Indian J. Hort. 67(3), September 2010: 348-352

Dynamics of growth and yield of garlic in variable planting time and applied nutrients

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ABSTRACT

A field experiment was conducted in *rabi* season to assess the performance of garlic under three sowing dates and eight nutrient levels. Vegetative growth parameters significantly influenced with the earliest dates of planting (November 15) along with NPK at 60, 60, 120 kg ha^{-1} in combination with either mustard cake or neemcake (5 t ha^{-1}) or FYM (30 t ha^{-1}). A reduction in nutrient levels and delay in planting beyond November 15 increased in shoot/ bulb ratio. The migration coefficient gradually decreased with delay in planting beyond November 15. The weight of individual clove was reduced by nearly 60% with delayed planting on December 25. Maximum yield of bulb was recorded (5.4 t ha^{-1}) with early planting date (November 15) along with application on NPK at the highest level in combination with mustard cake @ 5 t ha^{-1}. Compared to other dates of plantings under West Bengal conditions.

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

INTRODUCTION

Garlic (*Allium sativum* L.) is highly nutritive among all the bulb crops. In West Bengal garlic is grown mainly in the Gangetic plains and *Terai* zones. 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 are favourable for better bulb development. The climatic conditions during the *rabi* season in the Gangetic alluvial soils of West Bengal indicates that vegetative growth of garlic should be completed within January and accordingly planting in the field has to be done. Nutrients in right proportion play an important role in influencing the growth and yield of garlic (Ahmed *et al.* 1; Borabash and Kochina, 2; Das *et al.* 3; Naik and Hosamani, 7; Sardi and Timar, 11; Singh and Singh, 14; Valdes *et al.* 16; Zhang *et al.* 18). It was felt worth while to conduct a study on time of planting and level of nutrients for commercial production of garlic, a potential spice crop of West Bengal plains.

MATERIALS AND METHODS

The experiment was conducted at the Horticultural Research Station of the BCKV, Mohanpur, Nadia in Gangetic alluvial soil. The investigation was planned in a split plot design with three replications, three planting dates (November 15, December 01 and December 15) and 9 nutrient levels (T_1 – N : P_2O_5 : K_2O @ 60 : 60 : 120 kg ha^{-1} + mustard cake @ 5 t ha^{-1}; T_2 – N : P_2O_5 : K_2O @ 60 : 60 : 100 kg ha^{-1} + neem cake @ 5 t ha^{-1}; T_3 – N : P_2O_5 : K_2O @ 60 : 60 : 100 kg ha^{-1} + FYM @ 30 t ha^{-1}; T_4 – N : P_2O_5 : K_2O @ 45 : 45 : 60 kg ha^{-1} + mustard cake @ 3.75 t ha^{-1}; T_5 – N : P_2O_5 : K_2O @ 45 : 45 : 90 kg ha^{-1} + neem cake @ 3.75 t ha^{-1}; T_6 – N : P_2O_5 : K_2O @ 45 : 45 : 90 kg ha^{-1} + FYM @ 22.5 t ha^{-1}: T_7 – N : P_2O_5 : K_2O @ 30 : 30 : 60 kg ha^{-1} + neem cake @ 2.5 t ha^{-1} and T_8 – N : P_2O_5 : K_2O @ 30 : 30 : 60 kg ha^{-1} + FYM @ 15 t ha^{-1}).

Urea (N-source) was applied as top dressing in two equal splits at 30 and 45 days after planting. Single superphosphate (P-source) was applied as basal dressing during land preparation. Muriate of potash (K-source) was applied in three splits at land preparation, 30 and 45 days after planting. Garlic cloves were planted 15 cm apart in a row and row to row distance was 20 cm. Timely weeding and plant protection measures were adopted to ensure normal crop growth. Irrigation was given 10 to 15 days interval depending upon the soil moisture condition of the experimental plots.

Of the various characters, plant height, basal girth, number of green leaves plant^{-1}, total number of leaves plant^{-1}, root length, root diameter, total number of roots plant^{-1}, weight of bulbs, number of cloves bulbs^{-1} weight of individual cloves, bulb sizes (length and girth), clove size (length and girth), were noted. Besides, leaf area index (LAI), crop growth rate (CGR), specific leaf weight (SLW), dry matter content of plant, shoot : bulb ratio, migration coefficient were also computed (Watson, 17). Statistical analysis was done in split plot design following the method described by Panse and Sukhatme (8).

