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IMPROVEMENT OF GROWTH, YIELD AND QUALITY OF GARLIC (*ALLIUM SATIVUM* L.) CV. G-282 THROUGH A NOVEL APPROACH

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ABSTRACT
Garlic (*Allium sativum*L.) is one of the important members of family Alliaceae and use as vegetable as well as spices. The present experiment was conducted to find out the effect of bioregulators and liquid manuring on vegetative growth, yield and quality of garlic cv. G-282 under Lucknow condition. The experiment comprised with 9 treatments *i.*e. GA_3 @ 30 ppm,40 ppm and 50 ppm, NAA @ 275 ppm, 300 ppm, and 325 ppm, GA_3 @ 30 ppm + Liquid manure (LM) @ 100 ppm and NAA @ 275 ppm + Liquid manure (LM) @ 100 ppm and were replicated thrice and laid down following randomized block design. The results showed that among the all treatments, application of Gibberellic acid (GA_3) @ 30 ppm + Liquid manure (LM) @ 100 ppmimproving vegetative growth (plant height- 68.24 cm, leaf number- 9.09, basal diameter- 14.17 cm at 120 DAP), bulb yield (10.10 t/ha)and fresh (27.58g) and dry weight (7.51g) of bulb and TSS (32.42 ^{0}B). Thus, it can be concluded that treatment T_7 (GA_3 @ 30 ppm + Liquid manure (LM) @ 100 ppm) may be suggested for better growth and yield of garlic cv. G-282 under Lucknow subtropical condition.

INTRODUCTION

Organic and less hazardous production of garlic (*Allium sativum*L.) is now popularizing as garlic is one of the foremost Alliaceous crops (Alliaceae family), used as spice crop as well as vegetables. It is originated in Central Asia and Southern Europe especially in Mediterranean region (Thompson and Kelly, 1957). India is the second major producing country of garlic having 2.01 lakh ha. area, 1058 lakh mt production and 5.27 t/ha productivity next after China. India exported 22665.99 mt. garlic amounting Rs. 3957.75 lakh during 2012-13 (Anon., 2014). Allicin (allyl 2-propen ethiosulfinate or diallylthiosulfinate) is the principal bio-active compound present in garlic extract (Augusti and Mathew, 1975) which reduces level of blood cholesterol. Garlic has been considered as a rich source of carbohydrate, protein and phosphorus (Kurian, 1995). Basically, garlic contains many effective compounds [Allicin, allyl methyl thiosulfonate, 1-propenylallyl thiosulfonate and L- glutamyl-S-alkyl-L- cysteine] that exhibit antibiotic (Bakri and Daglas, 2005; Rees *et al.*, 1993; Yoshida *et al.*, 1998), antioxidant (Augusti and Sheela, 1996; Anwar and Meki, 2003), anticoagulant (Kiesewetter *et al.*, 1991; Ali and Thompson, 1995; Bordia *et al.*, 1996; Ali and Thomson, 1990; Thomson *et al.*, 2000), Hypocholesterolaemic (Ali *et al.*, 2000), Hypoglycemic (Augusti and Sheela, 1996), hypertensive activities (Ali *et al.*, 2000; Banerjee and Maulic, 2002), platelet aggregation (Rahman and Billington, 2000; Bordia, 1978; Bordia *et al.*, 1998; Venderhock *et al.*, 1980; Srivastava, 1986; Samson, 1982; Steiner and Lin, 1998; Baullin, 1981), antifungal (Dhingani *et al.*, 2013 and Saunshi *et al.*, 2014) and blood pressure lowering effect (Damru,1941; Harenberg *et al.*, 1988). Gibberellin, one of the important plant bio-regulators plays a major role in diverse growth processes including seed development, organ elongation, senescence and control of time of flowering (Ouzounidou *et al.*, 2008; Singh *et al.*, 2013, Das *et al.*, 2006 and Kumawat *et al.*, 2014). Liquid manure and some biodynamic preparations like- Panchagavya, Jeevamruth and Beejamruth contain macro and micro nutrients, vitamins, essential amino acids, growth promoting factors like IAA, GA and also beneficial microorganisms (Palekar, 2006 and Sreenivasa *et al.*, 2010). The liquid manure made from the natural sources is eco-friendly and gives sufficient nutrition for the plants without bad side effects for the crops or human beings. Both the bioregulators and liquid manures have influencing effect on garlic growth and yield, though no literature has been found in this regards specially for liquid manuring. Although, liquid manuring is very easy to prepare from kitchen waste and is very effective for waste management. Thus, the present investigation has been conducted with the main objective to assess the influence of plant bio-regulators and liquid manure on vegetative growth, yield and quality of garlic grown under Lucknow subtropical condition.

