
21 Dec	7.50	8.20	10.30	11.50	10.44	9.59	2.70	2.70	3.00	2.90	3.10	2.88
Mean B	8.41	9.04	11.12	11.27	10.78		2.85	2.95	3.23	3.21	3.16	
Factors	**C.D.**		**SE(d)**		**SE(m)**		**C.D.**		**SE(d)**		**SE(m)**	
Factor (A)	0.254		0.124		0.087		0.122		0.059		0.042	
Factor (B)	0.328		0.159		0.113		0.157		0.076		0.054	
Factor (AX B)	0.569		0.276		0.195		N/A		0.132		0.093	

	Yield plot^{-1} (kg)						Yield (t ha^{-1})					
Date of planting	**4 ×10 cm**	**8×10 cm**	**12×10 cm**	**16 ×10 cm**	**10 ×10 cm**	**Mean A**	**4 ×10 cm**	**8×10 cm**	**12×10 cm**	**16 ×10 cm**	**10 ×10 cm**	**Mean A**
7 Dec	0.75	1.05	1.02	0.93	1.04	0.96	2.51	3.48	3.68	3.10	3.47	3.19
14 Dec	0.96	1.11	1.13	0.90	1.05	1.05	3.20	3.70	3.71	3.00	3.50	3.42
21 Dec	0.84	0.96	1.05	0.84	1.06	0.95	2.80	3.20	3.50	2.70	3.50	3.14
Mean B	0.85	1.04	1.09	0.89	1.05		2.84	3.46	3.53	2.93	3.49	
Factors	**C.D.**		**SE(d)**		**SE(m)**		**C.D.**		**SE(d)**		**SE(m)**	
Factor (A)	0.037		0.018		0.013		0.124		0.060		0.043	
Factor (B)	0.048		0.023		0.017		0.161		0.078		0.055	
Factor (AX B)	0.083		0.041		0.029		0.278		0.135		0.095	

Conclusion

The result of the experiment revealed significant difference among interspacing different date of planting and it can be concluded early planting with spacing 12 x 10 cm was found for increase bulb weight, bulb diameter in respect of higher bulb yield. It is also found early planting, plants attained higher vegetative growth, which possibly led to the development of the largest bulbs.

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