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Response of Integrated Nutrient Management on Growth and Yield of Garlic. (*Allium sativum* L.) Cv.G-282

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ABSTRACT: An experiment was conducted during Rabi season 2019-20 at the Department of Agriculture Integral Institute of Agricultural science and Technology (IIAST), Integral University, Lucknow (U.P.). The experiment was laid out in a randomized block design with seven treatments and three replications. The treatments consisted of application of different combinations of biofertilizers. Biofertilizer increased the growth characters and yield in garlic. The maximum plant height was recorded (53.20 cm), Length of leaves (40.00 cm) and the maximum diameter of stem (13.41 mm) was recorded during investigation in T6 (*Azatobactor* @ 4 Kg/ha + *Azospirillum* @ 3 Kg/ha) and maximum yield was recorded in T_6- *Azatobactor* @ 4 Kg/ha + *Azospirillum* @ 3 Kg (9.00 t/ha). While minimum result was observed under T_0 control.

Keywords: INM, Biofertilizer, Growth and Quality.

INTRODUCTION

Garlic (*Allium sativum* L.) belonging to family Alliaceae it is the second important bulb crop after onion in India. Garlic originated from central Asia and spread to other parts of the world. In our country it is produced for home consumption as spice or condiment in the preparation of soup, pickle and other preservatives as well as a source of income (Alemu & Kassaet 2016). India leads in area and production of Garlic in the world. This occupies the production is 1.7 million tons out of total production of 28.7 million tons in the country. The productivity of Garlic in India is 1091.83 t/ha. The major producing states in India are Uttar Pradesh, Rajasthan, Bihar, Gujarat, Punjab, and Assam. Among these major growing states in the country, Uttar Pradesh has the reputation in producing quality of garlic. The cultivated area and production of Garlic in up is 190.5 million hectares. The productivity of Garlic in the state is 7.43 mt/ha. Its health benefits are varied and many Principles from garlic have been shown to have antibacterial, antifungal, antiviral and anti-protozoal activities. They also modulate the cardiovascular and immune systems, and have antioxidant and anticancer properties (Harris and Mantle 2001). A fresh bulb of garlic contains about (62.8%) moisture, (0.1%) fat, (0.8%) fiber and good source of carbohydrates, vitamin- C, Selenium, Phosphorous and Manganese (Verma *et al.*, 2018).

Plant nutrients plays an important role in crop production and used various source of nutrients, they supplied various essential plant nutrients for proper growth and internal metabolic activities in plant body. The integrated nutrient management is helpful in increasing the growth and yield in garlic. The growth and yield potential of garlic can be increased by application of different types of biofertilizer. The term “Bio-fertilizer” or more appropriately “Microbial inoculants” can generally be defined as preparation containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulolytic microorganism used for application to seeds, soils or composting areas with the objective of increasing the number of such microorganisms and accelerate those microbial process which augment the availability of nutrients that can be easily assimilated by plants (Damse *et al.*, 2014). Bio-fertilizers have beneficial return to increase population of soil microorganisms, especially in the surface layer of root rhizosphere, that create substances which stimulate plant growth (Kowser *et al.*, 2017).

Free- living nitrogen-fixing bacteria; e.g., *Azotobacter*, and *Azospirillum* were found to have not only the ability to fix N but also the secrete growth promoting factors similar to gibberellic acid and indole acetic acid, cytokines and auxins which could stimulate plant growth, increased root length and were responsible for root hair branching with an eventual increase in absorption of nutrients, and their ability to produce antibacterial and antifungal compounds (George *et al.*, 1995).

Bio-fertilizer increases soil fertility and crop yield, the use of bio-fertilizers has currently attained a special significance in crop production to address the sustainability issues and also, bio-fertilizers are known to play an important role in increasing availability of nitrogen and phosphorus beside producing hormones and anti-metabolites (Gill *et al.,* 1987).

MATERIAL AND METHOD

The present research work was conducted at Farm unit no. 6 Department of Agriculture, Integral Institute of Agricultural science and Technology (IIAST) Integral University, Lucknow-226026 (U.P.) during rabi season in the year 2019-20.

Growth attributes:

1. **Plant height (cm)**: The height of plants was measured from ground level to apex of the plant at 30 DAS, 60 DAS and at a time of harvesting. The average height was recorded and expressed in cm.

2. **Length of Leaves (cm):** The length of leaves is recorded from ground level to apex the length at 30 DAS, 60 DAS and at a time of harvesting. The average length was recorded and expressed in cm.

