***Original Research Article***

# Effect of Bio-stimulants on Growth and Yield of Garlic (*Allium sativum* L.)


## ABSTRACT

An experiment was conducted at Vegetable Farm, Department of Vegetable Science, College of Horticulture and Forestry, Jhalawar (Rajasthan) during *rabi* season (2021-2022) on garlic. The experiment consisted ten treatments of bio-stimulants*viz.* soil drenching of humic acid @ 4 g/lit. , soil drenching of humic acid @ 6 g/lit., soil drenching of humic acid @ 8 g/lit., soil drenching of seaweed extract @ 4 ml/lit., soil drenching of seaweed extract @ 6 ml/lit., soil drenching of seaweed extract @ 8 ml/lit., soil drenching of vermiwash @ 10 ml/lit., soil drenching of vermiwash @ 20 ml/lit. and soil drenching of vermiwash @ 30 ml/lit.and control and laid out in randomized block design with three replications.The result of present study clearly indicates that growth and yield attributes of garlic plant increased with the soil application of different bio-stimulants over control. Growth and yield attributes *viz.* number of leaves per plant, leaf length, plant height, chlorophyll content of leaves, fresh weight of bulb, bulb diameter,yield of bulb per plot and yield of bulb per hectare increased significantly due to application of humic acid. The maximum value of growth and yield parameters *i.e.* number of leaves per plant (7.32 and 9.33), length of leaves (48.44 cm and 63.28 cm), plant height (57.38 cm and 69.19 cm) at 60 and 90 DAS, respectively, chlorophyll content (1.87 mg/g), fresh weight of bulb (31.86 g), bulb diameter (4.83 cm), yield of bulb per plot (2.74 kg) and yield of bulb per hectare (212.99 q ha-1) were recorded with soil drenching of humic acid @ 8g/lit. and the minimum value of growth and yield parameters *i.e.* number of leaves per plant (6.16 and 7.35), length of leaves (34.99 cm and 52.27 cm), plant height (36.83 cm and 49.30 cm) at 60 and 90 DAS, respectively, chlorophyll content (0.57 mg/g), fresh weight of bulb (21.13 g), bulb diameter (3.25 cm), yield of bulb per plot (1.79 kg) and yield of bulb per hectare (141.10 q ha-1) with control.



**Key words:** Garlic, Humic acid, Seaweed extract, soil drenching and Vermiwash.

## 1. INTRODUCTION

Garlic (*Allium sativum* L.), a member of the Alliaceae family, is a polyphenolic and organosulfur enriched nutraceutical spice consumed since ancient times. Garlic and its secondary metabolites have shown excellent health-promoting and disease-preventing effects on many human common diseases, such as cancer, cardiovascular and metabolic disorders, blood pressure, and diabetes, through its antioxidant, anti-inflammatory, and lipid-lowering properties, as demonstrated in several in vitro, in vivo, and clinical studies. It is the second most widely spice crop of the cultivated *Allium* crops, next to onion in the world with a characteristic pungent smell. Garlic is originated in central Asia where it was extended to the Mediterranean region in the pre-historic dates [1]. Garlic is medicinal herb with underground compound bulbs covered by outer white thin scales with simple smooth round stem surrounded by the bottom by tubular leaf sheath.India ranks second after China in area (247.52 thousand hectare) and second in production (1259.27 thousand tonnes) of garlic with an average productivity of 5.09 metric tonnes per hectare. The major garlic producing states of India are Madhya Pradesh, Orissa, Rajasthan, Karnataka, U. P. and Gujarat. India is one of the garlic exporting countries of the world. In Rajasthan, garlic is grown extensively in the districts of Chittorgarh, Baran, Jodhpur, Jhunjhunu, Jhalawar, Udaipur, Kota, Dungarpur, Bundi, Jaipur and Sikar. The area under garlic cultivation in Rajasthan during 2021-22 was 3.93 lakh ha with production of 3208 MT[2].At present ever increasing population is exerting tremendous pressure on agriculture to meet their nutritional food requirement across the world. In order to achieve the current demand of food requirement, farmers are relying more on chemical fertilizers to achieve higher productivity per unit area. However, the efficiency of the chemical fertilizers already reached a plateau due to their indiscriminate use and resulted in poor soil fertility status of the agriculture fields in addition to accumulation of toxic substances in the harvested produces. Also, the cost of inorganic fertilizers is increasing enormously to an extent that they are not affordable by the small and marginal farmers. In this regard there is a need to identify the suitable substitute in place of chemical fertilizers which are economically cheaper and ecofriendly. In this juncture, the use of bio-stimulants plays an important role to sustain the soil health as well as productivity of the crops [3]. The use of bio-stimulants such as humic acid, seaweed extract and vermiwash results in higher growth, yield and quality of crops. Bio-stimulants contain macro nutrients, essential micro nutrients, many vitamins, essential micro

