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RESEARCH ARTICLE

EFFECT OF NITROGEN AND POTASSIUM ON GROWTH AND YIELD OF TWO GARLIC GENOTYPE

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Abstract

A field experiment was conducted to evaluate the interaction effect of nitrogen and potassium on growth and yield related characters of two garlic varieties at the of Spices Research Center, Bogra during november 2000 to march 2001. The experiment consists of two germplasm i.e. Accession G₁₉ and G₂₀ with four levels of nitrogen (0, 100, 200, 300 kg N ha⁻¹) and potassium (0, 100, 200, 300 kg K₂O ha⁻¹). The three factorial experiment was laid out in a randomized complete block design with three replications. Results demonstrated that there was significant variation present among the studied treatments. Between the varieties, accession G₂₀ showed the best performance (8.08 t ha⁻¹). The solitary application both of N and K₂O also increase the growth and yield of garlic at considerable amount. Among the treatments the highest bulb yield was achieved by using 200 kg ha⁻¹ of N and K₂O (9.62 and 8.61 t ha⁻¹ respectively). This study suggested that the treatment combination of accession G₂₀ with 200 kg N ha⁻¹ and 200 kg K₂O ha⁻¹ will be more profitable (11.03 t ha⁻¹) than any other studied treatment combinations.

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Introduction:-

Garlic is (*Allium sativum* L.) classified under the family *Alliaceae* (Allen, 2009) which includes 700 species of ornamental flowering plant. Among the spices it ranks next to (second) onion in the world (Voigt, 2004). In China and India it has been used for more than 5000 years, and in Egypt since 2000 B.C. (Kamenetsky and Rabinowitch, 2001). It is one of the major used spice in Bangladesh and used in different dishes for its pungent flavor. It also has medicinal value which is well recognized in the control and treatment of hypertension, worms, germs, bacterial and fungal diseases, diabetes, cancer, ulcer, rheumatism etc. (Kilgori *et al.*, 2007b; Samavatean *et al.*, 2011). The garlic oil is volatile and has sulfur combining compounds which is responsible for strong odor, its unique flavor and pungency as well as for the healthful benefits (Salomon, 2002). In many types of dishes ranging from vegetable soup, meat, salad, tomato combination, spaghetti, sausages and pickles garlic is a basic flavoring element (Brewster, 1994). Garlic is cultivated during the Rabi season in Bangladesh. In 2016-17, nearly 425401 MT bulbs of garlic were produced in Bangladesh from 163733 acres of land (BBS, 2017) which is higher than the past years. It indicates that the production of garlic is increasing day day in Bangladesh. But the average production (2.59 MT /acre) of Bangladesh is low compared to world production. That's why Bangladesh has to depend on import of

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garlic from other exporter countries. But this problem can be sorted out by using proper nutrient management practices (proper doses of different fertilizers) and also by using of high yielding variety. Improving productivity and quality of crop, soil nutrient management plays a significant role (Zhou *et al.*, 2005). Garlic is a nutrient exhaustive crop and removes a good amount of nitrogen, phosphorus and sulphur from the soil. To improve growth, yield and marketable proportions as well as quality of the crop uptake of sufficient nutrient by the garlic crop is important (Nai-hua *et al.*, 1998). Due to genetic and environmental factors, garlic yield is low in many parts of the world, in spite of its importance (increasing of garlic production and productivity) (Nonnecke, 1989). In many garlic producing areas, lack of available nutrients has been identified as the limiting factor next to soil water, due to uptake and liberation of N, P and S from soil organic matter depends upon availability of water (FAO, 2003). Nitrogen and potassium played an important role among the different nutrients in the growth and development of garlic. These are the most responsive nutrients, in terms of plant development and production, contributing to increased productivity and quality of the bulbs. Due to low levels of organic matter, most of the agricultural lands in Bangladesh are deficient in nitrogen. Imbalanced and poorly monitored nitrogen application to the environment limits yields and induces large losses of reactive nitrogen. (Cassman *et al.*, 2002). The rate of leaf initiation and extension of garlic in early growth is increased due to nitrogen application (Garcia, 1980; Koltunov, 1984). Bulb growth and development is also improved by nitrogen (Buwalda and Freeman, 1987, Fritsch *et al.*, 1990; Hossain, 1997). As the levels of nitrogen increased from 0 to 400 kg ha⁻¹ the growth and yield of garlic increased significantly beyond which yield declined (Lachica, 1982). The dry matter production of bulbs and bulb yield were increased due to nitrogen application (Hedge, 1988). Zaman *et al.*, 2011 reported that application of 150 kg N ha⁻¹ produced a good yield of garlic. Macêdo *et al.*, (2009) observed that an N dose of up to 180 kg ha⁻¹ enabled linear gains in the total productivity of cv. Roxo Pérola de Caçador. Fernandes *et al.*, (2010) observed increased linear behavior, and the dose of 320 kg ha⁻¹ of N yield values of 9.1 t ha⁻¹ of the total productivity of cv. Caçador LV. Many authors has also been reported that the positive and significant response of garlic to applied nitrogen (Brabma and Yousuf, 2008; Talukder *et al.*, 1998; Uddin, 1993). Besides this, potassium plays a crucial role in different plant metabolism, such as photosynthesis, photosynthates translocation, plant pores regulation, activation of plant catalyst and resistance against pests and diseases, hence improve the quality. It improves the color, glossiness and dry matter accumulation besides improving quality of the garlic. Garlic's demand for K ranges from 125 to 180 kg K₂O ha⁻¹ (Bertoni and Morard du L. Espagnacq, 1988). So it is very important to know the standard dose combination of nitrogen and potassium to achieve proper growth and development of garlic in Bangladesh condition. Since meager work has been conducted under Bangladeshi conditions in this regard, an investigation was conducted to assess the impact of interaction effect of nitrogen and potassium on yield and yield related characters of two garlic varieties.