3. **Diameter of stem (mm):** The diameter of stem is recorded to apex the length at 30 DAS, 60 DAS and at a time of harvesting. The average diameter was recorded and expressed in cm.

Treatment and Notations: The treatment tested in this experiment and their notations followed in the text of this research are given ahead.

Notations	Treatments
T0	Control
T1	RDF@ (N: P: K) 100: 50: 50 (Kg/ha)
T2	*Azatobactor* (100%) @ 8 Kg/ha
T3	*Azospirillum* (100%) @ 6 Kg/ha
T4	50%RDF+Azotobactor (50%) @ 4 Kg/ha
T5	50%RDF + *Azospirillum* (50%) @ 3 Kg/ha
T6	*Azatobactor* (@ 4 Kg/ha) + *Azospirillum* (@ 3 Kg)

RESULT AND DISCUSSION

Data was collected from five randomly selected plants leaving the border row and were tagged for recording periodical observations. Growth parameters were recorded at 30DAS, 60DAS and at a time of harvesting.

A. Growth attributes

Plant height (cm). The height of plants was measured from ground level to apex of the plant at 30 DAS, 60 DAS and at a time of harvesting. The average height was recorded and expressed in cm. These are tabulated and graphically analyzed statistically in (Table 1, Fig. 1). The data showed that the maximum plant height at 30 DAS was measured under the treatment T_6 (13.09cm) which is at par with T_4 (12.70cm) and the minimum plant height was recorded in T_0 (10.32 cm). At 60 DAS maximum plant height was recorded under the treatment T_6 (23.00cm), FollSowed by T_4 (23.21) and minimum plant height in T_0 (19.70cm). At the time of Harvest maximum plant height was recorded in T_6 (53.20cm) followed by T_4 (53.03 cm) and T_5 (52.96 cm) which was statically significant with each other. The minimum plant height was recorded in T_0 control (44.08cm). The plant height was significantly influenced by integrated source of nutrients at all the stages of crop growth. Increase in plant height was might be due to enhanced availability of nutrients and production of some growth promoting substances that might have caused cell elongation and multiplication. Further, nitrogen might have increased the chlorophyll content of leaves and resulted in increased synthesis of carbohydrates, which in turn has influenced cell elongation and multiplication and hence accelerated the vegetative growth (Yadav *et al.*, 2003). These results also conformity with the findings in Manzoor *et al.* (2006).

Table 1: Response of Integrated Nutrient management on Plant Height (cm).

Symbol	Treatment		Plant Height (cm)	
		30DAS	60DAS	At the time of Harvesting
T_0	Control	10.32	19.70	44.8
T_1	RDF @ (N: P: K) 100:50:50(Kg/ha)	12.45	23.23	53.11
T_2	*Azatobactor* (100%) @ 8 Kg/ha	12.62	22.96	52.64
T_3	*Azospirillum* (100%) @ 6 Kg/ha	12.38	23.00	52.59
T_4	50% RDF +*Azatobactor* (50%) @ 4 Kg/ha	12.70	23.21	53.03
T_5	50% RDF +*Azospirillum* (50%) @3Kg/ha	12.28	22.20	52.98
T_6	*Azatobactor* (@ 4 Kg/ha) +*Azospirillum* (@ 3 Kg)	13.09	23.52	53.20
SE(m)± **C.D. (5%)**		**0.145** **0.451**	**0.163** **0.508**	**0.116** **0.361**

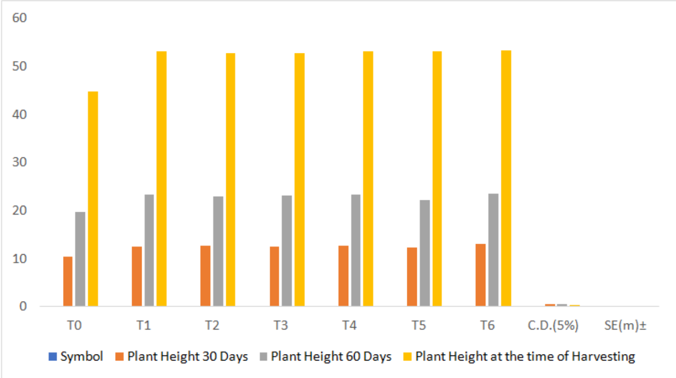

Fig. 1. Response of Integrated Nutrient management on Plant Height (cm).

