***Original Research Article***

# Effect of Bio-Stimulants on Quality and Soil Health 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/L, Soil drenching of Humic acid @ 6 g/L, Soil drenching of Humic acid @ 8 g/L, Soil drenching of Seaweed extract @ 4 ml/L, Soil drenching of Seaweed extract @ 6 ml/L, Soil drenching of Seaweed extract @ 8 ml/L, Soil drenching of Vermiwash @ 10 ml/L, Soil drenching of Vermiwash @ 20 ml/L and Soil drenching of Vermiwash @ 30 ml/L and control) and laid out in randomized block design with three replications. The result of present study clearly indicates that quality andsoil attributes of garlic plant increased with the soil application of different bio-stimulants over control. Quality and soil attributes *viz.*TSS (42.21 $^{0}$Brix), dry matter content (42.54 %), crude protein content (7.05%), and pungency (10.39 µ mol/g), organic carbon (0.60), as well as the available nitrogen (342.74 kg ha$^{-1}$) phosphorus (17.47 kg ha$^{-1}$) and potassium (220.90 kg ha$^{-1}$ ) content in soil after harvest of garlic, as compared to treatment T0 (control).



**Key words:** Garlic, Humic acid, Seaweed extract, bio-stimulants**,** soil drenching and pungency.


## 1. INTRODUCTION

Garlic (*Allium sativum* L.), a member of the Alliaceae family, is one of the most aromatic herbaceous annual spices. 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. The Humic 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 23.200 N latitude and 75.350 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 $m^{-1}$). 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). 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/L, Soil drenching of Humic acid @ 6 g/L, Soil drenching of Humic acid @ 8 g/L, Soil drenching of Seaweed extract @ 4 ml/L, Soil drenching of Seaweed extract @ 6 ml/L, Soil drenching of Seaweed extract @ 8 ml/L, Soil drenching of Vermiwash @ 10 ml/L, Soil drenching of Vermiwash @ 20 ml/L and Soil drenching of Vermiwash @ 30 ml/L 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 quality attributes

A perusal of data presented in Table 1.0 revealed that the quality attributes of garlic was significantly affected by the application of bio-stimulants. The findings indicated that TSS was significantly affected by different treatments. TSS ranged from 34.71 ˚Brix to 42.21 ˚Brix. Among the different treatments, maximum total soluble solid was recorded in treatment T3 *i.e.*, soil drenching of humic acid @ 8 g/L (42.21 ˚Brix), which was significantly superior over other treatments while the minimum TSS (34.71 ˚Brix) was recorded in T0.The significantly highest dry matter content

(42.54 %) was observed in treatment T3 (humic acid @ 8g/L) and lowest dry matter content (34.79%) was found under treatment T0 (control). The treatment T2 was found at par with treatment T3.A keen observation of the data revealed that soil drenching of different bio-stimulants at different doses had significantly affected on crude protein content. The crude protein content was found maximum (7.29 per cent) in treatment T3 while, treatment T0 (control) recorded minimum crude protein content (5.42 per cent). The treatment T2 was found at par with T3.The pungency in garlic also influenced significantly with the drenching of humic acid. Treatment T3 (humic acid @ 8g/L) found with maximum pungency level (10.39 µ mol/g) and minimum pungency in bulb (6.45 µ mol/g) was observed in treatment T0 (control). Soil drenching of humic acid significantly increased the quality attributes like TSS, dry matter content, crude protein content and pungency of garlic bulb over control. The maximum values of quality parameters *i.e.* TSS (42.21 0Brix), dry matter content (42.54), crude protein (7.05 %) and pungency (10.39 µ mol/g) was recorded in treatment T3 (humic acid @ 8g/l) and minimum under control (T0). This might be due to application of humic acid helped in vigorous vegetative growth and imparted deep green colour to the foliage which favoured photosynthesis activity of the plants, so that there was greater accumulation of food material *i.e.*, carbohydrates and this leads to the more synthesis of TSS content. These results are in close agreement with findings of Yildirim [6] in tomato, Nursel and Fikret [7] in potato. However, the humic acid application caused an increase in the content of dry matter, starch, total carbohydrates and elemental values in the tuber tissues, may be due to application of humic acid might have the ability to increase the availability of other nutrients like nitrogen, phosphorus and potassium, probably due to higher rate of mineralization and favorable conditions for microbial and chemical activity [8]. Protein synthesis in garlic due to positive influences of humic acid like hormonal activities through their participation in cell respiration, photosynthesis, oxidative phosphorylation and various enzymatic reaction {Chen and Aviad, [9]; Muscolo*et al.*, [10]}. A common assessment of pungency is made by measuring pyruvate formed as a stable primary compound from the enzymatic decomposition of flavour precursors and formed in a mole-for-mole relationship with flavour precursors and the concentration of humic acid development had positive increment in pungency. These results are in close agreement with findings of Manas *et al.*, [11] in garlic.

