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Effect of biostimulants on growth of onion (*Allium cepa* L.)

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Abstract
The field experiment was conducted during *rabi* season (2024-25) at Horticulture Garden of College of agriculture, Rajendranagar, Professor Jayashankar Telangana Agricultural University, Hyderabad, India. To know the effect of biostimulants on growth of onion. The experiment, comprised of nine treatments, was laid out in a randomized block design (RBD) with three replications. The growth of onion was significantly influenced due to foliar application of biostimulants. Various bistimulants were used like, seaweed extract, pink pigmented facultative methylotrophic bacteria (PPFM), moringa leaf extract, humic acid and vermiwash. Among various biostimulants used in the experiment RDF + foliar application of 19:19:19 @ 0.5% treatment (T_8) recorded significantly tallest plants, highest number of leaves plant^{-1} and dry matter production at 20, 40, 60 DAT and at harvest which was on par with RDF + foliar application of seaweed extract @ 0.25% (T_3) and RDF + foliar application of moringa leaf extract @ 3% (T_5) and these were superior over the remaining treatments. However lowest plant height, number of leaves and dry matter production was recorded in RDF (T_1) and followed by RDF + foliar application of water (T_2).

Keywords: Biostimulants, seaweed extract, PPFM, moringa leaf extract, humic acid, vermiwash growth, number of leaves and dry matter production

Introduction

Onion (*Allium cepa* L.) is one of the most widely cultivated vegetable crops across the globe. It Belongs to the family Amaryllidaceae and native to Central Asia, it holds the position of the second most important horticultural crop in India after tomato. It is a commercially valuable winter vegetable grown extensively in India, including Telangana. Culinary versatility, rich nutritional profile and therapeutic properties, onion is consumed in multiple forms like raw, cooked or processed into flakes, powders and pastes which made it indispensable in both household kitchens and the food industry (Bagali *et al.*, 2012) [2]. It contains high dietary fiber and sugars, with approximately 90% water content. Due to its distinctive flavor and health-promoting benefits, it is often referred to as the "Queen of the Kitchen" (Griffiths *et al.*, 2002) [6]. From an economic perspective, onion cultivation plays a significant role in sustaining farmers' livelihoods and contributes notably to India's export earnings, with the country ranking second globally in production after China. Within India, Maharashtra leads in onion production, followed by Karnataka and Gujarat.

In the present agricultural context, there is a growing emphasis on developing sustainable cultivation systems that minimize environmental damage. A promising strategy in this regard is the use of biostimulants, which can enhance the efficiency of conventional mineral fertilizers. In response to the rising demand for organic and eco-friendly technology, biostimulants have emerged as a practical and effective option for improving plant nutrition. These natural or synthetic substances, when applied to plants or soils, stimulate physiological processes that enhance nutrient uptake, increase stress tolerance and improve overall plant performance (Yakhin *et al.*, 2017) [17]. While they do not replace fertilizers, biostimulants contribute to better crop yields and soil health. Examples include humic substances, beneficial microorganisms such as *Trichoderma* spp., moringa leaf extract, pink pigmented facultative methylotrophs (PPFMs), seaweed extracts and vermiwash, all of which have been shown to enhance yield and improve the nutritional quality of produce (Rouphael and Colla, 2020) [13]. Integrating biostimulants with recommended fertilizer practices offers a costeffective approach to improving yield and quality by increasing resource-use efficiency and reducing dependence on excessive agrochemical inputs (Suhaini *et al.*, 2023) [15].

Materials and Methods

The field experiment was conducted during the *rabi* season of 2024–25 at the Horticulture Garden, College of Agriculture, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, Hyderabad, Telangana, India. The experimental site is situated at 17°19'14" N latitude, 78°24'58" E longitude, and an altitude of 563 m above mean sea level (MSL). The study was undertaken to evaluate the effect of biostimulants on the growth of onion (*Allium cepa* L.). A Randomized Block Design (RBD) was adopted with nine treatments and replicated thrice.