Materials And Method:-

The experiment was conducted at the farm of Spices Research Center, Bogra from november 2000 to march 2001 with a view to investigating the effect of nitrogen, potassium and garmplasm on the growth and yield of garlic. The three factorial experiment was laid out in a randomized complete block design with three replications. In each block, the land was divided into 32 plots and each plot size was 1.2 m x 1.0 m. The space between the blocks and plots were 1.0 m and 350 cm, respectively. The selected accessions of garlic cloves were placed at a depth of 2 cm in the soil with the use of a pointed stick. The organic matter content of the experimental plot was low and acidic in nature. The total N and exchangeable K status of the soil were also low. Ten days before the clove planting, the entire quantity of well decomposed cow dung and TSP @15 ton and 120 kg ha⁻¹ were applied at final land preparation. Urea and MoP were applied as a source of nitrogen and potassium at two split date (30 and 60 days after planting) as top dressing. Garlic seeds were planted in the first week of november. Intercultural operations were done as per required. Data on plant growth, yield parameters, and bulb yield were recorded. The mean for all treatments were calculated and the analyses of variances for most of the characters under consideration were performed by 'f' variance test. The significance of the difference between pairs of means was expressed as least significance different (LSD) test taking the probability level 5% as the minimum unit of significance (Gomez and Gomez, 1984).

Table 01:-Treatments of the experiment

Factor A: Two garmplasm	Factor B: Four levels of nitrogen	Factor C: Four levels of potassium
Accession G ₁₉	N ₀ : 0 k N ha ⁻¹ (control)	K ₀ : 0 kg K ₂ O ha ⁻¹ (control)
Accession G ₂₀	N ₁ : 100 kg N ha ⁻¹	K ₁ : 100 kg K ₂ O ha ⁻¹
	N ₂ : 200 kg N ha ⁻¹	K ₂ : 200 kg K ₂ O ha ⁻¹
	N ₃ : 300 kg N ha ⁻¹	K ₃ : 300kg K ₂ O ha ⁻¹

Results And Discussion:-

Plant height

Garlic varieties showed significant variation ($P < 0.01$) on the mean plant height at different days after planting (Table 02). Height of plant from both germplasm showed an increasing trend up to 90 DAP (Fig. 1). At 90 DAP, the higher plant height (51.97 cm) was obtained from Accession G₂, and the lower (49.75 cm) from Accession G₁. Fig. 3 and Fig. 5 showed among the different treatment of N and P, the rate of 200 kg N ha⁻¹ (55.36 cm) and 200 kg K₂O ha⁻¹ (47.96 cm) gave the maximum plant height respectively and minimum from the control treatment ($P < 0.01$). The positive and significant association of garlic to nitrogen has also been reported by many authors (Brabma and Yousuf, 2008; Talukder *et al.*, 1998; Uddin, 1993; Setty *et al.*, 1989; Soto, 1988). The interaction effect between nitrogen and potassium relating to plant height was also found to be significant (Table 02). At 90 DAP, the highest plant height (57.86 cm) was found in the treatment combination of 200 kg N ha⁻¹ and 200 kg K₂O ha⁻¹, with Accession G₂ and the lowest plant height (38.15 cm) was observed from 0 kg N ha⁻¹ and 0 kg K₂O ha⁻¹ treatment combination (Table 07).

Number of green leaves plant⁻¹

Accession G₂ produced the highest number of green leaves per plant (8.13) where Accession G₁ produced the lowest (7.67) at 90 DAP (Fig. 2). Among the different rates of fertilizer, 200 kg N ha⁻¹ (55.36 cm) and 200 kg K₂O ha⁻¹ (8.03) performed the best compared to control (Fig. 4 and Fig. 6). A similar result was also reported by Talukdar (1998) who obtained a higher leaf number from the same level of potassium. At 90 DAP, the maximum number of green leaves per plant (8.43) was obtained from 200 kg N ha⁻¹ and 200 kg K₂O ha⁻¹ treatment combinations, and the minimum number of green leaves per plant (6.75) was obtained from the combination of 0 kg N ha⁻¹ and 0 kg K₂O ha⁻¹ (Table 07). Karic *et al.*, (2005) investigated the response of leek to different levels of nitrogen and observed no effect on the number of leaves per plant in all N levels.

Number of cloves bulb⁻¹

Significant variation was observed among the accessions about the number of cloves per bulb (Table 02). The higher number of cloves per bulb (20.88) was found in Accession G₂, whereas the Accession G₁ produced the lower (19.22) (Table 03). The application of the highest average number of cloves per bulb was obtained from the plants grown with 200 kg N ha⁻¹ (23.63) and 200 kg K₂O ha⁻¹ (22.12) produced the maximum number of cloves per bulb while minimum from the control treatment at harvest (Table 02, 03 and 04). This is an agreement with the reports of several authors (Hossain, 1997; Talukder, 1998). The treatment combination of accession G₂ with 200 kg N ha⁻¹ and with 200 kg K₂O ha⁻¹ produced the maximum number of cloves per bulb (24.68 and 23.55 respectively), and the minimum (15.40 and 13.88 respectively) was observed from the combination of Accession G₁ with 0 kg N ha⁻¹ (Table 07). The result exhibited that the higher number of cloves per bulb was obtained due to the higher nutrient availability in soil, which enhanced the growth and development of the bulb.

Fresh weight of individual bulb

Significant variation was observed in fresh weight of the individual bulb at harvest between the germplasm (Table 02). The maximum fresh weight of the individual bulb (12.97 g) was observed in Accession G₂, and the minimum (12.05 g) was in Accession G₁ (Table 03). It may be due to that Accession G₂ gave the higher vegetative growth as well as leaf number. Among the treatment 200 kg N ha⁻¹ (15.41 g) and 200 kg K₂O ha⁻¹ (13.70 g) gave maximum fresh weight of individual bulb and minimum result was obtained from the control treatment (Table 03). Setty *et al.*, (1989) found the higher weight of the bulb from higher nitrogen levels up to the level of 200 kg N ha⁻¹. The significant variation among the combination of germplasm and different levels of nitrogen in the fresh weight of individual bulb. The fresh weight of the individual bulb varied from 8.95 g to 16.13 g. The highest fresh weight of the individual bulb (16.13 g) was obtained from the treatment combination of accession G₂ with 200 kg N ha⁻¹ (16.13 g) and 200 kg K₂O ha⁻¹ (14.09 g), whereas the lowest was observed in the accession G₁ with 0 kg N ha⁻¹ and 0 kg K₂O ha⁻¹ (Table 07).