Length of Leaves (cm): The length of leaves is recorded from ground level to apex. The length of leaves was recorded 30 DAS, 60 DAS and at a time of harvesting. The average Length was recorded and expressed in cm. These are tabulated and graphically analyzed statistically in (Table 2, Fig. 2). The data showed that the maximum length of leaves per plant at 30 DAS was measured under the T_6 (18.91cm) and minimum length of leaves per plant was measured under treatment T_0 (13.21 cm). At 60 days after sowing maximum length of leaves per plant was under treatment T_6 (26.53cm) followed by T_6 (26.42 cm), T_2 (26.45 cm), T_3 (26.39 cm), T_4 (26.40 cm), and T_5 (26.33 cm) which was statically significant with each other and minimum length of leaves per plant was recorded under T_0 control (25.15 cm). At a time of harvesting maximum length of leaves per plant was measured under the treatment T_6 (40.00 cm) followed by T_2 (39.75cm) and minimum length of leaves per plant was measured under T_0 (37.16 cm). Similar observation was recorded in case of length of leaves which showed that application of *Azotobacter* @ 100% recorded maximum length of leaves which was corroborated with the finding of these results are in conformity with the findings of Rohidas *et al.* (2010).

Table 2: Response of Integrated Nutrient management on Length of leaves (cm).

Symbol	Treatment	Length of leaves (cm)		
		30DAS	**60DAS**	**At the time of Harvesting**
T_0	Control	13.21	25.15	37.16
T_1	RDF @ (N: P: K) 100:50:50 (Kg/ha)	15.34	26.53	39.37
T_2	*Azatobactor* (100%) @8Kg/ha	18.41	26.45	39.75
T_3	*Azospirillum* (100%) @ 6 Kg/ha	16.73	26.39	38.71
T_4	50% RDF + *Azatobactor* (50%) @ 4 Kg/ha	18.51	26.40	39.32
T_5	50% RDF +*Azospirillum* (50%) @ 3 Kg/ha	18.16	26.33	38.43
T_6	*Azatobactor* (@ 4 Kg/ha) +*Azospirillum* (@ 3 Kg)	18.91	26.42	40.00
SE(m)±		**0.056**	**0.067**	**0.156**
C.D. (5%)		**0.175**	**0.210**	**0.485**

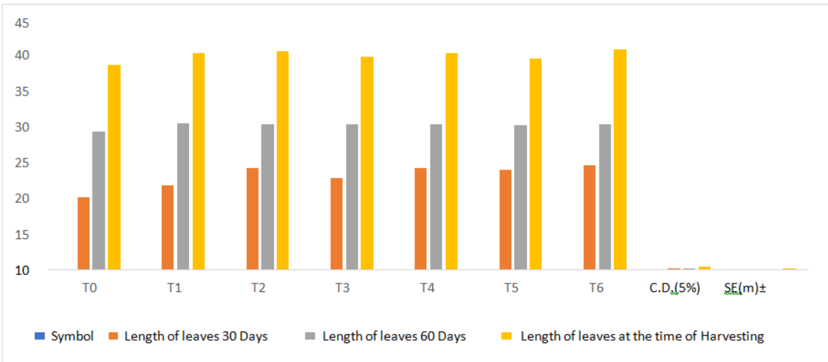

Fig. 2. Response of Integrated Nutrient management on Length of leaves (cm).

Diameter of stem (mm): The diameter of stem data observed at 30 DAS, 60 DAS and at a time of harvesting. These are tabulated and graphically analyzed statistically in (Table 3, Fig. 3). The data showed that the maximum diameter of stem at 30 DAS was recorded in T_4 (4.42 mm) at 60 DAS maximum diameter of stem was recorded in T_3 (6.93mm) while at a time of harvesting maximum diameter of stem was recorded in T_6 (13.41 mm) and the minimum diameter of stem was T_0 (7.61mm). Stem thickness might be due to appropriate fertilizer dosage and inherent plant growth regulators Indole acetic acid and Indole lactic acid associated with *Azospirillum* which might had promoted. root and shoot development in onion plant and had fixed substantial amount of atmospheric nitrogen. Biofertilizers promoted proliferation and nutrient based establishment of roots leading to profuse vegetative growth. These findings are in close conformity with outcomes revealed by Ram (2012). These results are also conformity with the findings of Kumar *et al.* (2011).