The experimental site featured sandy loam soil with a neutral pH of 7.2, low organic carbon content (0.38%) and low available nitrogen levels of 214.5 kg ha^{-1}. However, it exhibited high availability of phosphorus (28.21 kg ha^{-1}) and potassium (276.63 kg ha^{-1}). A seed rate of 10 kg ha^{-1} was used. Onion seedlings were raised on a nursery bed of 15 m × 1 m × 0.15 m under a shade net. Seeds were mixed with sand to ensure uniform distribution and sown at a spacing of 5 cm between lines. Transplanting was carried out at a spacing of 15 cm × 10 cm in main field plots measuring 4.5 m × 3.5 m. The treatments included, T_1 - Recommended Dose of Fertilizer (RDF) *i.e.*, N: P_2O_5: K_2O kg ha^{-1},T_2 - RDF + foliar application of water, T_3 - RDF + foliar application of seaweed extract @ 0.25%, T_4 - RDF + foliar application of pink pigmented facultative methylotrophic bacteria(PPFM) @ 2%,T_5 - RDF + foliar application of moringa leaf extract @ 3%, T_6 - RDF + foliar application of humic acid @ 0.5%, T_7 - RDF + foliar application of vermiwash @ 3%,T_8 - RDF + foliar application of 19:19:19 @ 0.5%, T_9 - RDF + foliar application of urea @ 2%. Foliar application of biostimulants was done in twice at 30 and 45 DAT. The growth parameters were recorded at 20, 40, 60 DAT and harvest. The data collected from the experiment were statistically analyzed by using analysis of variance (ANOVA) for randomized block design *i.e.*, RBD (Gomez and Gomez, 1984) [5].

Results and Discussion

Effect of biostimulants on plant growth parameters

Plant height (cm)

All treatments influenced onion plant height, showing a progressive increase with advancing days after transplanting (DAT).Table 1 summarizes how foliar spray of biostimulants effected the height of onion plants at 20, 40,60 DAT and at harvest.

At 20 DAT, no significant differences were observed among the treatments regarding plant height. However, at 40 DAT, following the first foliar spray at 30 DAT, significant differences were observed among the treatments. The highest plant height (45.93 cm) was recorded in T_8 (RDF + foliar application of 19:19:19 @ 0.5%), followed by T_3 (RDF + foliar application of seaweed extract @ 0.25%) with 45.59 cm and T_5 (RDF + foliar application of moringa leaf extract @ 3%) with 45.28 cm. These treatments were found to be on par with each other and significantly superior to other treatments. While significantly lower plant height (29.89 cm) was registered with treatment T_1(RDF) which was in line with T_2 (RDF + foliar application of water).

After second spray at 45 DAT, observations recorded at 60 DAT and harvest showed the tallest plants (62.84 cm and 70.89 cm) in T_8 *i.e.*, RDF + foliar application of 19:19:19 @ 0.5% which was on par with T_3 (62.62 cm and 70.54 cm) and T_5 (62.29 cm and 70.27 and these were significantly superior to other treatments. The control *i.e.*, RDF (T_1) recorded lowest plant height (55.13 cm and 61.87 cm) which was in line with T_2 *i.e.*, RDF + foliar application of water (55.53 cm and 62.04 cm), respectively.

The superior plant height in RDF + foliar application of 19:19:19 @ 0.5% (T_8) was might be due to the balanced and readily available N, P and K from foliar application, ensuring rapid nutrient uptake and vigorous growth (Ninama *et al*., 2023; Bhavya *et al.*, 2024) [9, 3]. Increased height in RDF + foliar application of seaweed extract @ 0.25% (T_3) may be attributed to auxins in seaweed extract that promote cell division and elongation (Gollan and Wright, 2006; Pramanick *et al.*, 2014) [4, 11], while RDF + foliar application of moringa leaf extract @ 3% (T_5) performance could be due to zeatin, vitamins and antioxidants in moringa leaf extract enhancing shoot elongation (Abdalla, 2013; Rana *et al.*, 2019) [1, 12].

Number of leaves per plant

The comparative effect of biostimulant application on the number of leaves per plant at different growth stages (20, 40, and 60 DAT, and at harvest) is presented in Table 2.

At 20 DAT, although numerical differences were observed among treatments, they were found to be statistically non-significant. Significant differences were evident from 40 DAT onwards, following the first foliar spray at 30 DAT. At 40 DAT, the maximum number of leaves (7.81) was recorded with T_8 (RDF + foliar application of 19:19:19 @ 0.5%), which was statistically at par with T_3 (RDF + foliar application of seaweed extract @ 0.25%) with 7.72 and T_5 (RDF + foliar application of moringa leaf extract @ 3%) with 7.65. These treatments showed statistically better to all other treatments. The lowest number of leaves (5.48) were noted in T_1 *i.e.*, RDF which is in line with T_2 *i.e.*, RDF+ foliar spray of water (5.62).

All treatments showed further improvement at 60 DAT and harvest after the second foliar spray at 45 DAT. The highest number of leaves (9.26 and 11.62) was recorded in T_8 (RDF + foliar application of 19:19:19 @ 0.5%), followed by T_3 *i.e.*, RDF + foliar application of seaweed extract @ 0.25% (9.23 and 11.55) and T_5 (RDF + foliar application of moringa leaf extract @ 3%) (9.18 and 11.45), these were statistically similar with each other and superior than other treatments. Conversely, minimum number of leaves (7.11 and 8.98) was observed in T_1, which is on par with T_2 (7.16 and 9.04).