**3.2 Effect of bio-stimulants on soil attributes:**

A perusal of data presented in Table 2.0 revealed that the soil attributes of garlic was significantly affected by the application of bio-stimulants. The findings indicated that organic carbon in soil at the time of harvested of the crop recorded was found significant in all treatment of bio-stimulants. The maximum available Organic carbon (0.60) was found in treatment T3 and minimum (0.44) in treatment T0. The treatment T2 was found at par with T3. Soil drenching of humic acid @ 8g/L increased final OC by 27.66 per cent over the initial OC.Drenching of humic acid resulted in significant effect on available nitrogen in soil after harvest as compared to control. The maximum available nitrogen (342.74 kg/ha) was found in treatment T3 and minimum (337.30 kg/ha) in treatment T0 and the treatment T2 was found at par with T3 .Soil drenching of humic acid @ 8g/L (T3) increased final N by 1.40 per cent over the initial N.The soil drenching of humic acid had significant effect on available phosphorus in soil after harvest as compared to control. The maximum available phosphorus (17.47 kg/ha) was found in treatment T3 and minimum (15.03 kg/ha) was recorded in treatment T0, respectively. The treatment T1 and T2 were found at par with treatment (T3). The soil drenching of humic acid @ 8g/L increased final phosphorus by 17.54 percent over the initial P2O5. Soil drenching with humic acid resulted in significant effect on available potassium in soil after harvest as compared to control. The maximum available potassium (219.90 kg/ha) and minimum (214.25 kg/ha) was observed in treatment T3 and T0, respectively after harvest. The treatment T3 was found highly superior among all the treatments. Soil drenching of humic acid @ 8g/L increased final K2O by 1.42 per cent over the initial K2O.Application of humic acid significantly influenced the soil nutrient status after harvest the garlic crop. Data as regard to the effect of humic acid (@ 8g/L) on soil parameters like organic carbon (0.60%), N (343.48 kg ha-1), P2O5 (18.44 kg ha-1), K2O (220.90 kg ha-1) were found influenced over control. The increase in the availability of nitrogen, phosphorus and potassium in soil after harvest of garlic might be due to the proper decomposition and mineralization of humic acid. Humic acid supplied available nitrogen, phosphorus and potassium directly to the plants after being decomposed and mineralized and also had solubilizing effects on fixed form of nutrients. In fact, all the available nutrients in soil are not utilized by the plant and rest remained in soil which increased their availability after harvest. Humic acid (HA) is the active constituent of organic humus, which can play a very important role in soil conditioning and plant growth [12]. Physically, it promotes good soil structure and increases the water holding capacity of the soil; biologically it enhances the growth of useful soil organisms, while chemically it serves as an adsorption and retention complex for inorganic plant nutrients [13]. Humic acid increases the porosity of soil and improve growth of root system which leads to increase the shoot system. Humic acid degrade soil, improve its physical, chemical, biological and nutritional characteristics by degrading clay particles and increasing water holding capacity [9]. These results are in close conformity with findings of Selim *et al.*, [14] in potato.

## 4. CONCLUSION

It is concluded that the quality and soil 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 quality and good soil health. These levels of bio-stimulants may be passed on to the farmers for obtaining higher monetary returns of zone V$^{th}$ of Rajasthan.

## REFERENCES


1. Thompson HC andKelly WC. Vegetable crops. *Mc Grew Hill Book Co., New York*. 1957; 368-370.
2. Anonymous. Area and Production of Horticulture Crops. *National Hoticulture Board. Gurugram, Haryana, India*. 2022.
3. Verma S, Babu A, Patel A, Singh SK, Pradhan SS and Verma SK. Significance of vermiwash on crop production: *A review Journal of Pharmacological Phytochemestry*. 2018; **7**(2):297-301.
4. Sreenivasa MN, Nagaraj M, Naik, Bhat SN and Beejamruth. A source for beneficial bacteria. *Karnataka Journal of Agricultural Sciences*. 2010;**17** (3): 72-77.
5. Chongre S, Mondal R, Biswas S, Munshi A, Mondal R andPramanick M. Effect of liquid manure on growth and yield of summer green gram (*Vigna radiata* L. Wilczek). *Current Journal of*

*Applied Sciences and Technology*. 2019; **38**(6):1-7.

