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EFFECT OF PLANTING TIME AND PLANT DENSITIES ON YIELD AND YIELD CONTRIBUTING CHARACTERS IN GRLIC (*ALLIUM SATIVUM* L.) Cv. JAMNAGAR

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Abstract

Different plant population densities and planting time on yield and yield contributing characters of garlic was investigated using split plot design with four planting dates and six plant densities. Significant differences in bulb weight, number of cloves per bulb, size of clove, yield per plant and yield per ha were recorded due to planting time, plant densities and their interaction. Planting of garlic on 1st November recorded significantly higher yields and delayed plantings reduced the yield further. The highest bulb yield (88.75 q/ha) was recorded when planting was done on 1st November. The lowest yield was obtained from 15th December (62.71 q/ha) planting. Higher plant density with 900 plants/plot spaced with 10 × 5 cm yielded 109.51 q/ha. The lowest yield (57.41 q/ha) was obtained with 300 plants/plot spaced with 20 × 7.5 cm. The bulb characters like bulb weight, number of cloves/bulb, size of clove were recorded to be the highest with early planting on 1st November with lower plant population of 300 plants/plot spaced with 20 × 7.5 cm.

Key words : Garlic, planting time, planting density, yield.

Introduction

Garlic (*Allium sativum* L.) is an important spice and condiment crop of India. Garlic requires moderately cool climate. Too cold and too hot conditions are not suitable for satisfactory growth of the plant. Planting of garlic too early or too late results in very poor growth and yield. Rahim *et al*. (1984) and Hari Om and Shrivastava (1979) reported that the time of planting is most important factor for obtaining vigour and highest yield of garlic. Same way plant population per unit area markedly influences its productivity. Bulb yield per unit area in the vegetable is comparatively low, which can be enhanced by standardization of cultural practices amongst, which planting date and plant population play a major role. Farmers have experience regarding some cultural aspects of garlic, but the vigour and yield are low due to lack of technical know-how particularly time of planting and plant density. By keeping in view the above aspect as a gap, the present study has been undertaken.

Materials and Methods

The experiment was conducted under irrigated conditions at Model Orchard, College of Horticulture, Rajendranagar, Hyderabad during 2011-2012 in late *rabi* season. The main objectives of the trial were to find out the performance of six plant densities 10 × 5 cm (900 plants/plot), 15 × 5 cm (600 plants/plot), 20 × 5 cm (450 plants/plot), 10 × 7.5 cm (600 plants/plot), 15 × 7.5 cm (400 plants/plot) and 20 × 7.5 cm (300 plants/plot) on four dates of planting 1st November, 15th November, 1st December, and 15th December. The experiment was laid out in split-plot design with three replications. The plot size was kept 3 m × 1.5 m for each treatment. Fertilizers were applied at the rates of 125: 62.5 and 62.5 kg per hectare in the form of urea, single super phosphate and muriate of potash, respectively. Besides, 25 tonnes of FYM per hectare were applied before final land preparation. At planting, 50% of nitrogen and entire quantity of phosphorus and potash were applied as basal dose and mixed thoroughly in the soil. Remaining 50% of nitrogen was top dressed after four weeks of planting. All the cultural and management practices like hoeing, weeding, irrigation and sprays for insect pests and disease control etc were carried out uniformly for all treatments.

Data on bulb weight (g), number of cloves/bulb, size of clove (cm), yield/plant (g) and yield/ha (q) were subjected to statistical analysis using split-plot design and ANOVA technique suggested by Panse and Sukhatme (1985).

Results and Discussion

Number of days taken to reach maturity

When garlic was planted on 1st November recorded highest number of days taken to reach maturity (124.94) (table 1), while minimum number of number of days (99.55) taken to reach maturity was recorded in 15th December planting. The plants might have received favourable climatic conditions include temperature, humidity and day length, which resulted (33.0ºC maximum and 15.4ºC minimum temperature, 73% humidity) in optimum time to reach maturity in early planting, while the maturity period was reduced in late sowings because of unfavorable conditions like very high temperatures. The plants are exposed to increasing high temperatures before bulb initiation and during growth and development in the period from February to April as a result the maturity period was reduced in later plantings. Similar trend was observed by Jamroz *et al*. (2001).