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Table 1. Effect of nutrients and planting date on growth and development of garlic.

Treatment	Plant height (cm)	Plant girth (cm)	Total leaves plant^{-1}	Leaf area plant^{-1} (m^2)	Leaf area index	Root length (cm)	Toot number	Root dry matter (g)	Specific leaf weight (g cm^{-1})	Shoot / bulb ratio	Migration coefficient
Nutrient											
T_1	60.9	3.82	15.6	123.6	0.412	7.82	53.4	10.04	0.009	0.149	87.1
T_2	63.1	3.71	15.6	106.8	0.363	8.17	51.6	10.02	0.009	0.151	86.9
T_3	59.1	3.58	15.9	105.4	0.353	8.32	53.0	8.58	0.009	0.152	86.9
T_4	56.1	3.14	14.9	85.8	0.286	7.61	44.0	6.15	0.009	0.147	87.3
T_5	57.8	3.12	15.1	74.9	0.250	7.56	47.2	6.90	0.009	0.161	86.2
T_6	56.4	3.19	15.2	75.3	0.251	7.62	35.2	6.68	0.009	0.156	86.3
T_7	48.0	2.81	14.5	60.1	0.200	7.45	33.2	5.32	0.008	0.188	84.3
T_8	52.3	2.83	14.6	61.8	0.206	7.11	36.2	4.16	0.009	0.128	84.7
T_9	52.6	2.76	15.1	61.0	0.203	7.12	44.3	4.97	0.008	0.179	85.2
CD (P = 0.05)	5.355	0.548	0.318	22.227	0.074	0.330	8.894	1.940	NS	0.022	1.569
Planting date											
S_1	56.3	3.22	20.0	84.1	0.250	7.64	44.3	6.98	0.010	0.174	87.1
S_2	56.6	2.96	15.2	67.1	0.224	6.52	42.9	8.95	0.007	0.165	86.8
S_3	51.6	2.62	10.1	34.2	0.112	6.41	36.1	5.34	0.008	0.199	84.4
CD (P = 0.05)	0.636	0.033	0.171	0.916	0.003	0.063	0.822	0.218	0.0003	0.011	0.848
Planting date	3.87	NS	0.670	5.578	0.018	0.385	2.209	1.325	0.0017	NS	NS

Table 2. Effect of nutrients and planting dates on crop growth rate (g/m^2/day) in garlic.

Treatment	Days after planting			
	65	85	105	125
Nutrient				
T_1	0.038	0.182	0.203	0.326
T_2	0.044	0.176	0.225	0.322
T_3	0.043	0.168	0.180	0.268
T_4	0.030	0.115	0.168	0.194
T_5	0.033	0.113	0.176	0.248
T_6	0.033	0.109	0.138	0.216
T_7	0.027	0.081	0.133	0.182
T_8	0.020	0.085	0.076	0.122
T_9	0.018	0.092	0.122	0.156
CD (P = 0.05)	0.009	0.033	0.052	0.089
Planting date				
S_1	0.017	0.049	0.043	0.226
S_2	0.031	0.121	0.273	-
S_3	0.047	0.204	-	-
CD (P = 0.05)	NS	0.038	0.108	-

RESULTS AND DISCUSSION

Plant height and girth were significantly influenced by different dates of planting and nutrient application. There was an increase in plant height and basal girth with early planting (November 15). The increase in plant height was more pronounced when the plants received NPK nutrients at 60, 60 and 120 kg ha^{-1} in combination with either mustard cake (5 t ha^{-1}), neem cake (5 t ha^{-1}) or FYM (30 t ha^{-1}). The beneficial influence on plant height and girth due to early planting had been reported by Das *et al.* (3), and Qaryouti and Kasarawi (9). Beneficial effect of NPK nutrient in combination with organic manure has also been reported by Das *et al.* (4) and Seno *et al.* (11). Singh and Singh (14), recorded better growth and yield in garlic with higher nitrogen rate (160 kg ha^{-1}) and early planting (10 September).