Bulb yield

In relation to bulb yield, the studied accessions and the treatment showed significant variation (Table 02). The higher bulb per plot (0.97 kg) was produced by the Accession G₂ and lower from Accession G₁ (0.90 kg) (Table 03). The higher yield obtained from Accession G₂ was due probably due to the production of larger bulbs. Application of 200 N ha⁻¹ gave the highest yield per plot (1.16 kg) and lowest from the control treatment (0.68 kg). Similarly 200 Kg K₂O ha⁻¹ gave the maximum yield per plot (1.03 kg) and lowest from the control treatment (0.84 kg) (Table 03). The lowest yield per plot was observed from control treatment. This result was in partial conformity with the finding

of Lachica (1982), Setty *et al.*, (1989) and Amin (1998). The combined effect of garmpiasm and different levels of potassium in respect of yield per plot and yield per hectare was found to be significant (Fig. 7 and 8). The maximum yield per plot (1.32 kg) was recorded from the treatment combination of accession G₂ with 200 kg N ha⁻¹ and the minimum (0.48 kg) from accession G₁ with 0 kg N ha⁻¹ and 0 kg K₂O ha⁻¹ (Table 07). There was no significant interaction effect of garmpiasm, nitrogen and potassium on bulb yield per plot (Table 02).

Conclusion:-

The growth and yield parameters of this research indicated that the varieties had significant differences in the studied characters. Between the varieties, accession G₂₀ showed best performance by producing vegetative growth and higher bulb yields. The outcome of N and P fertilizer application on the performance of different garlic varieties suggested that both the fertilizer significantly enhanced plant height, produced the bulbs of greater marketable yield, total bulb yield. Among the different treatments, the highest bulb yield was achieved by using 200 kg ha⁻¹ of N and K. It was apparent from the above result that the treatment combination of accession G₂₀ with 200 kg N ha⁻¹ and 200 kg K₂O ha⁻¹ was more profitable than the rest of the treatment combinations.

Table 02:- Analysis of variance on the data of growth and yield of garlic as influenced by garmpiasm, nitrogen and potassium

Source of variation	Degree of freedom (df)	Mean square										No. of cloves /bulb	Bulb fresh weight (g)/plant	Yield /plot (kg)
		Plant height (cm) at					Number of green leaves/plant at							
		30 DA P	45 DA P	60 DAP	75 DAP	90 DAP	30 DA P	45 DA P	60 DA P	75 DA P	90 DA P			
Block	2	0.002	1.41	0.65	0.78	5.18	0.009	0.17	0.02	0.001	0.16	0.23	0.18	0.005
Treatment	31	0.83**	16.20**	32.24**	62.82**	86.28**	0.02**	0.23**	0.53**	0.28**	0.73**	38.43*	20.89**	0.12*
Garmpiasm (A)	1	25.16**	20.78*	111.07**	68.78**	118.90**	0.38**	2.10**	3.23**	0.88**	5.13**	66.82*	20.22**	0.11*
Nitrogen (B)	3	0.03	88.61**	258.35*	561.14**	718.50**	0.02	0.53**	3.86**	2.07**	4.84**	226.57**	176.47**	1.04*
A X B	3	0.04	1.45	2.07*	2.60*	2.03*	0.04	0.06	0.05**	0.20**	0.06	2.12**	1.69*	0.01
Potassium (C)	3	0.004	38.15**	23.65**	46.79**	108.93**	0.04	0.17	0.14**	0.24**	0.29*	83.54*	23.42**	0.15*
A X C	3	0.01	1.77	0.59	1.11	0.36	0.01	0.08	0.03**	0.01	0.10	5.19**	0.08	0.001
B X C	9	0.03	8.51*	3.08*	4.05*	6.88*	0.02	0.22*	0.07**	0.03**	0.09	4.39**	1.08*	0.01*
A X B X C	9	0.02	.67	0.73	0.82	0.51	0.02	0.06	0.04**	0.02*	0.09	1.42**	1.4**	0.01
Error	62	0.089	3.205	0.501	0.660	0.450	0.009	0.086	0.011	0.008	0.102	0.189	0.226	0.003

DAP: Days After Planting

Table 03:- Main effect garmpiasm, nitrogen and potassium on growth and yield of garlic

Treatment Combinations	Bulb fresh weight (g) plant ⁻¹	No. of cloves bulb ⁻¹	Yield plot ⁻¹ a (kg)
G ₁	12.05	19.22	0.90
G ₂	12.97	20.88	0.97
LSD (0.05)	0.19	0.18	0.02
LSD (0.01)	0.26	0.24	0.03
Levels of nitrogen			

N ₀	9.14	15.88	0.68
N ₁	11.69	19.14	0.88
N ₂	15.41	23.63	1.16
N ₃	13.79	21.56	1.04
LSD (0.05)	0.27	0.25	0.03
LSD (0.01)	0.36	0.003	0.33
Levels of Potassium			
K ₀	11.32	17.70	0.84
K ₁	12.29	19.65	0.92
K ₂	13.70	22.12	1.03
K ₃	13.72	20.74	0.95
LSD (0.05)	0.27	0.25	0.03
LSD (0.01)	0.36	0.33	0.04

a =unit plot size was 1.2 m x 1.0 m	G ₁ = Accession G ₁₉ G ₂ = Accession G ₂₀
N ₀ = 0 kg N/ha N ₁ = 100 kg N/ha N ₂ = 200 kg N/ha N ₃ = 300 kgN/ha	K ₀ = 0 kg K ₂ O/ha K ₁ = 100 kgK ₂ O/ha K ₂ = 200 kg K ₂ O/ha K ₃ =300 kgK ₂ O/ha