The days taken to reach maturity was significantly influenced by different plant densities. At final harvest maximum days taken to reach maturity (121.82) (table 1) was recorded with the plant density 300 plants/plot with spacing of 20 × 7.5 cm. But days taken to reach maturity was minimum (110.72) in the crop with higher density 900 plants/plot with spacing of 10 × 5 cm. This could be due to reduction in competition amongst seedlings which attributed better environmental condition enabling availability of more moisture, nutrients and light for crop growth in reduced plant density. While all above conditions are not available in higher density, hence require less number of days to reach maturity.

The interaction of dates of planting and plant densities significantly influenced the days taken to reach maturity (table 2).

Shoot to bulb ratio

The shoot to bulb ratio differed significantly by different planting dates. Plants which were planted on November 1st recorded maximum shoot to bulb ratio (0.51) (table 1), while minimum shoot to bulb ratio (0.27) was obtained from the plants, which were planted on December 15th. The results are mainly based on weight of shoot and bulb, as the shoot and bulb weights differed with planting dates.

Plant density also showed significant effect in shoot to bulb ratio. Shoot to bulb ratio recorded to be maximum (0.46) (table 1) in closer spacing with higher density 900 plants/plot with spacing of 10 × 5 cm. Minimum shoot to bulb ratio was recorded (0.27) in wider spacing with lower density 300 plants/plot with spacing of 20 × 7.5 cm. This might be depending on shoot weight and bulb weight.

The interaction of dates of planting and plant densities significantly influenced the shoot to bulb ratio. However, the maximum value (0.59) (table 2) was recorded in 1st November planting with 900 plants/plot spaced 10 × 5 cm. Minimum value (0.17) was recorded with 15th December planting with 300 plants/plot spaced 20 × 7.5 cm. This could be attributed to the enhanced availability of nutrients at the appropriate time which encouraged good vegetative growth. The growth ultimately enhances the production of bulbs resulting in decrease of shoot to bulb ratio.

Bulb weight

Data in table 1 revealed that maximum bulb weight (19.59 g and 7.64 g of both fresh weight and cured weight, respectively) were obtained when crop planted on 1st November. Minimum bulb weights of fresh and cured (14.82g and 5.72 g, respectively) obtained from crop planted late on 15th December. The increase in bulb weight might be due to vigorous growth in garlic means production of more of leaves, which helped in the synthesis of more photosynthates and thus resulting in increased accumulation of carbohydrates and other metabolites which ultimately determined the weight of bulbs. Late planted crops put forth poor vegetative growth, thus causing reduced photosynthetic activity due to lesser foliage area which might have resulted in lower bulb weight. These results are in confirmity with the findings of Singh *et al*. (2010) in garlic, Izquierdo *et al*. (1981) in onion that whose results also supported that early planting result in higher bulb weight.

Bulb weight was increased with increase in plant spacing and decrease in plant population. At final harvest, lower density with 300 plants/plot with spacing of 20 × 7.5 cm resulted in production of maximum bulb weight (22.09 g fresh weight and 8.61 g cured weight) (table 1), while it was minimum (14.26 g fresh weight and 5.47 g cured weight) in higher plant population of 900 plants/plot with spacing of 10 × 5 cm. Mainly due to reduction in competition among seedlings and also greater spacing helped the individual plant to utilize more resources like soil water, nutrition, air and light to put up better growth of leaves and bulb weight through higher photosynthetic efficiency. These results are similar to Purewal and Dargan (1961) in garlic, Akoun (2004), Lokesh *et al*. (2000) in onion. They also reported that the lower density resulted in higher bulb weight.

