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## Influence of bio-stimulants and method of application on growth, yield and quality of onion (*Allium cepa* L)

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### Abstract

This study evaluates the impact of bio-stimulants and their application methods on the growth, yield, and quality of onions (*Allium cepa* L.). Conducted during the rabi season of 2021-22 at Anand Agricultural University, the experiment involved six bio-stimulants - Azotobacter, Azospirillum, NPK Consortia, Phosphorus Solubilizing Bacteria (PSB), Vesicular Arbuscular Mycorrhiza (VAM), and Jeevamrut—with two application methods: seedling dip and soil application. The results revealed that the NPK Consortia applied via soil significantly enhanced plant height, leaf count, bulb weight, and bulb dimensions compared to other treatments. These findings suggest that using NPK Consortia as a bio-stimulant through soil application is an effective approach for improving onion crop yield and quality.

**Keywords:** Onion, *Allium cepa*, bio-stimulants, growth

### Introduction

Onion (*Allium cepa* L.) is one of the most significant bulbous vegetable crops grown in India since ancient times. Often called the “Queen of the Kitchen,” the edible part of the onion is a modified underground stem known as the ‘bulb.’ Onions are primarily valued for their green leaves, along with both immature and mature bulbs, which can be eaten raw or cooked. They are frequently used in salads, while mature onion bulbs are favoured in soups and as a flavouring agent in various dishes. Onion belongs to the Alliaceae family and originated in Central Asia. The *Allium* genus includes 300 to 500 species, which are widely found in the northern temperate regions (Thompson and Kelley, 1957) <sup>[17]</sup>.

Onion is mainly cultivated as a *Rabi* crop; however, it is also raised as kharif in Maharashtra and Gujarat to catch off-season market. The growth and yield of cultivated crop plants are mainly influenced by two principal factors viz., genetical and cultural or management factors. The first factor deals with various breeding techniques for the improvement in crop varieties and second factor deal with agronomical practices viz., planting date, spacing, fertilizer, irrigation, cultivation method, plant protection and weed control etc. Both factors have been exploited by various research workers in respective fields with varied success. However, efforts are still continued in directions to gain further higher and higher yields.

Bio-stimulants, also known as Bio-enhancers, are organic products available in powder or liquid form. They are created through the active fermentation of animal and plant residues over a specific period. These products are rich in microbial consortia, macro and micronutrients, and substances that promote plant growth, including immunity enhancers. They are used to treat seeds and seedlings, enhance the decomposition of organic materials to enrich soil, and boost plant vigor. Additionally, they can serve as an effective tool for fertigation across various crops (Pathak and Ram, 2012) <sup>[11]</sup>.

*Azotobacter* spp. is most specifically noted for their nitrogen fixing ability but they have also been noted for their ability to produce different growth hormones (IAA and other auxins, such as gibberellins and cytokinins), vitamins and siderophores. *Azotobacter* is capable of converting nitrogen to ammonia, which in turn is taken up by the plants. *Azotobacter* sp. can also produce antifungal compounds to fight against many plant pathogens.

*Azospirillum* inoculation helps plants attain better vegetative growth and reduces the need for nitrogenous fertilizers by 20-30%. The application of *Azospirillum* has a significant effect on nutrient uptake, which may increase growth, nitrogen uptake, and yield in various crops (Subbian, 1994)<sup>[16]</sup>.

The phosphate solubilizing bacteria (PSB) solubilize the insoluble phosphates and make them available for crop plants in the rhizosphere region. Several soil bacteria and fungi notably species of *Pseudomonas*, *Bacillus*, *Penicillium* and *Aspergillus* etc. secrete organic acids and lower the pH in their vicinity to bring about solubilization of bound phosphates in soil. Increase in the yield of various crops were demonstrated due to inoculation of peat-based cultures of Phosphobacteria and saving up to 50 per cent of recommended level of P<sub>2</sub>O<sub>5</sub> was observed in many experiments.

In recent years, Bio-NPK consortium are gaining much popularity. Bio-NPK consortium contain five strains of agriculturally beneficial microorganism (two nitrogen fixer, two Phosphate solubilizer and one potash mobilizer) is the one-time solution for all the macronutrient (N, P, and K) requirement of crop. Use of Bio-NPK consortium @ 3-5 ml for root dipping treatment can save up to 25% N, P, K chemical fertilizer with increase in growth and yield with reduction of soil, water and air pollution (Vaghela *et al.*, 2019)<sup>[19]</sup>.