Table 04:-Combined effect of germplasm and nitrogen on growth and yield of garlic

Treatment combinations	Plant height (cm) at					Number of green levels plant at ⁻¹					Fresh weight bulb plant ⁻¹ (g)	No. of cloves bulb ⁻¹	Yield plot ⁻¹ (kg)
	30 DAP	45 DAP	60 DAP	75 DAP	90 DAP	30 DA P	45 DA P	60 DA P	75 DA P	90 DA P			
G ₁ N ₀	24.10	30.26	34.04	38.01	42.40	4.17	5.46	5.80	6.63	6.99	8.95 11.42	15.40 18.03	0.65 0.86
G ₁ N ₁	24.08	32.22	37.52	44.10	49.81	4.76	5.59	6.42	7.08	7.03	14.69	22.58	1.10
G ₁ N ₂	24.11	34.12	39.92	48.30	54.21	4.78	5.63	6.65	7.08	7.90	13.14	20.86	1.00
G ₁ N ₃	24.11	34.12	39.92	48.30	54.21	4.78	5.63	6.65	7.08	7.90	9.33	16.36	0.70
G ₂ N ₀	24.11	33.62	40.72	48.01	52.52	4.86	5.68	6.26	6.71	7.58	11.97	20.24	0.90
G ₂ N ₁	24.10	33.62	40.72	48.01	52.52	4.90	5.93	6.78	7.13	8.08	16.13	24.68	1.21
G ₂ N ₂	25.03	30.92	35.37	39.27	43.80	4.89	5.84	6.89	7.27	8.30	14.45	22.25	1.08
G ₂ N ₃	25.21	32.73	39.72	46.72	52.30						0.39 0.52	0.35 0.47	0.04 0.06
LSD(0.05)	0.24	1.46	0.58	0.66	0.55	0.08	0.24	0.09	0.07	0.26			
(0.01)	0.32	1.94	0.77	0.88	0.73	0.10	0.32	0.11	0.10	0.35			

a =unit plot size was 1.2 m x 1.0 m	G ₁ = Accession G ₁₉ G ₂ = Accession G ₂₀
N ₀ = 0 kg N/ha N ₁ =100kg N/ha	N ₂ =200kg N/ha N ₃ = 300 kgN/ha

Table 05:-Combined effect of garmplasm and potassium on growth and yield of garlic

Treatment combinations	Plant height (cm) at					Number of green levels plant ⁻¹ at					Fresh weight bulb plant ⁻¹ (g)	No. of clovesbulb ⁻¹	Yield plot ⁻¹ a (kg)
	30 DAP	45 DAP	60 DAP	75 DAP	90 DAP	30 DA P	45 DA P	60 DA P	75 DA P	90 DA P			
G ₁ K ₀	24.10	30.26	34.04	38.01	42.40	4.17	5.46	5.80	6.63	6.99	10.80	17.40	0.81
G ₁ K ₁	24.08	32.22	37.52	44.10	49.81	4.76	5.59	6.42	7.08	7.03	11.80	18.83	0.88
G ₁ K ₂	24.11	34.12	39.92	48.30	54.21	4.81	5.72	6.76	7.14	8.08	13.31	20.68	1.01
G ₁ K ₃	24.11	34.13	39.91	48.31	54.22	4.78	5.63	6.65	7.08	7.90	12.29	19.96	0.92
G ₂ K ₀	24.11	33.63	40.71	48.01	52.52	4.86	5.68	6.26	6.71	7.58	11.84	18.00	0.88
G ₂ K ₁	24.10	33.64	40.72	48.02	52.53	4.90	5.93	6.78	7.13	8.08	12.29	18.00	0.88
G ₂ K ₂	25.03	30.92	35.37	39.27	43.80	4.89	5.84	6.89	7.27	8.30	11.84	20.47	0.96
G ₂ K ₃	25.21	32.73	39.72	46.77	52.30	4.91	6.14	7.16	7.59	8.58	11.84	20.47	0.96
	25.11	35.73	42.62	49.99	56.49	4.91	6.14	7.16	7.59	8.58	14.09	21.53	0.99
	25.13	34.58	43.12	49.22	55.30	4.89	5.84	6.89	7.27	8.30	13.16	0.35	0.04
LSD(0.05)	0.24	1.46	0.58	0.66	0.55	0.08	0.24	0.09	0.07	0.26			
(0.01)	0.32	1.94	0.77	0.88	0.73	0.10	0.32	0.11	0.10	0.35			

Table 06:-Combined effect of nitrogen and potassium on growth and yield of garlic

Treatment combinations	Plant height (cm) at					Number of green levels plant ⁻¹ at					Fresh weight bulb plant ⁻¹ (g)	No. of cloves bulb ⁻¹	Yield plot ⁻¹ a (kg)
	30 DAP	45 DAP	60 DAP	75 DAP	90 DAP	30 DA P	45 DA P	60 DA P	75 DA P	90 DA P			
N ₀ K ₀	24.44	26.68	32.03	35.10	38.15	4.78	5.20	5.85	6.45	6.75	7.74	13.88	0.53
N ₀ K ₁	24.55	31.07	34.22	38.60	3.40	4.77	5.2	5.87	6.70	6.92	8.85	15.62	0.66
N ₀ K ₂	24.59	32.59	36.12	40.68	45.78	4.77	5.60	6.27	6.80	7.48	10.20	17.38	0.77
N ₀ K ₃	24.69	32.04	36.45	40.16	45.08	4.82	5.85	6.13	6.72	7.48	9.78	16.63	0.75
N ₁ K ₀	24.70	31.74	37.99	44.41	48.21	4.82	5.92	6.67	7.05	7.82	10.95	17.43	0.85
N ₁ K ₁	24.67	33.02	38.49	45.48	50.85	4.83	5.67	6.52	7.12	7.90	11.46	19.02	0.85
N ₁ K ₂	24.63	33.32	38.86	46.12	53.06	4.2	5.7	6.72	7.27	7.97	12.48	20.58	0.94
N ₁ K ₃	24.58	31.81	39.14	45.03	52.10	4.5	5.72	6.50	7.00	7.93	11.88	19.52	0.88
N ₂ K ₀	24.65	33.73	40.46	47.71	52.98	4.83	5.83	6.93	7.28	8.22	14.12	19.92	1.06
N ₂ K ₁	24.58	34.46	40.87	48.69	54.73	4.88	5.95	6.92	7.38	8.33	14.99	22.55	1.12
N ₂ K ₂	24.65	36.24	41.80	50.52	57.86	4.85	5.18	7.07	7.48	8.43	17.36	27.15	1.30