The interaction of dates of planting and plant densities significantly influenced the bulb weight. At harvest, bulb weight was maximum (24.40 g fresh weight and 9.52 g

Table 1: Effect of planting date and plant densities on yield contributing characters of garlic

Treatment	Bulb weight (g)		No. of cloves/bulb	Size of clove (cm)		Days taken for Maturity	Shoot to bulb ratio
	F.W	C.W		L	G		
Dates of planting							
1st November	19.59	7.64	17.00	2.46	1.09	124.94	0.51
15th November	18.69	7.29	16.07	2.38	0.99	121.47	0.39
1st December	15.63	6.10	14.83	2.24	0.91	119.69	0.31
15th December	14.82	5.72	13.67	2.13	0.83	99.55	0.27
SEm±	0.346	0.158	0.472	0.082	0.029	4.553	0.046
C.D at 5%	0.847	0.385	1.163	0.202	0.070	11.141	0.113
Plant densities							
10 × 5 cm (900 plants/plot)	14.26	5.47	10.84	1.98	0.70	110.75	0.46
15 × 5 cm (600 plants/plot)	15.25	5.95	14.58	2.10	0.80	113.89	0.44
20 × 5 cm (450 plants/plot)	15.43	6.02	15.49	2.24	0.90	116.84	0.39
10 × 7.5 cm (600 plants/plot)	16.65	6.49	16.59	2.34	0.99	116.42	0.36
15 × 7.5 cm (400 plants/plot)	19.42	7.58	16.95	2.45	1.12	118.76	0.31
20 × 7.5 cm (300 plants/plot)	22.09	8.61	17.91	2.69	1.20	121.82	0.27
S.Em.±	0.502	0.203	0.365	0.064	0.038	2.437	0.034
C.D. at 5%	1.015	0.410	0.738	0.129	0.076	4.925	0.069

F.W - Fresh weight, C.W - Cured weight, L- Length, G - Girth.

cured weight) in 1st November planting with 300 plants/plot spaced 20 × 7.5 cm (table 2).

Number of cloves per bulb

The number of cloves per bulb was significantly higher in early date of planting recording maximum (17.00) in crop planted on 1st November (table 1). Minimum number of cloves per bulb was recorded in 15th December planted crop (13.67). It was mainly due to prevalence of optimum climatic conditions during initial stage resulted in increased bulb weight it results in increased number of cloves/bulb, as such both have direct relationship with yield. Similar results were observed by Singh and Phogat (1989) in garlic.

Plant densities showed marked effect in increasing the number of cloves per bulb which was evident from the fact that lesser plant density with 300 plants/plot with spacing of 20 × 7.5 cm (table 1) resulted in higher number of cloves per bulb (17.91). Number of cloves per bulb was minimum (10.84) in the plants with higher density 900 plants/plot with spacing of 10 × 5 cm. This could be due to increased bulb weight.

The interaction of dates of planting and plant densities significantly influenced the number of cloves per bulb. At harvest, number of cloves per bulb was maximum (19.51) in 1st November planting with 300 plants/plot spaced 20 × 7.5 cm (table 2).

Size of clove

The 1st November recorded maximum clove size of 2.46 cm in length and 1.09 cm in girth (table 1). While minimum (2.13 cm in length and 0.83 cm in girth) was recorded in 15th December planted plants. Increased clove size mainly due to increased vegetative growth, bulb weight and number of cloves per bulb which confirm the results of Chattopadhyay *et al*. (2006) in garlic.

Data in table 1 revealed that lower plant density of 300 plants/plot with spacing of 20 × 7.5 cm (S_6) recorded maximum size of clove (2.69 cm in length and 1.20 cm in girth), while the plants in higher density 900 plants/plot with spacing of 10 × 5 cm (S_1) recorded minimum size of cloves (1.98 cm in length and 0.70 cm in girth). Higher size of clove might be due to greater accumulation of assimilates which resulted by better utilization of nutrients, moisture and light among plants and increase in size of cloves per bulb.

The interaction of dates of planting and plant densities significantly influenced the size of clove (table 2).