MATERIALS AND METHODS

The experimental site is situated at 26º50′ N latitude, 80º52′E longitude and altitude of 111 meter above mean sea level at

Horticultural Research Farm (soil pH of 8.2), Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow-226025 during 2013 - 2014. Planting materials viz. bulbs of garlic (*Allium sativum* L.) cv. G-282 were obtained from National Horticulture Research Development Foundation (NHRDF), Kanpur. The field experiment was laid down with nine treatments with three replications following randomized block design. The treatment combinations were T_0-Control (Water spray), T_1-Gibberellic acid (GA_3) @ 30 ppm, T_2-Gibberellic acid (GA_3) @ 40 ppm,T_3-Gibberellic acid (GA_3) @ 50 ppm, T_4-Naphthalene acetic acid (NAA) @ 275 ppm, T_5-Naphthalene acetic acid (NAA) @ 300 ppm, T_6-Naphthalene acetic acid (NAA) @ 325 ppm,T_7-Gibberellic acid (GA_3) @ 30 ppm + Liquid manure (LM) @ 100 ppm,T_8-Naphthalene acetic acid (NAA) @ 275 ppm + Liquid manure (LM) @ 100 ppm. Cloves were planted at the spacing of 18 x 15 cm accommodating 16 cloves per plot. Light irrigation was given prior planting just to moisten the soil. The NAA, GA_3 and liquid manures were applied as foliar spray on 30, 45 and 60 days after planting (DAP). NAA and GA_3 solution were prepared by dissolving required amount of bio-regulators in 1 N NaOH and Ethanol, respectively. Liquid manure was prepared by fermenting the mixture of kitchen wastes in our own way *i.e.* potato peel (500g), carrot peel (200 g), legume leaf (300 g), neem leaf (200g), tulsi leaf (100 g), cow dung (1.5 kg) in 6.0 liter of water. Then this concentrated solution was diluted to make required concentration of 100 ppm of liquid manure. The observations were taken at regular intervals from eight randomly selected plants per each replication on vegetative growth and yield parameters. The quality parameters like- TSS, pH and moisture percentage were recorded after harvesting of bulb at 140 days after planting. The bulbs and cloves were dried at 66 °C for 72 hours to calculate the biomass and moisture content. The recorded data was analyzed statistically following the analysis of variance as stated by Panse and Sukhatme (1985). All the materials (potato peel, carrot peel, legume leaf, neem leaf, tulsi leaf and water) of liquid manure were collected from the local area and weighted according to the composition. Those were cut into small pieces, mixed with cow dung and added water in container as required. Composition was monitored every day and stirred in every three days interval and extra water was added as and when needed. It was ready after about 40-45 days of mixing and sample of liquid manure was studied for macro and micro nutrients at Central Soil Salinity Research Institute (CSSRI) Lucknow. Liquid manure was diluted in three ratios 1:5, 1:10 and 1:15 with water and applied at 30, 45 and 60 days after planting in experimental field.

RESULTS AND DISCUSSION

Effect of plant bio-regulators and liquid manure on growth parameters of garlic

The observations clearly indicated that plant height, number of leaves, length of leaves and basal diameter of garlic increased by the application of plant bio-regulators and liquid manure (Table 1). A significant increase in plant height was recorded at 90 and 120 DAP under T_7 (GA_3 30 ppm + liquid manure 100 ppm) compared to other treatments. The number of leaves per plant also increased significantly at 60 and 90 DAP, but