Vesicular-Arbuscular Mycorrhizae (VAM) has been reported to increase the uptake of phosphorus. It is believed to increase the uptake of Zn, Cu, Mn and Fe. Production of growth promoters, tolerance to pathogens and boosting synergistic interaction with beneficial soil microorganisms such as N-fixers and P-Solubilisers, are the other advantage associated with use of VAM.

Jeevamrut is a fermented liquid product prepared by mixing up cow dung (10 kg) with cows urine (10 litre), jaggery (2 kg), legume flour (2 kg) and handful of *gochar* or forest soil. Jeevamrut also contains enormous amount of microbial load which multiply and enhance N fixation and nutrient mobilization and utilization increase the soil fertility (Palekar, 2006)<sup>[9]</sup>. Jeevamrut contains small amount of macro and micronutrients as well as growth hormones which is helpful in enhancing the growth and yield of crops. Due to availability of easy energy source particularly jeggary multiply the organisms enormously and during fermentative process produce beneficial metabolites such as organic acids and antibiotics which are effective against other pathogenic.

As regard to the productivity the combined application of fertilizers and bio-enhancer to increase yield has paramount importance in ameliorating the yield. Use of inorganic fertilizers now a day is costly affair and increases cost of cultivation. Secondly the sole application of inorganic fertilizers deteriorates soil fertility level day by day, which affect the production, economics of production and human health, while organic manure and bio-fertilizers are cheap, easily available and eco-friendly, giving quality produce, improving keeping quality, TSS and pungency. It improves the physiochemical properties like soil structure, infiltration rate, porosity, water holding capacity, bulk density, etc. and also very useful for the sustainable crop production as well as soil fertility and productivity (Vaghela *et al.*, 2019)<sup>[19]</sup>.

## Methods and Materials

The present investigation entitled Effect of bio-stimulants and method of application on growth, yield and quality of onion

(*Allium cepa* L.) was carried out during *rabi* season of 2021-22 at Horticultural Research Farm, B.A. College of Agriculture, Anand Agricultural University, Anand. Present investigation comprising two factors *i.e.*, Six levels of bio-stimulant *i.e.*, *Azotobacter* (B<sub>1</sub>), *Azospirillum* (B<sub>2</sub>), NPK Consortia (B<sub>3</sub>), Phosphorus Solubilising Bacteria (B<sub>4</sub>), Vesicular Arbuscular Mycorrhiza (B<sub>5</sub>) and Jeevamrut (B<sub>6</sub>); method of application *i.e.*, Seedling dip (M<sub>1</sub>) and Soil application (M<sub>2</sub>) with absolute control. Thus, there were total 13 treatment combinations under study. The experiment was laid out in Randomized Block Design with factorial concept with three replications. To raise the crop, the recommended package of practices was followed, which included applying fertilizer (N.P.K 100:50:50) with FYM (20 t/ha). Seedlings were treated with different bio-stimulants for 15 to 20 minutes and soil application of the bio-stimulants was conducted at the second irrigation.

## Results and Discussion

### Effect of Bio-Stimulants on different paraments of onion:

Data presented in Table 1 revealed that effect of different bio-stimulants on plant height at 45 and 90 DAT, No. of leaves per plant at 90 DAT, Average weight of bulb (g), Polar diameter (cm) and Equatorial diameter (cm) were found significant during 2021-22 *rabi* season. Review of Table 1 showed that the maximum plant height of (69.24 and 87.17 cm) at 45 and at 90 DAT, No. of leaves per plant (11.55) at 90 DAT, average weight of bulb (123.66 g), polar diameter of bulb (5.09 cm) and equatorial diameter of bulb (6.06 cm) were observed under treatment NPK Consortia (B<sub>3</sub>). Whereas No. of leaves per plant at 45 DAT and TSS (°Brix) were as noted non significant.

### Effect of method of application on different paraments of onion:

Data presented in Table 1 show that significantly influence of method of application on average weight of bulb 113.41 (g) was observed under soil application during experiment. whereas plant height at 45 and 90 DAT, No. of leaves per plant at 45 and 90 DAT, Polar diameter, Equatorial diameter and TSS (°Brix) were recorded non significant.