Yield

The bulb yield of garlic was significantly influenced

Table 2: Combined effect of planting date and plant densities on yield contributing characters in garlic

Treatment Dates of planting	Plant spacing	Bulb weight (g)		No. of cloves/ bulb	Size of clove (cm)		Days taken for Maturity	Shoot to bulb ratio
		F.W	C.W		L	G		
1st November	10 × 5 cm (900 plants/plot)	17.21	6.71	12.00	2.07	0.86	119.25	0.59
	15 × 5 cm (600 plants/plot)	17.63	6.89	16.77	2.25	0.94	122.32	0.57
	20 × 5 cm (450 plants/plot)	17.71	6.91	17.17	2.41	1.06	125.38	0.54
	10 × 7.5 cm (600 plants/plot)	19.11	7.46	18.20	2.52	1.13	124.85	0.50
	15 × 7.5 cm (400 plants/plot)	21.47	8.38	18.40	2.64	1.24	127.37	0.46
	20 × 7.5 cm (300 plants/plot)	24.40	9.52	19.51	2.86	1.33	130.49	0.40
15th November	10 × 5 cm (900 plants/plot)	16.20	6.32	11.40	2.02	0.74	117.77	0.47
	15 × 5 cm (600 plants/plot)	16.75	6.53	15.23	2.15	0.85	120.49	0.45
	20 × 5 cm (450 plants/plot)	16.91	6.60	16.24	2.35	0.93	121.54	0.42
	10 × 7.5 cm (600 plants/plot)	17.96	7.01	17.22	2.46	1.04	121.25	0.39
	15 × 7.5 cm (400 plants/plot)	20.70	8.07	17.79	2.54	1.14	121.37	0.34
	20 × 7.5 cm (300 plants/plot)	23.65	9.22	18.54	2.75	1.22	126.38	0.28
1st December	10 × 5 cm (900 plants/plot)	12.54	4.90	10.11	1.94	0.65	115.66	0.43
	15 × 5 cm (600 plants/plot	13.67	5.33	14.06	2.07	0.76	118.77	0.38
	20 × 5 cm (450 plants/plot)	14.08	5.49	15.05	2.17	0.85	119.30	0.33
	10 × 7.5 cm (600 plants/plot)	15.02	5.86	16.15	2.26	0.94	120.32	0.29
	15 × 7.5 cm (400 plants/plot)	18.08	7.06	16.36	2.37	1.10	120.68	0.25
	20 × 7.5 cm (300 plants/plot)	20.42	7.94	17.27	2.62	1.16	123.40	0.21
15th December	10 × 5 cm (900 plants/plot)	11.10	3.97	9.86	1.89	0.56	90.32	0.38
	15 × 5 cm (600 plants/plot)	12.97	5.06	12.27	1.94	0.67	93.98	0.34
	20 × 5 cm (450 plants/plot)	13.01	5.07	13.51	2.06	0.75	101.15	0.29
	10 × 7.5 cm (600 plants/plot)	14.49	5.65	14.79	2.14	0.87	99.27	0.25
	15 × 7.5 cm (400 plants/plot)	17.44	6.81	15.25	2.26	1.00	105.61	0.20
	20 × 7.5 cm (300 plants/plot)	19.91	7.76	16.34	2.51	1.12	106.99	0.17
Interaction								
S × D	SEm±	1.004	0.406	0.731	0.127	0.075	4.874	0.068
	C.D at 5%	2.031	0.820	1.478	0.258	0.153	9.850	0.138
D × S	SEm±	0.980	0.403	0.819	0.143	0.075	6.366	0.078
	C.D at 5%	2.033	0.840	1.773	0.309	0.156	14.253	0.169

F.W - Fresh weight, C.W - Cured weight, L- Length, G - Girth.

by the different dates of planting. Crop planted on 1st November recorded maximum bulb yield (7.64 g /plant and 88.75 q/ha) when compared to other dates of planting (table 3). Minimum bulb yield (5.72 g/plant and 64.21 q/ha) was recorded in 15th December planted crop. 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. Higher metabolism, greater photosynthates mobilization and better source sink relationship helped to produce higher yield. Bulb volume, bulb diameter and bulb weight also might have influenced the bulb yield. Singh *et al*. (2010), Adekpe *et al*. (2008), Chattopadhyay *et al*. (2006) in garlic also reported that the early planting results in higher yield compared to later plantings.