nutrients, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms [4].The bio-stimulants easily disperse in water and are readily available to plants compared to bulky organic manures. Thehumic acid, seaweed extract jeevamrutha, beejamrutha, panchagavya, sanjivak, amrithpani, vermiwash, brahmastra, cow urine and enriched biodigester bio-stimulants are easily available ecofriendly bio-stimulants which contains macro nutrients, essential micro-nutrients, amino acids, vitamins, growth promoting substances like IAA, GA and beneficial micro-organisms [5]. So, looking to the importance of bio-stimulants and looking to the daily need of today's life it has become necessary to use these bio-stimulants to sustain human health as well as soil health. In view of the above facts and realizing the importance of bio-stimulants the present study to find out effect of bio-stimulants on growth and yield of garlic.

## 2. MATERIALS AND METHODS

An experiment was conducted at Vegetable Farm, Department of Vegetable Science, College of Horticulture and Forestry, Jhalawar (Rajasthan) during *rabi* season (2021-2022) on garlic. According to Agro-ecological region map brought out by National Bureau of Soil Survey and Land Use Planning, Jhalawar falls in Agro-ecological region No.06. Geographically, is situated at is situated between $23.20^0$ N latitude and $75.35^0$ E longitude at an altitude of 632.2 meters above (MSL). The soil of experimental site was clay loam in texture (sand 23.6 %, silt 37.6 % and clay 39.8 %), slightly saline in reaction EC (0.54 dS $m^{-1}$). (How it will be saline?)The experimental soil was medium in available nitrogen (217 kg $ha^{-1}$), phosphorus (16.93 kg ha-1) and high in potassium (336 kg $ha^{-1}$) and sufficient in DTPA extractable micronutrients (Zn 0.42 mg $kg^{-1}$, Fe 5.21 mg $kg^{-1}$, Cu 0.85 mg $kg^{-1}$ and Mn 2.90 mg $kg^{-1}$) with pH (7.6)(How DTPA Zn is sufficient as it is less than 0.6 ppm critical limit).In general, 100:50:50:50 kg $ha^{-1}$ NPK and S, respectively, along with FYM 50 tonnes/ha is recommended. As a basal dose, complete dose of P, K and S and one-third dose of N should be applied along with FYM. Remaining one-third dose of N should be applied after a month of planting and one-third after 45 to 50 days. The experiment consisted ten treatments of bio-stimulants *viz.* soil drenching of humic acid @ 4 g/lit., soil drenching of humic acid @ 6 g/lit., soil drenching of humic acid @ 8 g/lit., soil drenching of seaweed extract @ 4 ml/lit., soil drenching of seaweed extract @ 6 ml/lit., soil drenching of seaweed extract @ 8 ml/lit., soil drenching of vermiwash @ 10 ml/lit., soil drenching of

vermiwash @ 20 ml/lit. and soil drenching of vermiwash @ 30 ml/lit. and control and laid out in randomized block design with three replications. Solution was prepared according to the treatments by dissolving it in water and soil drenching was done at 30 and 60 DAS.

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of bio-stimulants on growth attributes

A perusal of data presented in Table 1.0 revealed that the growth attributes of garlic was significantly affected by the application of bio-stimulants. The data on different levels of bio-stimulants indicated that the soil drenching of humic acid @ 8 g/lit. produced maximum number of leaves per plant (7.32 and 9.33) at 60 and 90 DAS, respectively and minimum number of leaves per plant (6.16 and 7.35) at 60 and 90 DAS, respectively was produced when no bio-stimulants was applied control in garlic. However, the treatment humic acid @ 6g/lit. was found at par with soil drenching of humic acid @ 8 g/lit.at both 60 and 90 DAS.Significantly maximum length of leaves was found with soil drenching of humic acid @ 8 g/lit. with 48.44 cm and 63.28 cm at 60 and 90 DAS, respectively and minimum was found with control *i.e.* 34.99 cm and 48.79 cm at 60 and 90 DAS, respectively. However, the humic acid @ 6g/lit. was found at par with treatment soil drenching of humic acid @ 8 g/lit. at both 60 and 90 DAS.The plant height was recorded at 60, 90 DAS and significant differences were noticed due to application of bio-stimulants over control. Data indicated that the plant height of garlic responded significantly due to application of bio-stimulants at 60 and 90 DAS. The treatment Humic acid @ 8g/lit. was found significantly superior with 57.38 cm and 69.19 cm plant height at 60 and 90 DAS, respectively, with respect to control, which had lowest plant height 36.83 cm and 49.30 cm at 60 and 90 DAS and treatment T2 was found at par with treatment T3 at 60 and 90 DAS.The observation of the data revealed that effect of bio-stimulants doses increased the chlorophyll content significantly over the control. The total chlorophyll content was recorded maximum (1.87 mg/100 g) in treatment humic acid 8g/lit. while, the minimum (0.66 mg/100 g) in treatment control.The result of present study clearly indicates that growth attributes of garlic plant increased with the soil application of different bio-stimulants over control. Growth attributes *viz.* number of leaves per plant, leaf length, plant height and chlorophyll content of leaves increased significantly due to application of humic acid. The influence of humic