Table 1: Effect of PGRs and liquid manure on growth parameters of garlic

Treatment	Plant height (cm)				Number of leaves				length of leaves				Basal diameter (mm)			
	30DAP	60 DAP	90 DAP	120 DAP	30DAP	60 DAP	90 DAP	120 DAP	30DAP	60 DAP	90 DAP	120 DAP	30DAP	60 DAP	90 DAP	120 DAP
T_0	21.66	31.09	55.03	60.10	3.33	5.33	7.24	8.36	18.60	27.90	37.57	40.17	5.09	8.47	10.74	11.64
T_1	24.70	34.65	59.80	63.41	3.64	5.56	8.80	9.38	21.36	30.94	41.27	42.06	5.22	8.46	11.31	12.24
T_2	25.64	38.06	63.74	64.38	3.67	5.69	8.62	9.16	21.34	32.70	43.35	43.52	5.38	8.76	10.47	11.51
T_3	24.66	36.31	58.26	57.58	3.60	5.60	8.13	8.73	20.32	29.87	39.45	39.92	5.21	7.98	11.90	13.05
T_4	23.86	34.69	61.39	58.87	3.58	5.56	8.11	8.84	20.32	30.30	42.71	43.12	5.26	8.13	12.14	13.06
T_5	24.43	36.13	63.21	61.30	3.58	5.58	7.76	8.96	20.77	30.82	45.15	45.44	4.81	7.81	11.89	12.65
T_6	24.92	36.36	64.76	66.39	3.73	5.71	7.44	8.64	19.82	31.84	42.23	46.23	4.94	8.17	11.20	12.07
T_7	25.46	37.11	65.99	68.24	4.02	6.02	7.80	9.09	23.48	32.99	43.58	44.44	5.14	8.42	13.34	14.17
T_8	24.50	35.58	63.39	64.49	3.64	5.64	7.69	8.93	20.87	30.89	40.21	42.59	4.73	7.99	11.18	11.88
SEM (±)	2.044	2.662	0.457	0.474	0.275	0.087	0.035	0.481	1.576	2.130	0.326	4.580	0.367	0.603	0.719	0.679
CD (P = 0.05)	N.S.	N.S.	0.97	1.00	N.S.	0.18	0.08	N.S.	N.S.	N.S.	0.69	N.S.	N.S.	N.S.	1.58	1.44

Table 2: Effect of PBRs and liquid manure on the yield and quality parameters of garlic

Treatment	Yield		Diameter of bulb (cm)		Number of cloves	Weight of bulb (g.)		Weight of cloves (g.)		Moisture content (%)		TSS (^{0}B)	pH
	plot (kg)	ha (t/ha)	Equatorial	Polar	per bulb	Fresh	Dry	Fresh	Dry	Bulb	Clove		
T_0	0.32	7.48	3.82	3.37	19.51	22.43	6.26	1.64	0.35	79.00	77.31	30.63	6.20
T_1	0.36	8.35	4.06	3.39	25.59	22.78	6.62	1.82	0.46	75.79	75.41	31.69	6.37
T_2	0.38	8.77	4.40	3.41	23.82	23.78	6.52	2.20	0.42	81.25	80.81	31.97	6.28
T_3	0.38	8.79	4.11	4.05	22.93	24.07	6.47	2.50	0.64	73.09	73.21	32.27	6.38
T_4	0.35	8.17	3.82	3.90	22.36	20.69	6.31	1.91	0.55	72.07	77.47	31.70	6.38
T_5	0.34	7.97	3.84	4.37	21.87	21.68	6.47	1.71	0.31	82.17	79.71	30.82	6.39
T_6	0.41	9.49	4.20	4.18	24.40	25.78	7.29	2.40	0.47	80.19	79.55	31.61	6.42
T_7	0.44	10.10	4.17	4.90	29.29	27.58	7.51	3.02	0.73	76.43	72.78	32.42	6.46
T_8	9.51	32.38	3.88	4.18	26.80	26.16	7.00	2.14	0.46	78.69	79.04	32.38	6.36
SEM (±)	0.012	0.868	0.027	0.33	0.276	0.344	0.160	0.486	0.141	2.612	3.540	0.868	0.150
CD (P = 0.05)	0.03	1.86	0.06	0.70	0.58	0.73	0.34	N.S.	N.S.	N.S.	N.S.	1.86	N.S.