The number of green leaves retained plant^{-1} was found to be maximum (105 DAP) with 15 November planting. It decreased approaching harvest stage. Significant influence was also recorded by the different levels of nutrients. Incorporation of neem cake (5 t ha^{-1}) with NPK nutrient at 60, 60, 120 kg ha^{-1} was found more effective on retention of green leaves plant^{-1}. In general, a reduction in nutrient levels and delay in planting decreased the number of green leaves plant^{-1} during later stages of crop growth also finds support from Das *et al.* (3). The root length continuously increased upto 105 DAP with the earliest planting (November 15), while the increase was continued upto 85 DAP and 65 DAP with planting on December 5 and December 25. The response of different levels of nutrient on root length was very distinct and significant throughout the growth period. Incorporation of FYM @ 30 t ha^{-1} found most effective in improving root length of garlic. However, the interaction effect had no significant effect on root length. The total number of roots plant^{-1} on November 15 planting, however, exceeded the root number of late planting garlic. The nutrient levels, N, P and K at 60, 60, 120 kg ha^{-1} along with mustard / neem cake @ 5 t ha^{-1} most remarkable and significantly influenced the root number plant^{-1} followed by a reduction in nutrient levels by 25 and 50 percent respectively.

The rate of dry matter accumulation was nearly 3 times in December 5 planting over the earliest planting on November 15. Incorporation of mustard cake (5 t ha^{-1}), neem cake (5 t ha^{-1}) or FYM (30 t ha^{-1}) along with N, P and K at 60, 60, 120 kg ha^{-1} on dry matter accumulation was more pronounced although statistically at par. The increase in dry matter content with the earliest planting (November 15) was more marked and pronounced after 125 DAP. The interaction of planting dates on nutrients had no significant influence on dry matter content up to 85 DAP.

Early planting (November 15) had lower LAI during initial growth stages (upto 65 – 85 DAP). LAI was recorded highest (0.250) with earliest planting after 125 DAP. Higher LAI was recorded when plants received NPK at 60, 60 and 120 kg ha^{-1} along with either neem cake (5 t ha^{-1}), mustard cake (5 t ha^{-1}) or

FYM (30 t ha^{-1}). The interaction of nutrient × planting dates showed significant influence at later stages of crop growth. The CGR of garlic with earliest planting lagged behind the later planting dates upto 105 DAP which however, increased many fold during 105 – 125 DAP. Application of N, P and K at 60, 60 and 120 kg ha^{-1} along with neem cake (5 t ha^{-1}) exhibited highest CGR (0.381 m^{-2} day^{-1}) of second planting date (December 15). A reduction in nutrient level by 50 percent under T_7, T_8 and T_9 treatments decreased the CGR by nearly 50% as compared to T_1, T_2 and T_3 treatments. The SLW was recorded highest (0.015 g / cm^2) with December 25 planting followed by 0.012 g / cm^2 with November 15 / December 5 planting. The CGR recorded higher also with the application of N, P and K at 60, 60 and 120 kg ha^{-1} in combination with either mustard cake @ 5 t ha^{-1} (T_1) or neem cake @ 5 t ha^{-1} (T_2). FYM @ 30 t ha^{-1} (T_3). A delay in planting beyond November 15 increased the shoot / bulb ratio. In contrast the effect of nutrient on shoot / bulb ratio gradually was more pronounced and significant. The highest value of migration coefficient (87.1) was recorded with the first planting date and it decreased gradually with delay in planting. The different levels of nutrient produced a significant difference in migration coefficient.

The size of bulb was recorded maximum (length 4.69 cm and girth 12.1 cm) with the first planting while it was maximum with the nutrients N, P, K at 60, 60 and 120 kg ha^{-1} along with mustard cake @ 5 t ha^{-1} (T_1) followed by T_3 and T_2 treatments. Rahman and Talukdar (10) also observed a gradual decline in bulb size in garlic after November 15 planting. Early planting (November 15) produced the maximum length (4.21 cm) of clove followed by 3.71 and 3.55 cm with second and third planting date. Delayed planting reduced drastically the clove size. Application of N, P and K at 60, 60 and 120 kg ha^{-1} along with FYM @ 30 t ha^{-1} (T_3) produced clove with highest girth (3.56 cm) followed by 3.47 cm in T_1 treatment. The results corroborate the findings of Hillman and Noordiyati (6). It may be mentioned here that increased bulb weight and bulb yield in garlic were recorded with 120 – 75 – 75 kg NPK ha^{-1} by Ahmed *et al* (1). The weight of bulb was recorded higher (16.2 g) with November 5 planting followed by 12.6 g (December 5) and 8.8 g (December 25). Thus delay in planting gradually decreased the weight of bulb. Weight of individual clove was recorded maximum (0.997 g) with the November 15 planting followed by 0.809 g with the December 15 planting. The individual clove weight was reduced by 60 per cent with planting on December 25. The result finds support of the work of Rahman and Talukdar (10). The effect of nutrients on interaction of nutrients x planting date did not produce significant effect in this regard. The number of cloves bulb^{-1} did not vary significantly due to different planting dates. Application of different levels of nutrients was however, influenced significantly the number of cloves bulb^{-1}. A reduction in nutrient level by 50 per cent decreased the number of cloves bulb^{-1} by more than 35 per cent. The result supports the findings