acid soil drench on plant growth characters might be due to improving the soil physical and chemical characters. It could be concluded that, the causative juvenile of these consequence has been attributed also to many laborers like increasing in cell diaphragm permeability, oxygen uptake, breathing and photosynthesis, phosphate uptake, root and cell protaction and ion transport, chelating unavailable nutrients and buffering soil pH [6]. It might be due to shoot promoting effect of humic acid and its effect on root activity andnitrate root-shoot distribution that it turn causes changes in the root-shoot distribution of certain cytokinins, polyamines and abscisic acid thus affecting shoot growth [7]. Thus, adequate supply of humic acid as soil drenching in different doses resulted in greater availability of nutrients particular in crop root zone. Increased availability of nutrients in the root zone coupled with increased metabolic activity at the cellular level might have increased the nutrient uptake and accumulation in the vegetative plant parts which in turn resulted in improved plant growth attributes. These results are in close proximity with earlier researches of Halime *et al.*, [8] and El-Nemr *et al.*, [9] in cucumber, Fatma, *et al*., [10] in potato, Abdel-Razzak *et al*., [11] in garlic, Samy *et. al*., [12] in Jerusalem artichoke and El-metwaly[13] in sweet potato.

Choloropyll(Chlorophyll) content in garlic leaves also increased significantly with the application of humic acid over control. Chlorophyll content might be due to the accelerated nitrogen and nitrate adsorption, increasing nitrogen metabolism and protein production by humic acid [14] as well. However, it is clear that humic acid application tended to have the highest values from photosynthetic pigments and such effect were distinct via using the higher rate of humic acid and there are many reports the positive effect of humic acid on the chlorophyll content of various plants, Garlic [15] whose results are consistent with the finding of this study.

**3.2 Effect of bio-stimulants on yield attributes**

A perusal of data presented in Table 2.0 revealed that the yield attributes of garlic was significantly affected by the application of bio-stimulants. The findings indicated that the fresh weight of bulb was significantly affected by different treatments. The fresh weight of bulb varied from 21.13 to 31.86 g. The maximum fresh weight of bulb (31.86 g) was recorded in treatment humic acid @ 8g/lit., whereas minimum value of fresh weight of bulb (21.13 g) was recorded in treatment control. Treatment T2, T6 and T9 were

found at par with treatment T3. The observation of data revealed that effect of bio-stimulants increases the diameter of bulb significantly over the control. The maximum bulb diameter (4.83 cm) was recorded in treatment humic acid @ 8g/lit. while, the minimum bulb diameter (3.25 cm) was recorded in treatment control. The soil drenching of humic acid also had significant effect on bulb yield per plot of garlic as compared to control. The treatment humic acid @ 8g/lit. had maximum bulb yield per plot with 2.74 kg/plot while the minimum was recorded in control with 1.79 kg/plot. Further, a critical examination of data indicates that drenching of humic acid significantly increased the bulb yield per hectare. The maximum bulb yield (212.99 q/ha) was registered under treatment humic acid 8g/lit. while, the minimum bulb yield per hectare (141.10 q/ha) was found in treatment T0.The result of present study clearly indicates that yield attributes of garlic plant increased with the soil application of different bio-stimulants over control. Yield attributes *viz.* fresh weight of the bulbs, bulb diameter, bulb yield per plot and bulb yield per hectare increased significantly due to application of humic acid.Production of heavier fresh weight of the bulbs, bulb diameter, bulb yield per plot and bulb yield per hectare compared to those harvested from plants in control treatment may be attributed to more vigorous growth of plants, in response to humic acid application [16]. This might be due to humic acid led to increased fruit weight through positive physiological effect such as impact of metabolism of plant cells, photosynthesis and increasing the concentration of leaf chlorophyll [17]. The increment in yield might be also due to hormone like activity of the humic acid through their participation in cell respiration, photosynthesis, protein synthesis and various enzymatic reaction [18]. Incorporation of humic acid substances into soils stimulated root growth as well as stimulated the proliferation, branching and initiation of root hairs and could partially be attributed to enhanced nutrient uptake. {Cooper *et al.* [19]; Canellas *et al*., [20]; Khaled and Fawy, [21]}. These findings are in accordance with the findings of Yildrim [22] in tomato.