N_2K_3	24.54	34.33	41.9 3	49.69	5.85	4.87	5.75	6.92	7.32	8.33	15.16	24.90	1.14
N_3K_0	24.63	33.47	41.1 6	47.12	52.49	4.85	5.68	6.82	7.08	8.97	12.46	19.56	0.93
N_3K_1	24.64	34.10	41.4 2	48.05	53.97	4.82	5.60	6.78	7.12	8.08	13.87	21.40	1.04
N_3K_2	24.62	34.77	42.4 9	49.86	55.02	4.83	5.88	6.75	7.28	8.22	14.76	23.35	1.13
N_3K_3	24.57	34.1 1	42.7 0	49.3 5	45.2 2	4.85	5.78	6.73	7.2 0	8.1 3	14.08	21.92	1.04
LSD (0.05)	0.34	2.07	0.82	0.94	0.77	0.11	0.34	0.12	0.10	0.37	0.55	0.05	0.06
LSD (0.01)	0.46	2.75	1.09	1.25	1.03	0.15	0.45	0.16	0.14	0.49	0.73	0.67	0.08

Treatment combinations	Plant height (cm) at					Number of green levels plant ⁻¹ at					Fresh weight bulb plant ⁻¹ (g)	No. of cloves bulb ⁻¹	Yield plot ⁻¹ (kg)
	30 DAP	45 DAP	60 DAP	75 DAP	90 DAP	30 DAP	45 DAP	60 DAP	75 DAP	90 DAP			
G ₁ N ₀ K ₀	24.11	26.14	30.55	34.55	37.53	4.70	5.10	5.47	6.40	7.10	7.32	13.30	0.48
G ₁ N ₀ K ₁	24.10	30.27	33.38	37.84	42.53	4.67	5.53	5.77	6.67	7.27	8.63	15.37	0.64
G ₁ N ₀ K ₂	24.07	32.42	35.91	39.95	45.15	4.70	5.37	6.10	6.73	7.33	10.18	16.90	0.76
G ₁ N ₀ K ₃	24.14	32.20	36.33	39.69	44.38	4.77	5.83	5.87	6.73	7.27	9.67	16.02	0.73
G ₁ N ₀ K ₀	24.16	30.89	37.01	43.56	47.27	4.77	6.00	6.57	7.03	7.67	10.34	16.50	0.78
G ₁ N ₁ K ₁	24.07	32.52	37.46	44.13	49.31	4.77	5.47	6.30	7.10	7.73	10.80	17.97	0.81
G ₁ N ₁ K ₂	24.03	33.15	37.58	44.58	51.27	4.73	5.53	6.60	7.27	7.80	12.40	19.20	0.93
G ₁ N ₁ K ₃	24.05	32.32	38.02	44.12	51.00	4.77	5.37	6.20	6.93	7.70	12.13	18.47	0.89
G ₁ N ₂ K ₀	24.15	32.77	39.07	46.62	51.57	4.80	5.67	6.80	7.10	8.00	13.16	19.97	0.99
G ₁ N ₂ K ₁	24.08	33.54	39.64	47.58	53.80	4.83	5.73	6.70	7.17	8.10	14.03	21.40	1.05
G ₁ N ₂ K ₂	24.15	36.41	40.35	49.65	56.28	4.80	6.00	6.83	7.27	8.17	17.06	24.87	1.28
G ₁ N ₂ K ₃	24.05	33.80	40.57	49.39	55.23	4.80	5.47	6.70	7.03	8.03	14.49	24.07	1.09
G ₁ N ₃ K ₀	24.10	32.40	39.85	46.14	51.01	4.80	5.60	6.73	6.93	7.80	12.38	19.83	0.93
G ₁ N ₃ K ₁	24.10	34.61	40.14	46.96	52.87	4.77	5.53	6.63	7.07	7.87	13.73	20.57	1.93
G ₁ N ₃ K ₂	24.14	34.053	41.58	49.58	53.87	4.77	5.73	6.67	7.10	8.00	13.58	21.77	1.07
G ₁ N ₃ K ₃	24.05	33.05	41.47	49.41	52.76	4.80	5.67	6.57	7.20	7.93	12.87	21.27	0.96
G ₂ N ₀ K ₀	24.77	27.20	33.51	35.65	38.77	4.87	5.30	6.23	6.50	7.40	8.16	14.47	0.57
G ₂ N ₀ K ₁	25.00	31.86	35.06	39.36	44.27	4.87	5.70	5.97	6.73	7.57	9.06	15.87	0.68
G ₂ N ₀ K ₂	25.11	32.75	36.34	41.40	46.42	4.83	5.83	6.43	6.87	7.63	10.21	17.87	0.77
G ₂ N ₀ K ₃	25.23	31.88	36.57	40.66	45.77	4.87	5.87	6.40	6.73	7.70	9.89	17.23	0.74
G ₂ N ₁ K ₀	25.24	32.59	38.96	45.26	49.16	4.87	5.83	6.77	7.07	7.97	11.56	18.37	0.87
G ₂ N ₁ K ₁	25.26	33.51	39.51	46.84	52.38	4.90	5.8	6.73	7.13	8.07	12.11	20.07	0.91
G ₂ N ₁ K ₂	25.23	33.51	40.14	47.66	54.45	4.90	5.9	6.83	7.27	8.13	12.56	21.97	0.94
G ₂ N ₁ K ₃	25.12	31.29	40.25	47.14	53.20	4.93	6.07	6.80	7.07	8.17	11.62	20.57	0.87
G ₂ N ₂ K ₀	25.16	34.70	41.86	48.81	54.40	4.87	6.00	7.07	7.47	8.43	15.07	19.87	1.13