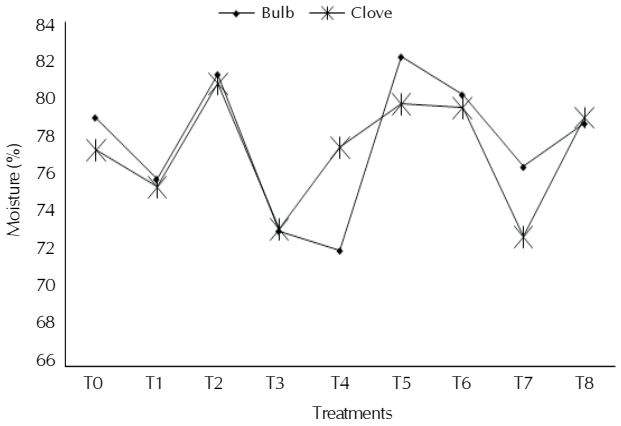

Figure 1: Moisture content in bulbs and cloves under different treatments

the increase at initial (30 DAP) and final stage (120 DAP) was found statistically *at par*. Similarly, length of leaves was improved significantly only at 90 DAP. It was also observed that in all cases of vegetative growth the rate of increase in plant height, number and length of leaves decreased and non-significant differences was recorded at initial stages of growth. At the early stages of growth the bioregulators were not applied so they showed uniformity (almost) in growth whereas, at the later stage *i.e.* 120 DAP the crop gone under maturity which also showed the non-significant improvement. The better increase in growth under treated plants might be due to the fact that it might enhance the source to sink relationship, accumulation of photosynthates and efficient utilization of food reserve for development in garlic. Use of plant bioregulators (PBRs) as foliar application was found to increase vegetative growth significantly at all stages of crop growth over control. These results agreed with the finding of Das *et al.* (1985) who obtained significant improvement in yield of garlic by foliar application of NAA and in guava by Maji and Das (2014). Concerning the effect of PBRs and liquid manure on the maximum length of leaves was given in same table and recorded that the significant growth at the 90 DAP under treatment T_5 followed by T_7(GA_3 30 ppm + liquid manure 100 ppm).

It was also observed that the maximum basal diameter was recorded significantly at 90 DAP under 30 ppm GA_3 + 100 ppm liquid manure concentration treatment. It was found that the growth regulators are involved in enhancing photosynthetic activity, assimilation of photosynthetic products resulted rapid cell division and cell elongation in the growing part of the plant or stimulation of growth besides increasing uptake of nutrients. These results are in agreement with other investigators (Mandal *et al.*, 2003, Patel *et al.* 2010, Govind, 2014 in garlic and Maji, 2010 in guava).

Effect of plant bio regulators and liquid manure on quality of garlic bulb and cloves

Garlic yield was increased significantly due to different concentration of PBRs (Table 2). The highest yield (0.44 kg/ plot and 10.10 t/ ha) was obtained from T_7 (GA_3 @ 30 ppm and liquid manure @ 100 ppm) followed by T_8 (NAA @ 275 ppm and liquid manure @ 100 ppm), however, the lowest yield (0.32 kg/plot and 7.48 t/ ha) was obtained in control close to the yield under T_4 (NAA @ 275 ppm). These results corroborated with the findings of Maurya and Lal (1975), Nandekar and Swarkar (1992) and Das *et al* (1985) who reported yield improvement through application of NAA and GA_3.

Bulb and clove physical characters in terms of average number of cloves per bulb, fresh and dry weight of bulb and cloves were improved by the application of PBRs (Table 2) as compared to control. The maximum equatorial diameter of bulb (4.40 cm) was found in the treatment T_2 (GA_3 @ 40 ppm) followed by 4.20 cm in the treatment T_6 (NAA @ 300 ppm). The minimum equatorial diameter was observed in treatment T_0 (control) (Table 2). In the case of polar diameter of bulb the maximum data was recorded (4.90 cm) in the T_7 (GA_3 30 ppm + liquid manure 100 ppm) and minimum (3.37 cm) was observed in the control treatment (T_0). The maximum number of cloves per bulb (29.29) were recorded with T_7 (GA_3 @ 30 and LM @ 100 ppm) followed by T_8 (NAA @ 275 ppm and LM @ 100 ppm). GA_3 and NAA induced cell division and rapid cell elongation in growing portion causing increase the bulb size as well as number of cloves.

It was also observed that foliar application of PBRs in different treatments proved beneficial in increasing the bulb and clove weight in compression to the control. The maximum bulb weight (27.58 g) and maximum clove weight (3.02 g) were recorded with T_7 (GA_3 @ 30 ppm and LM @ 100 ppm) which was closely related to T_8 (NAA @ 275 ppm and LM @ 100

ppm) and subsequent effect was also reflected in dry weight and moisture content of bulb and cloves (Figure 1). The increase in weight might be due to more photosynthesis rate and better accumulation of food material in plant coupled with increasing growth character by cell division, cell elongation and cell enlargement that might have ultimately increased the bulb and clove weight. Minimum dry weight of both bulb and clove (6.26g and 0.35g, respectively) were found in control treatment (T_0).