**Control vs Rest:** Data presented in Table 1 show that results for the absolute control in terms of plant height (63.36 and 80.96 cm) at 45 and 90 DAT, No. of leaves per plant (10.75) at 90 DAT, average weight of bulb (109.05 g), Polar diameter (4.73 cm) and Equatorial diameter (5.67 cm) significantly different from the rest of the treatments. whereas plant height at 45 and 90 DAT, No. of leaves per plant at 45 and 90 DAT, Polar diameter, Equatorial diameter and TSS (°Brix) were recorded non-significant.

This might due to nitrogen which present in novel organic liquid fertilizer increased the rate of vegetative growth, which resulted in plant height and leaves. Moreover, nitrogen increase the cation exchange capacity of plant roots and that makes them efficient in absorbing other nutrient ions like phosphorus, potassium etc. Nitrogen which present in novel organic liquid fertilizer is responsible for the formation, growth and development of the cell and accelerating the synthesis of chlorophyll and amino acid which are associated with major photosynthesis process of plant, it causes an increase in the formation of meristematic tissues. Similar result finding was also reported by Anon. (2012)<sup>[11]</sup>, Anon. (2014)<sup>[12]</sup>, Deore *et al.*, (2014)<sup>[4]</sup>, Shah (2019)<sup>[14]</sup>, Champaneri *et al.*, (2021)<sup>[15]</sup>, Rathva *et al.*, 2024<sup>[12]</sup> and Rathva *et al.*, 2024<sup>[13]</sup>.

**Table 1:** Effect bio-stimulants and method of application on growth, yield and quality attributes of onion

Treatment	Plant height at 45 DAT	Plant height at 90 DAT	No. of leaves per plant at 45 DAT	No. of leaves per plant at 90 DAT	Average weight of bulb (g)	Polar diameter (cm)	Equatorial diameter (cm)	TSS (°Brix)
<b>Bio-stimulants(B)</b>								
B <sub>1</sub> : <i>Azotobacter</i>	64.37	81.81	7.93	10.85	111.26	4.78	5.72	12.21
B <sub>2</sub> : <i>Azospirillum</i>	61.71	78.98	7.86	10.52	105.09	4.63	5.58	12.10
B <sub>3</sub> : NPK Consortia	69.24	87.17	8.07	11.55	123.66	5.09	6.06	12.42
B <sub>4</sub> : PSB	59.87	77.42	7.82	10.30	100.81	4.52	5.45	12.03
B <sub>5</sub> : VAM	67.04	85.03	8.00	11.28	117.23	4.95	5.92	12.34
B <sub>6</sub> : Jeevamrut	57.96	75.38	7.76	10.04	96.29	4.42	5.33	11.95
S.Em. ±	2.34	2.45	0.29	0.30	3.39	0.13	0.17	0.18
C.D. at 5%	6.82	7.14	NS	0.87	9.90	0.38	0.50	NS
<b>Method of Application(M)</b>								
M <sub>1</sub> : Seedling dip	63.20	80.70	7.90	10.75	104.71	4.72	5.67	12.16
M <sub>2</sub> : Soil application	63.53	81.23	7.91	10.77	113.41	4.74	5.68	12.19
S.Em. ±	1.35	1.41	0.17	0.17	1.96	0.07	0.10	0.10
C.D. at 5%	NS	NS	NS	NS	5.72	NS	NS	NS
<b>Control vs Rest</b>								
Control	53.23	70.34	7.63	9.44	84.56	4.24	5.09	11.75
Rest	63.36	80.96	7.90	10.75	109.05	4.73	5.67	12.17
S.Em. ±	0.95	2.55	0.30	0.31	3.53	0.13	0.18	0.19
C.D. at 5%	2.78	7.44	NS	0.90	10.91	0.39	0.52	NS
C.V.%	9.14	7.88	8.89	7.08	7.75	6.73	7.38	3.60

### Conclusion

Based on the results of this study, it can be concluded that the NPK Consortia through soil application @ 1 litre/ha was the most effective method for enhancing growth parameters, such as plant height at 45 and 90 days after transplanting, as well as the number of leaves per plant at 90 days after transplanting. Additionally, this application improved yield parameters, including the average weight of the bulb (g), and quality traits such as polar diameter (cm) and equatorial diameter (cm) in rabi onion cultivation.

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