G₂N₂K₁	25.0 9	35.37	42.0 9	49.7 9	55.6 7	4.93	6.17	7.13	7.60	8.57	15.95	23.70	1.20
G₂N₂K₂	25.1 6	38.68	43.2 4	51.3 9	59.4 3	4.90	6.37	7.30	7.70	8.70	17.65	29.43	1.32
G₂N₂K₃	25.0 3	34.86	43.2 8	49.9 9	56.4 6	4.93	6.03	7.13	7.60	8.63	15.82	25.73	1.19
G₂N₃K₀	25.1 6	34.55	42.4 7	48.2 7	53.9 7	4.90	5.77	6.90	7.23	8.13	12.54	19.28	0.94
G₂N₃K₁	25.1 8	3.58	42.7 0	49.1 5	55.0 7	4.87	5.67	6.93	7.17	8.30	14.01	22.23	1.05
G₂N₃K₂	25.1	35.03		50.1 5	56.4 7	4.90	6.03	6.83	7.47	8.43	15.94	24.93	1.20

a =unit plot size was 1.2 m x 1.0 m	G ₁ = Accession G ₁₉ G ₂ = Accession G ₂₀
N ₀ = 0 kg N/ha N ₁ =100kg N/ha N ₂ =200kg N/ha N ₃ = 300 kgN/ha	K ₀ =0kg K ₂ O/ha K ₁ = 100kgK ₂ O/ha K ₂ =200kg K ₂ O/ha K ₃ =300kgK ₂ O/ha

Table 07:-Combined effect of garplasm, nitrogen and potassium on the growth and yield of garlic

a =unit plot size was 1.2 m x 1.0 m	G ₁ = Accession G ₁₉ G ₂ = Accession G ₂₀
N ₀ = 0 kg N/ha N ₁ =100kg N/ha N ₂ =200kg N/ha N ₃ = 300 kgN/ha	K ₀ =0kg K ₂ O/ha K ₁ = 100kgK ₂ O/ha K ₂ =200kg K ₂ O/ha K ₃ =300kgK ₂ O/ha

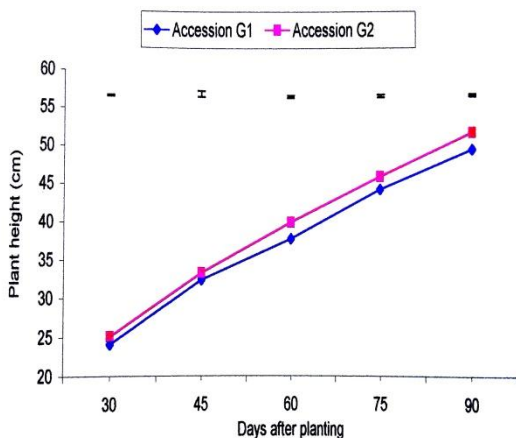


Fig. 1:-Effect of garplasm on plant height of garlic at different days of planting

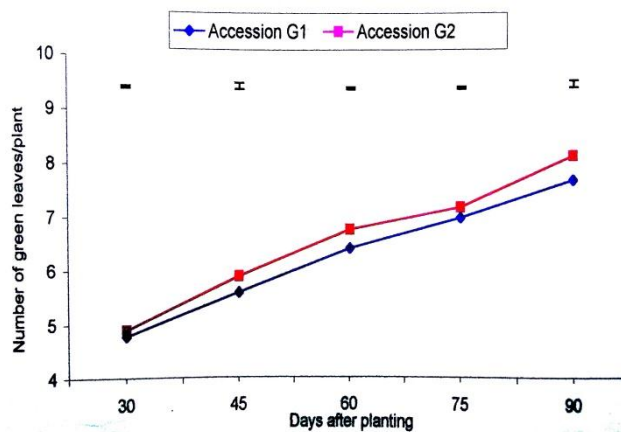


Fig. 2:-Effect of garplasm on no. of green leaves of garlic at different days of planting

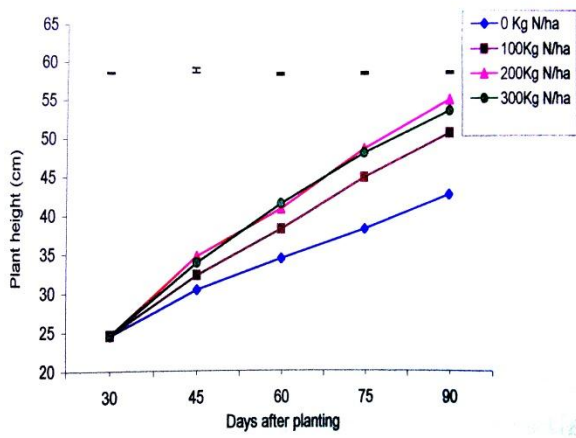


Fig. 3:-Effect of nitrogen on plant height of garlic at different days of planting

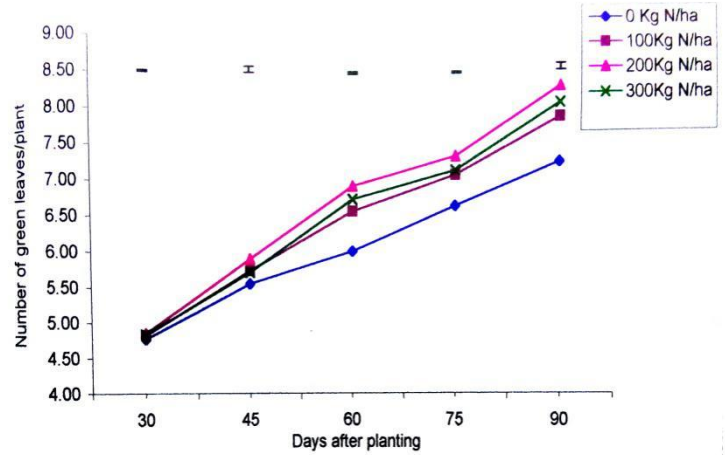


Fig. 4:-Effect of nitrogen on no. of green leaves of garlic at different days of planting