Among the quality parameters the effect of PBRs and liquid manuring was recorded for TSS and p^H. It was observed that significantly maximum (32.42ºB) TSS content in garlic was determined under the treatment T_7 (GA_3 @ 30 ppm and LM @ 100 ppm) followed by T_8 (NAA @ 275ppm and LM @ 100 ppm). The minimum TSS content (30.63 ºB) was observed in the control treatment T_0. Similarly, the highest p^H (6.46) was also recorded in T_7 (GA_3 @ 30 ppm and LM @ 100 ppm) and the lowest (6.20 p^H) in control indicating that garlic under control were more acidic than the treated one. However, no report was found regarding the effect of PBRs and liquid manuring on TSS and pH of garlic but, Dandena *et al.* (2010) stated that TSS might be increased due to the assimilates export from the leaves, import by fruits and the fruit carbon metabolism are the factors that finally influence TSS of tomato. Graham and Bllesteros (2006) also reported that GA_3 increased proteins, soluble carbohydrates, ascorbic acid and starch and â carotene in the tomato. Higher sugar content in tomato fruits treated with 50 mg GA_3 was also obtained by Kataoka *et al.* (2009) and Singh *et al.* (2014).

Thus, it can be concluded that treatment T_7 (GA_3 @ 30 ppm + Liquid manure (LM) @ 100 ppm) may be suggested for better growth and yield of garlic cv. G-282 under Lucknow subtropical condition having high soil pH.

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NATIONAL ENVIRONMENTALISTS ASSOCIATION

AND ITS OFFICIAL ORGAN

The Bioscan

An International Quarterly Journal of Life Science

Started in 1988, the National Environmentalists Association has been reorganized in 2006 and now is an association functioning with full vigour and new impetus to meet its objectives with the co-operation of like minded environment conscious academicians from different parts of the nation.

MEMBERSHIP OF THE ASSOCIATION

Any graduate having interest in environmental conservation and protection of nature and natural resources can be the member of the association.

To be the member of the association the application form given below should be duly filled up and sent to the Secretary of the association along with a demand draft of Rs. 750/- (After the 25% concession) for annual membership and Rs. 7500/- (After the 25% concession) for life membership.

FELLOWSHIP OF THE ASSOCIATION

The Association is awarding FELLOWSHIP to deserving academicians / researchers /scientists who are LIFE MEMBERS of the Association after reviewing their bio-data by the Fellows and the Executive Members of the association. The Fellows are privileged to write **F.N.E.A.** after their names .The prestigious Fellowship also includes a citation in recognition of their contribution to society in general and the endeavour for the noble cause of environment in particular.

AWARDS OF THE ASSOCIATION

The Association in its Seminars and Conferences provides the following category of awards on annual basis.

1. **The young scientists award** : It is given to the researchers below the age of 35 years.

2. **The senior scientists award** : It is awarded to the academicians above the age of 35 years.

3. **The best paper award**: It is awarded to the contributor of the Journal **The Bioscan** during the year.

4. **The best paper presentation award** : It is awarded to the scholar whose presentation is the best other than the young scientist category.

5. **The best oration award** : It is awarded to the scholar who delivered invited speech.

6. **The recognition award** : It is awarded to those senior scholars who have contributed to the subject through their continued research .

7. **The environmental awareness award** : It is awarded to those who, apart from their research contribution, have done commendable extension work for environmental betterment.

The number of recipients of award in each category will vary depending upon the recommendation of the panel of judges and the executive committee. The association has the provision to institute awards in the name of persons for whom a with desired sum is donated in consultation with the executive body.

PUBLICATION OF THE ASSOCIATION

In order to provide a platform to a vast group of researchers to express their views and finding of research as well as to promote the attitude of quality research among the scholars of younger generation the association publishes an international quarterly journal – **THE BIOSCAN (ISSN:0973-7049).** For the benefit of the potential contributors **instructions to authors** is given separately in this journal. However, the details regarding the journal and also the association can be seen on our website *www.thebioscan.in.*

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