6. Yildirim E. Foliar and soil fertilization of humic acid affect productivity and quality of tomato. *Acta Agriculturae Scandinavica Section B-Soil and Plant Science*. 2007;**57**(2): 182-186.
7. Nursel CK and Fikret A.The effect of humic acid applications on growth and quality properties of potato (*Solanum tuberosum* L.*)*. *Journal of Institute of Science and Technology*. 2021; **11**(2): 1559-1567.
8. Nardi SD, Pizzeghello, Muscolo A and Vianello A. Physiological effects of humic substances on higher plants. *Soil Biology and Biochemistry*. 2002;**34**(1): 1527-1536.
9. Chen Y, Avaid T. Effect of Humic substances on plant growth. American Society of Agronomy and Soil Science. 1990;13(1): 161-186.
10. Muscolo A, Bovalo F, Gionfriddo F and Nardi S. Earthworm humic matter produces of auxin like effect on Daucus carrota cell growth and nitrate metabolism. *Soil Biology and Biochemistry*. 1999;**31**(1): 1303-1311.
11. Manas D, Soumya G andKheyaliS. Effect of humic acid application on accumulation of mineral nutrition and pungency in garlic (*Allium sativum L*.). *International Journal for Biotechnology and Molecular Biology Research*. 2014;**5**(2): 7-12.
12. Benedetti MF, Van Riemsdijk WH, Koopal LK, KinniburghDG, Gooddy DC and Milne CJ. Metal ion binding by natural organic matter: from the model to the field. *GeochimicaCosmochimica Acta*. 1996; **60**(14): 2503-2513.
13. Brannon CA and Sommers LE. Preparation and characterization of model humic polymers containing organic phosphorus. *Soil Biology and Biochemistry*. 1985;**17**(2): 213-219.
14. Selim EM, El-Neklawy AS and El-Ashry SM. Beneficial effects of humic substances fertigation on soil fertility to potato grown on sandy soil. *Australian Journal of Basic and Applied Sciences*. 2009;**3**(4): 4351-4358.

**Table 1.Effect of bio-stimulants on quality of garlic bulb**

| **Treatments** | **Total Soluble Solids (0Brix)** | **Dry matter content (%)** | **Crude protein content (%)** | **Pungency in bulb (μ mol/g)** |
|---|---|---|---|---|
| T1: Control | 34.71 | 34.79 | 5.42 | 6.45 |
| T2: Soil drenching of Humic acid @ 4 g/lit. | 38.99 | 38.63 | 6.17 | 9.31 |
| T3: Soil drenching of Humic acid @ 6 g/lit. | 40.09 | 41.59 | 6.65 | 9.91 |
| T4: Soil drenching of Humic acid @ 8 g/lit. | 42.21 | 42.54 | 7.29 | 10.39 |
| T5: Soil drenching of Seaweed @ 4 g/lit. | 36.74 | 35.27 | 6.08 | 7.62 |
| T6: Soil drenching of Seaweed @ 6 g/lit. | 37.88 | 37.27 | 6.11 | 8.06 |
| T7: Soil drenching of Seaweed @ 8 g/lit. | 40.00 | 39.12 | 6.20 | 9.85 |
| T8: Soil drenching of Vermiwash @ 10 ml/lit. | 38.12 | 38.35 | 6.13 | 9.03 |
| T9: Soil drenching of Vermiwash @ 20 ml/lit. | 38.34 | 38.58 | 6.16 | 9.12 |
| T10: Soil drenching of Vermiwash @ 30 ml/lit. | 39.23 | 39.04 | 6.20 | 9.85 |
| **SEm ±** | **0.61** | **1.05** | **0.27** | **0.09** |
| **CD (5%)** | 1.81 | **3.13** | **0.80** | **0.27** |

**Table 2.Effect of bio-stimulants on soil health after harvest of garlic crop**

| Treatments | Organic carbon (%) | Available N (kg/ha) | Available $P_2O_5$ (kg/ha) | Available $K_2O$ (kg/ha) |
|---|---|---|---|---|
| Initial value | 0.47 | 338.0 | 14.86 | 213.2 |
| T1: Control | 0.44 | 337.7 | 15.03 | 214.2 |
| T2: Soil drenching of Humic acid @ 4 g/lit. | 0.54 | 339.8 | 16.64 | 217.4 |
| T3: Soil drenching of Humic acid @ 6 g/lit. | 0.59 | 340.4 | 16.91 | 217.7 |
| T4: Soil drenching of Humic acid @ 8 g/lit. | 0.60 | 342.7 | 17.47 | 220.9 |
| T5: Soil drenching of Seaweed @ 4 g/lit. | 0.50 | 338.1 | 16.11 | 216.2 |
| T6: Soil drenching of Seaweed @ 6 g/lit. | 0.51 | 338.3 | 16.14 | 216.5 |
| T7: Soil drenching of Seaweed @ 8 g/lit. | 0.52 | 339.2 | 16.37 | 217.3 |
| T8: Soil drenching of Vermiwash @ 10 ml/lit. | 0.46 | 337.3 | 15.72 | 215.2 |
| T9: Soil drenching of Vermiwash @ 20 ml/lit. | 0.46 | 337.3 | 15.84 | 215.8 |
| T10: Soil drenching of Vermiwash @ 30 ml/lit. | 0.49 | 337.3 | 16.01 | 215.8 |
| **SEm ±** | 0.02 | **0.95** | **0.36** | **1.0** |
| **CD (5%)** | 0.06 | **2.81** | **1.06** | **2.9** |