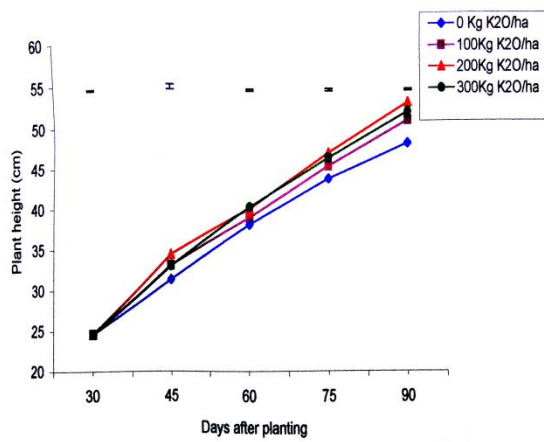


Fig. 5:-Effect of potassium on plant height of garlic at different days of planting

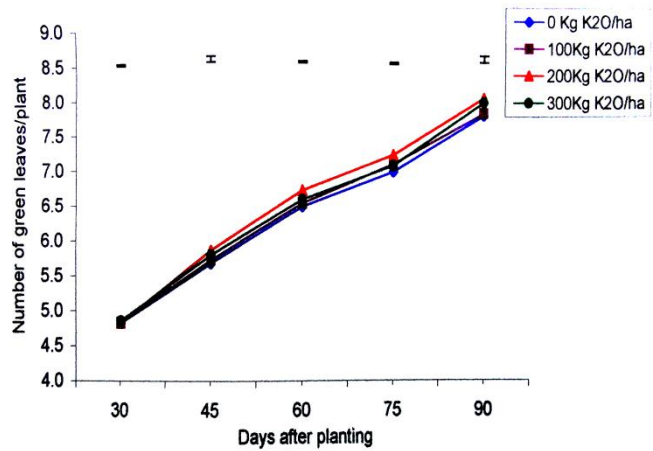


Fig. 6:-Effect of potassium on no. of green leaves of garlic at different days of planting

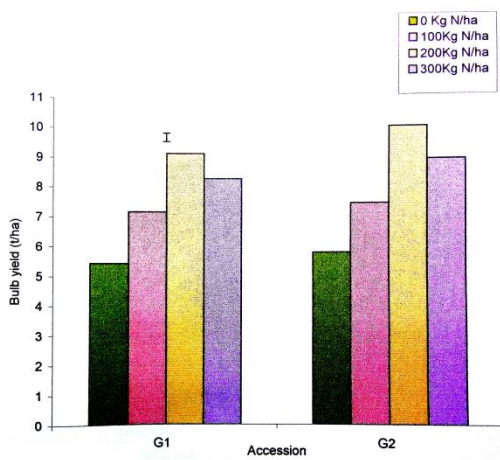


Fig. 7:-Combined effect of germplasm and nitrogen on the yield of garlic (t/ha) at different days of planting

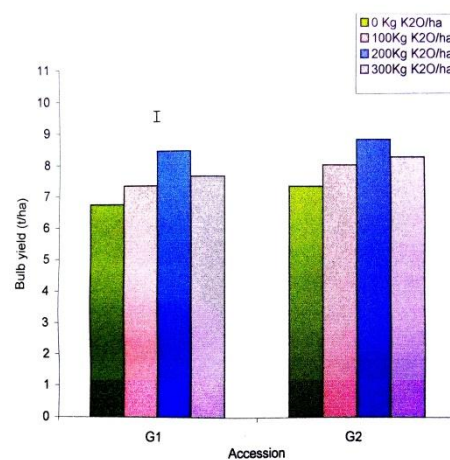


Fig. 8:-Combined effect of germplasm and potassium on the yield of garlic at different days of planting

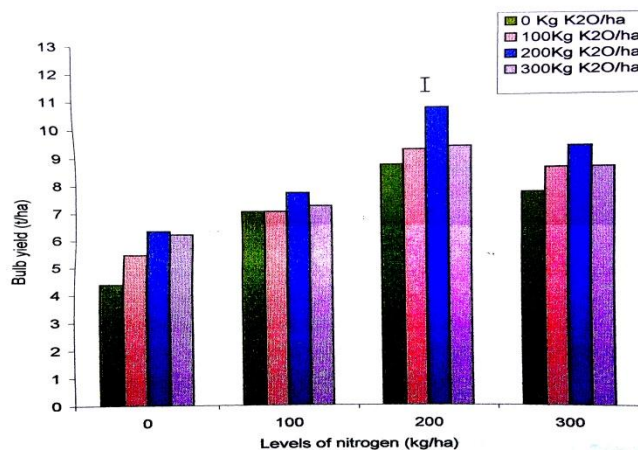


Fig. 9:- Combined effect of nitrogen and potassium on the yield of garlic (t/ha) at different days of planting
In all the figure vertical bars indicate LSD at 0.05 level