Plant densities showed marked effect in increasing the yield of garlic which was evident from the fact that the yield/plant was maximum (8.61 g/plant) with lowest

Table 3 : Effect of planting date and plant densities on yield of garlic.

Treatment	Yield/plant (g)	Yield/ha (q)
Dates of planting		
1st November	7.64	88.75
15th November	7.29	84.35
1st December	6.10	69.62
15th December	5.72	64.21
SEm±	0.158	1.575
C.D at 5%	0.385	3.855
Plant densities		
10 × 5 cm (900 plants/plot)	5.47	109.51
15 × 5 cm (600 plants/plot)	5.95	79.34
20 × 5 cm (450 plants/plot)	6.02	60.19
10 × 7.5 cm (600 plants/plot)	6.49	86.60
15 × 7.5 cm (400 plants/plot)	7.58	67.36
20 × 7.5 cm (300 plants/plot)	8.61	57.41
SEm ±	0.203	2.580
C.D at 5%	0.410	5.215

Table 4 : Combined effect of planting date and plant densities on yield of garlic.

Treatment / Dates of planting	Plant spacing	Yield/ plant (g)	Yield/ ha (q)
1st November	10 × 5 cm (900 plants/plot)	6.71	134.30
	15 × 5 cm (600 plants/plot)	6.89	91.71
	20 × 5 cm (450 plants/plot)	6.91	69.11
	10 × 7.5 cm (600 plants/plot)	7.46	99.45
	15 × 7.5 cm (400 plants/plot)	8.38	74.46
	20 × 7.5 cm (300 plants/plot)	9.52	63.50
15th November	10 × 5 cm (900 plants/plot)	6.32	126.39
	15 × 5 cm (600 plants/plot)	6.53	87.10
	20 × 5 cm (450 plants/plot)	6.60	65.96
	10 × 7.5 cm (600 plants/plot)	7.01	93.42
	15 × 7.5 cm (400 plants/plot)	8.07	71.77
	20 × 7.5 cm (300 plants/plot)	9.22	61.48
1st December	10 × 5 cm (900 plants/plot)	4.90	97.93
	15 × 5 cm (600 plants/plot	5.33	71.09
	20 × 5 cm (450 plants/plot)	5.49	54.93
	10 × 7.5 cm (600 plants/plot)	5.86	78.14
	15 × 7.5 cm (400 plants/plot)	7.06	62.72
	20 × 7.5 cm (300 plants/plot)	7.94	52.93
15th December	10 × 5 cm (900 plants/plot)	3.97	79.42
	15 × 5 cm (600 plants/plot)	5.06	67.47
	20 × 5 cm (450 plants/plot)	5.07	50.75
	10 × 7.5 cm (600 plants/plot)	5.65	75.40
	15 × 7.5 cm (400 plants/plot)	6.81	60.51
	20 × 7.5 cm (300 plants/plot)	7.76	51.72
Interaction			
S × D	SEm±	0.406	5.160
	C.D at 5%	0.820	10.430
D × S	SEm±	0.403	4.967
	C.D at 5%	0.840	10.251

plant density of 300 plants/plot with spacing of 20 × 7.5 cm (table 3). Minimum yield/plant (5.47 g/plant) was recorded in crop with highest density of 900 plants/plot with spacing of 10 × 5 cm. On the other hand, higher plant density with 900 plants/plot with spacing of 10 × 5 cm resulted in higher yield of garlic (109.51 q/ha). Minimum yield/ha (57.41 q/ha) were recorded in crop with lower density of 300 plants/plot with spacing of 20 × 7.5 cm. The reduction in total yield could be due to decrease in plant population. However, it was observed to be partly compensated by an increase in yield of large sized cloves and a decrease in small sized cloves. The highest yield at high plant density levels can be attributed to compensatory effect of number of plants per unit area. The difference between the highest and the lowest population could be due to higher net assimilate obtained at higher population density per unit area. Increased productivity at higher plant population resulting from efficient utilization of resources and closer planting enabled maximum interception of radiant energy and conversion to biomass than wider spaced plants. While, the yield/plant was more in wider spaced plants might be due to well utilization of nutrients and also having larger space for enlargement of bulbs.