## 4. CONCLUSION

It is concluded that the growth and yield parameters of garlic showed considerable increment due to soil application of Humic acid @ 8g/L and Humic acid @ 6g/L. Hence this dose of bio-stimulants proved as beneficial for increasing productivity and good health. These levels of bio-stimulants may be passed on to the farmers for obtaining higher monetary returns of zone $V^{th}$ of Rajasthan.

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**11Table 1.Effect of bio-stimulants on growth parameters of garlic.**

| **Treatments** | **Nos. of leaves** | | **Length of leaves (cm)** | | **Plant height (cm)** | | **Chlorophyll content (mg/gfresh tissue)** |
|---|---|---|---|---|---|---|---|
| | 60 DAS | 90 DAS | 60 DAS | 90 DAS | 60 DAS | 90 DAS | |
| $T_1$: Control | 6.16 | 7.35 | 34.99 | 48.79 | 36.83 | 49.30 | 0.66 |
| $T_2$: Soil drenching of Humic acid @ 4 g/lit. | 6.52 | 8.32 | 43.06 | 56.56 | 46.26 | 60.65 | 1.13 |
| $T_3$: Soil drenching of Humic acid @ 6 g/lit. | 6.91 | 9.23 | 44.56 | 58.54 | 53.06 | 64.56 | 1.45 |
| $T_4$: Soil drenching of Humic acid @ 8 g/lit. | 7.32 | 9.33 | 48.44 | 63.28 | 57.38 | 69.19 | 1.87 |
| $T_5$: Soil drenching of Seaweed @ 4 g/lit. | 6.30 | 7.64 | 36.81 | 53.13 | 39.34 | 54.42 | 0.82 |
| $T_6$: Soil drenching of Seaweed @ 6 g/lit. | 6.31 | 7.76 | 39.15 | 55.70 | 42.93 | 57.58 | 0.97 |
| $T_7$: Soil drenching of Seaweed @ 8 g/lit. | 6.64 | 9.16 | 44.17 | 57.12 | 49.34 | 62.15 | 1.27 |
| $T_8$: Soil drenching of Vermiwash @ 10 ml/lit. | 6.43 | 7.88 | 40.86 | 56.00 | 43.36 | 57.91 | 1.03 |
| $T_9$: Soil drenching of Vermiwash @ 20 ml/lit. | 6.47 | 8.29 | 42.09 | 56.27 | 44.40 | 60.64 | 1.05 |
| $T_{10}$: Soil drenching of Vermiwash @ 30 ml/lit. | 6.59 | 8.38 | 43.11 | 56.66 | 47.18 | 61.38 | 1.20 |
| **SEm ±** | **0.20** | 0.32 | **1.40** | **1.51** | **1.96** | **1.58** | **0.08** |
| **CD (5%)** | **0.61** | **0.95** | **4.16** | **4.48** | **5.82** | **4.68** | **0.25** |

**Table 2.Effect of bio-stimulants on yield attributes and yield of garlic.**

| **Treatments** | **Fresh weight of bulb (g)** | **Bulb diameter(cm)** | **Bulb yield per plot (kg)** | **bulb yield per hectare (q/ha)** |
|---|---|---|---|---|
| $T_1$: Control | 21.13 | 3.25 | 1.79 | 141.10 |
| $T_2$: Soil drenching of Humic acid @ 4 g/lit. | 26.10 | 4.10 | 2.19 | 174.41 |
| $T_3$: Soil drenching of Humic acid @ 6 g/lit. | 28.74 | 4.26 | 2.46 | 191.74 |
| $T_4$: Soil drenching of Humic acid @ 8 g/lit. | 31.86 | 4.83 | 2.74 | 212.99 |
| $T_5$: Soil drenching of Seaweed @ 4 g/lit. | 23.25 | 3.70 | 1.93 | 154.83 |
| $T_6$: Soil drenching of Seaweed @ 6 g/lit. | 25.19 | 3.79 | 2.13 | 166.39 |
| $T_7$: Soil drenching of Seaweed @ 8 g/lit. | 28.73 | 4.26 | 2.43 | 191.68 |
| $T_8$: Soil drenching of Vermiwash @ 10 ml/lit. | 25.20 | 3.81 | 2.16 | 167.54 |
| $T_9$: Soil drenching of Vermiwash @ 20 ml/lit. | 25.48 | 3.96 | 2.18 | 170.02 |
| $T_{10}$: Soil drenching of Vermiwash @ 30 ml/lit. | 28.47 | 4.16 | 2.40 | 187.96 |
| **SEm ±** | **1.67** | **0.18** | **0.09** | **6.65** |
| **CD (5%)** | 4.96 | **0.55** | **0.25** | **19.75** |