Table 3. Effect of nutrients and planting dates, on yield and yield attributing characters of garlic.

Treatment	Yield (kg ha^{-1})	Yield (t ha^{-1})	Weight of bulb (g)	Length of bulb (cm)	Girth of bulb (cm)	No. of cloves	Weight of clove (g)	Length of clove (cm)	Girth of clove (cm)
Nutrient									
T_1	0.777	5.18	15.6	4.99	12.1	29.8	0.708	3.99	3.47
T_2	0.769	5.13	15.4	4.92	12.1	27.8	0.753	3.89	3.28
T_3	0.712	4.95	14.8	4.93	11.4	24.1	0.847	3.86	3.56
T_4	0.637	4.25	12.7	4.60	11.3	24.9	0.731	3.61	3.28
T_5	0.639	4.26	12.8	4.51	11.1	24.6	0.706	3.67	3.16
T_6	0.632	4.21	12.6	4.49	10.8	22.9	0.764	3.81	3.13
T_7	0.509	3.40	10.2	4.51	10.2	21.6	0.658	3.43	3.08
T_8	0.472	3.15	9.4	4.31	10.2	18.7	0.752	3.71	3.22
T_9	0.453	3.02	9.1	4.42	10.0	19.2	0.672	3.56	3.23
CD (P = 0.05)	0.021	0.223	1.300	0.371	0.623	5.350	NS	NS	0.255
Planting date									
S_1	0.809	5.40	16.20	4.7	12.1	24.1	0.997	4.21	3.58
S_2	0.629	4.19	12.60	4.60	11.4	20.5	0.809	3.71	3.43
S_3	0.439	2.93	8.80	4.10	9.5	26.5	0.390	3.25	2.30
CD (P = 0.05)	0.100	0.667	2.012	0.424	0.710	NS	0.243	0.377	0.444

of Setty *et al.* (13). The bulb yield was recorded maximum (0.809 kg plot^{-1} and 5.40 t ha^{-1}) with first planting date followed by 0.629 kg plot^{-1} and 4.19 t ha^{-1} and 0.439 kg plot^{-1} and 2.93 t ha^{-1} with second and third planting dates respectively. The reduction in bulb yield was nearly 22 and 45 per cent with December 5 and December 25 planting respectively over 15 November planting. Higher yield with earlier planting was also obtained by Das *et al.* (3), and Rahaman and Talukdar (10). The higher bulb yield plot^{-1} and hectare^{-1} recorded with application of NPK at 60, 60 and 120 kg h^{-1} along with mustard cake @ 5 t ha^{-1} (T_1) and did not differ significantly with neem cake (5 t ha^{-1}) application. Sirohi (15) obtained better performance with respect to bulb diameter, number of cloves bulb^{-1} and bulb yield (5.5 cm, 37.2 and 100.1 of ha^{-1}) respectively upon planting on 11 October at closer spacing (15 × 10 cm). Several workers have also reported the beneficial effect of NPK fertilizer in combination with organic manures in increasing the yield of garlic (Seno *et al.,* 12; Zhang *et al.*, 18).

It appears from the results that garlic should be planted during the second fortnight of November for better yield in the Gangetic alluvial soils of West Bengal. Regarding fertilizer schedule, NPK should be applied@ 60, 60 and 120 kg ha^{-1} along with incorporation of mustard cake (5 t ha^{-1}) or neem cake (5 t ha^{-1}) or FYM (30 t ha^{-1}).

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Received: August, 2007; Revised: May, 2010;
Accepted : June, 2010