Yield (t/ha). The yield (t/ha) data taken at after harvesting harvest. These are tabulated and graphically analyzed statistically in Table 4 and the data showed that the maximum yield t/ha was recorded under treatment T_6 (9.00 t/ha) which was at par with treatment T_4 (8.28 t/ha) and the minimum yield t/ha was recorded in T_0 (5.67t/ha). The increase in bulb yield owing to this treatment may be due to the fact that N and P play an important role in synthesis of chlorophyll and amino acid and *Azotobacter* and PGPR ensured the continuous supply of these nutrients, very limited work has been earned out on the use of bio-fertilizers in garlic. The higher yield was found in onion with those receiving *Azospirillum* and PSB in combination with chemical fertilizers against to their corresponding treatments without biofertilizer could be due to association with higher population of these N fixing bacteria and PSB in the soil which activated the more effective interaction with plant roots to ensure higher nutrient uptake (Ismail, 1995). The yield improvement might be due to vigorous habit in terms of plant height, leaf length, number of leaves and plants developed under *Azospirillum* or *Azotobacter*. *Azospirillum* might have fixed higher amount of nitrogen in soil and made available to the plants resulting in better uptake of N by plants This ultimately may increase the photosynthetic assimilation. All these physiological activities brought about increase in bulb size and bulb weight as the weight of individual bulb increased it reflected positively on the total bulb yield. The results are closely in consonance with the finding of Singh and Singh *et al.* (2002).

Table 3: Response of Integrated Nutrient management on diameter of Stem (mm).

Symbol	Treatment	Diameter of Stem (mm)		
		30DAS	60DAS	At the time of Harvesting
T_0	Control	3.41	6.07	7.61
T_1	RDF @ (N: P: K) 100: 50: 50 (Kg/ha)	4.21	6.90	11.90
T_2	*Azatobactor* (100%) @ 8 Kg/ha	4.19	6.65	12.43
T_3	*Azospirillum* (100%) @ 6 Kg/ha	4.29	6.93	11.73
T_4	50% RDF + *Azatobactor* (50%) @ 4 Kg/ha	4.42	6.78	12.41
T_5	50% RDF + *Azospirillum* (50%) @ 3 Kg/ha	4.17	6.80	12.32
T_6	*Azatobactor* (@4Kg/ha) +*Azospirillum* (@ 3 Kg)	5.13	8.27	13.41
SE(m)± **C.D. (5%)**		**0.043** **0.135**	**0.064** **0.199**	**0.059** **0.184**

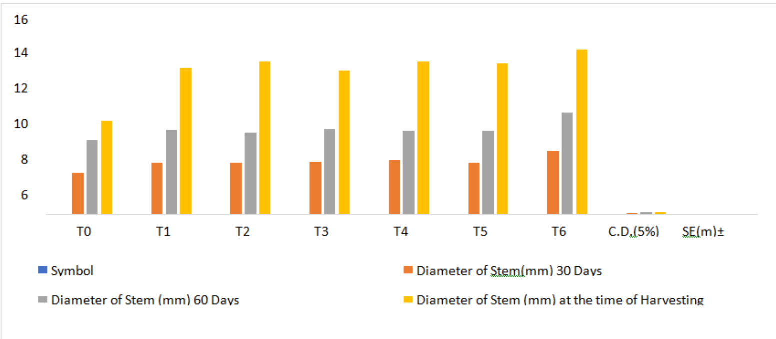

Fig. 3. Response of Integrated Nutrient management on diameter of Stem (mm).

Table 4: Response of Integrated Nutrient management on Yield (t/ha).

T_0	Control	5.67
T_1	RDF @ (N: P: K) 100: 50: 50 (Kg/ha)	8.02 8.38
T_2	*Azatobactor* (100%) @ 8 Kg/ha	8.28
T_3	*Azospirillum* (100%) @ 6 Kg/ha	7.05
T_4	50% RDF + *Azatobactor* (50%) @ 4 Kg/ha	6.02
T_5	50% RDF + *Azospirillum* (50%) @ 3 Kg/ha	7.23
T_6	*Azatobactor* (@ 4 Kg/ha) +*Azospirillum* (@ 3Kg)	9.00
SE(m)± **C.D. (5%)**		0.138 0.429

CONCLUSIONS

On the basis of the forgoing discussion it can be concluded that the Integrated nutrient management is help in increasing the growth and yield of garlic. The growth and yield potential of garlic can be increased by application of (*Azatobactor* @ 4 Kg/ha + *Azospirillum* @ 3 Kg/ha) which is found most effective for increasing vegetative characters as well as increase the yield of garlic. Therefore if we are seen all these things we say this dose of biofertilizer was performed better with respect to growth characters as well as yield.

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Conflict of Interest. None.

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