The interaction of dates of planting and plant densities significantly influenced the yield of garlic. Maximum bulb yield (134.30 q/ha) was recorded in 1st November planting with 900 plants/plot spaced 10 × 5 cm (table 4) while minimum bulb yield (51.72 q/ha) in 15th December planting with 300 plants/plot spaced 20 × 7.5 cm. Maximum bulb yield (9.52 g/plant) was recorded in 1st November planting with 300 plants/plot spaced 20 × 7.5 cm, while minimum bulb yield (3.97 g/plant) in 15th December planting with

900 plants/plot spaced 10 × 5 cm. Similar results were reported by Jamroz *et al*. (2001) in garlic and Nagre *et al*. (1985) in onion.

Acknowledgements

Yield contributing characters and yield of garlic were significantly influenced by the planting date and plant densities. This might be due to favourable climatic conditions during growth period as well as enhanced biological activity and proper nutrition to the crop. Thus, for better bulb character and marketable yield of garlic, better planting time and plant population is suggested.

References

Adekpe, D. I., J. A. Y. Shebayan, D. B. Ishaya, C. P. Shinggu, M. A. Mahadi and Y. Mansir (2008). Effect of weed control, date of planting and intra-row spacing on the performance of garlic (*Allium sativum* L.) under irrigation at kadawa, Nigeria. *Crop Research*, **35(1&2)** : 35-41.

Akoun, J. (2004). Effect of plant density and manure on the yield and yield components of the common onion (*Allium cepa* L.) Var. Nsukka Red. *Nigerian Journal of Horticultural Science*, **9** : 43-48.

Chattopadhyay, P. K., M. A. Hasan, K. K. Mandar and S. Chand (2006). Dynamics of growth and yield of garlic (*Allium sativum*) in variable planting time and applied nutrients. *Indian Journal of Horticulture*, **63(3)** : 298-301.

Izquierdo, J. A., C. R. Maeso and J. Villamil (1981). Effect of sowing and transplanting dates on yield of valenciana type onions. *Investigacioues Agronomicas*, **2** : 34-37.

Lokesh, K. L., V. P. Kalapa and R. Veere Gowda (2000). National symposium on onion and garlic, production and post harvest management, challenges and strategies. Nov. 19-21.

Muhammad, Jamroz, Muhammad Ishtiaq, Nisar Naeem, Niaz Muhammad, Buzerg Jamiher and Javed Iqbal (2001). Effects of different planting dates and spacing on growth and yield of garlic *Cv.* Bianco. *On line Journal of Biological Sciences*, **1(4)** : 206-208.

Nagre, P. K., L. V. Kulwal and P. B. Kale (1985). Effect of different dates of transplanting and spacing on growth and yield of onion cv. Local White. *PKV Research Journal*, **9(2)** : 77-80.

Om, Hari and R. P. Srivastava (1974). Influence of the time of planting on the growth and yield of garlic. *Progressive Horticulture*, **6** : 71-76.

Panse, V. G. and P. V. Sukhatme (1985). *Statistical Methods for Agricultural Workers*. ICAR, New Delhi.

Purewal, S. S. and K. S. Dargan (1961). Effect of fertilizers and spacing on the development and yield of garlic (*Allium sativum*). *Indian Journal of Agronomy*, **5** : 262-268.

Rahim, M. A., M. A. Siddique and M. M. Hussain (1984). Effect of time of planting mother bulb size and plant density on the yield of garlic. *Bangladesh Journal of Agriculture Research*, **9(2)** : 112-118.

Singh, Pratibha, I. S. Naruka, S. S. Rathore, R. P. S. Shaktawat and P. P. Singh (2010). Response of garlic (*Allium sativum*) cultivars to different date of sowing in Malwa region of Madhya Pradesh. *Indian Journal of Agricultural Sciences*, **80(7)** : 645-648.

Singh, R. V. and K. S. Phogat (1989). Effect of different sowing times on growth and bulb yield of garlic. *Progressive Horticulture*, **21** : 145-147.