References:-

- Allen, J. (2009). Garlic production. Factsheet, Garlic production, order number 97-007. www.omafra.gov.on.ca/english/crops/facts/09-011w.htm
- Amin, M. R. (1998). Effects of different levels of nitrogen and potassium on the growth and yield of garlic. M. Sc. Thesis. Dept. of Hort. Bangladesh Agril. Univ., Mymensingh, 79.
- BBS. (2017). Statistical Pocket Book of Bangladesh. Bangladesh Bureau of Statistics, Stat. Div., Minist. Planning, Govt. People's Rep. Bangladesh, 143-145.
- Bertoni, G. & Morard du L. Espagnacq, P. (1988). Dynamique de l'absorption des elements mineraux l'ail (*Allium sativum* L.). *Agrochimica*, 32 (5-6): 519-530.
- Brahma, S. & Yousuf, M. N. (2008). Effect of nitrogen and potassium on the growth and yield of garlic. Research Report for 2007-2008. Spices Research Centre, BARI Shibgong, Bogra, 77-81.
- Brewster, J.L. (1994). Onions and other vegetable Alliums. CAB International, Wallingford, UK.
- Buwalda, J. G. & Freeman, R. E. (1987). Effect of nitrogen fertilizers on the growth and yield of potato, onion, garlic and hybrid squash. *Scientia Hort.* 33 (3/4): 61-173.
- Cassman, K. Dobermann, A. and Walters, D. (2002). Agroecosystems, nitrogen use efficiency and nitrogen management. *Ambio* 31(2), 132-140.
- Fernandes, J.C.F., Büll LT., Corrêa, J.C., Pavan, M.A. & Imaizumi, I. (2010). Resposta de plantas de alho livres de vírus ao nitrogênio em ambiente protegido. *Hortic. Bras.*, 28(1): 97-101.
- Food and Agricultural Organization (FAO). (2003). Global review of area and production of garlic, 135-139.
- Fritsch, F. N. Christian, N. G. & Ferreya, E. R. (1990). Response of garlic (*Allium sativum* L.) cv. Espanol INIA to nitrogen fertilization. *Investigation Agricola*, 10 (2): 85-89 [Cited from Hort., 66 (10): 990,1992].
- Garcia, A. (1980). Sprouting before harvest in garlic. *Commun. Tech. Emp. Bras. Pesqui. Agropecu. Pelotas*, 9, 3.
- Hedge, D.M. (1988). Effect of irrigation and nitrogen fertilizers on yield, quality, nutrient uptake and water use of onion (*Allium cepa* L.). *Singapore J. Printice Hall of. India*, 16(2): 111-123.
- Hossain, M. M. (1997). Effect of different levels of nitrogen and potash on the growth and yield of garlic. M.Sc. Thesis. Dept. of Hort., Bangladesh Agril. Univ., Mymensingh, 65.
- Kamenetsky, R., & Rabinowitch, H.D. (2001). Floral development in bolting garlic. *Sex. Plant Repr.*, 4, 235-241.
- Karic, L., Vukasinovic S. and Znidarcic. D. (2005). Response of leek (*Allium porrum* L.) to different levels of nitrogen dose under agro-climate conditions of Bosnia and Herzegovina. *Acta agriculturae Slovenica*, 85(2): 219-226.
- Kilgori, M., Magaji M. & Yakubu A. (2007b). Productivity of two garlic (*Allium sativum* L.) cultivars as affected by different levels of nitrogenous and phosphorous fertilizers in Sokoto, Nigeria. *American-Eurasian Journal of Agriculture and Environmental Science*, 2(2): 158-168.
- Koltunov, V.A. (1984). Effect of different fertilizer rates and garlic productivity and storability. *V'isn. Sil's kogospodars koi Nauki*. 11: 52-54.

19. Lachica, J. F. (1982). The effect of tillage, NPK levels and population density on the growth and yield of garlic. *CLSU Scientia. J.*, 3(2): 9-19.
20. Macêdo, F.S., Souza, R.J., Carvalho, J.G. Santos, B.R. & Leite L.V.R. (2009). Produtividade de alho vernalizado em função de doses de nitrogênio e molibdênio. *Bragantia*, 68(3): 657-663.
21. Nai-hua, Y. Dingguo, Z. & Wang, J. (1998). Phosphorus and Potassium Nutrient Management for Vegetable Soils in Shanghai and Guangdong. In: Donald L. Armstrong (Ed.), *Better Crops International*, 12(1): 1.
22. Nonnecke, I.L. (1989). *Vegetable Production*, New York. 657.
23. Salomon, R. (2002). Virus diseases in garlic and the propagation of virus free planting. In: Rabinwitch, H.D. and L. Currah (Eds.). *Allium crop sciences: Recent advances*. CAB International, Wallingford, UK. 311-327.
24. Samavatean, N, Rafiee. S, Mobli. H, & Mohammadi. A, (2011). An analysis of energy use and relation between energy inputs and yield, costs and income of garlic production in Iran. *Renewable Energy*, 36: 1808-1813.
25. Setty, B. S., Sulikeri G. S. & Hulamani N. C. (1989). Effect of N, P and K on growth and yield of garlic (*Allium sativum* L.). *Karnataka J. Agril. Sci*, 2 (3): 160-164.
26. Soto, J.A. (1988). Nutritional requirements of onion (*Allium cepa* L.) in the soils of northern cartago II. Critical levels for PK and S response to N. *Agron. Costarricense*, 12(1): 52-57.
27. Talukder, A.F.M., Rahim M.A. & Anwar H.R.M.M. (1998). Effect of planting time with different levels of nitrogen on the growth and yield of garlic. *Bangladesh J. Train. Dev.*, 13(1 &2): 159-166.
28. Uddin, A.F.M.J. (1993). Effect of planting time, nitrogen and potash levels on the growth and yield of garlic. M. Sc. Thesis, Dept. Hort., Bangladesh Agril. Univ., Mymensingh. 39.
29. Voigt, C. (2004). Gloriousgarlic herb of the year 2004. *Journal of International Herb Association Horticulture Committee*, Virginia State University. 1-6.
30. Zaman, M.S., Hashem M.A., Jahiruddin M., & Rahim M.A., (2011). Effect Of Nitrogen For Yield Maximization Of Garlic In Old Brahmaputra Flood Plain Soil. *Bangladesh Journal of Agricultural Research*, 36(2): 357-367.
31. Zhou, Y., Wang D., Zhu, J., Liu, Q. & Fan, M.X. (2005). The role of sulfur fertilizers in balanced fertilization. In: L.J. De Kok and E. Schnug (eds.), *Proceedings of the 1st Sino-German Workshop on Aspects of Sulfur Nutrition of Plants 23-27 May 2004 in Shenyang, China*, Landbauforschung Völkenrode, Special Issue 283:171-176.