Nitrogen promotes vegetative growth, phosphorus aids energy transfer and root development and potassium regulates enzyme activation, collectively increasing leaf number (Mehta *et al.*, 2017) [8]. Seaweed extract enhances shoot length and leaf production due to auxins like IAA, which regulate tissue differentiation (Pascual *et al.*, 2020) [10], while moringa leaf extract stimulates leaf growth through its zeatin, antioxidant and nutrient content (Hala *et al.*, 2021) [7].

Dry matter production (kg ha^{-1})

A significant increasing trend in dry matter production from 40 DAT to harvest was observed with the application of RDF in combination with foliar sprays of various biostimulants, as presented in Table 3.

At 20 DAT, differences among treatments were non-significant. At 40 DAT, after the first foliar spray, significant difference was recorded. The highest dry matter (2060 kg ha^{-1}) was recorded with T_8 (RDF + foliar application of 19:19:19 @ 0.5%) which was in line with T_3 *i.e.*, RDF + foliar application of seaweed extract @ 0.25% (2052 kg ha^{-1}) and T_5 (RDF + foliar application of moringa leaf extract @ 3%) (2049 kg ha^{-1}). These treatments were statistically greater than other treatments. The RDF plot (T_1) registered the lowest dry matter (1728 kg ha^{-1}), which was similar to RDF + foliar application of water (T_2: 1752 kg ha^{-1}).

Similarly after second spray at 45DAT, T_8 (RDF + foliar application of 19:19:19 @ 0.5%) recorded the maximum dry matter (7058 kg ha^{-1} and 24725 kg ha^{-1}),which was statistically similar to T_3 (RDF + foliar application of seaweed extract @ 0.25%) with dry matter of 7025 kg ha^{-1} and 24460 kg ha^{-1} and T_5 *i.e.*, RDF + foliar application of moringa leaf extract @ 3% with dry matter of and 6986 kg ha^{-1} and 24202 kg ha^{-1}, respectively, which were significantly greater than other treatments. T_1(RDF) recorded the lowest dry matter (5047 kg ha^{-1} and 20238 kg ha^{-1}), which was comparable with RDF + foliar spray of water (T_2:5053 kg ha^{-1} and 20568 kg ha^{-1}) in the observations recorded at 60 DAT and at harvest.

The superiority of RDF + foliar application of 19:19:19 @ 0.5% was likely due to the balanced and readily available N, P and K supporting protein synthesis, shoot growth and photosynthate translocation (Sharifi *et al.*, 2018) [14]. Seaweed extract (T_3) enhanced dry matter due to presence of cytokinins, auxins and betaines that promote cell division (Thirumaran *et al.*, 2009) [16], similarly presence of zeatin and antioxidants that stimulates cell enlargement, growth which resulted in high dry matter with moringa leaf extract (Yasmeen *et al.*, 2014) [186].

Table 1: Effect of foliar application of biostimulants on plant height (cm) of onion at 20, 40, 60 DAT and harvest.

Treatments		Plant height (cm)			
		20 DAT	40 DAT	60 DAT	Harvest
T_1	Recommended Dose of fertilizer (RDF)	23.17	39.09	55.13	61.87
T_2	RDF + foliar application of water	23.20	39.17	55.53	62.04
T_3	RDF + foliar application of seaweed extract @ 0.25%	23.55	45.59	62.62	70.54
T_4	RDF + foliar application of pink pigmented facultative methylotrophic bacteria (PPFM) @ 2%	24.17	41.93	58.51	65.86
T_5	RDF + foliar application of moringa leaf extract @ 3%	23.88	45.28	62.29	70.27
T_6	RDF + foliar application of humic acid @ 0.5%	23.43	42.24	59.42	66.72
T_7	RDF + foliar application of vermiwash @ 3%	23.65	42.53	59.97	67.08
T_8	RDF + foliar application of 19:19:19 @ 0.5%	23.39	45.93	62.84	70.89
T_9	RDF + foliar application of urea @ 2%	23.66	42.03	58.93	66.45
S Em ±		5.01	0.82	0.94	1.00
CD (5%)		NS	2.44	2.81	3.01

Table 2: Effect of foliar application of biostimulants on number of leaves $plant^{-1}$ of onion at 20, 40, 60 DAT and harvest.

Treatments		Number of leaves $plant^{-1}$			
		20 DAT	40 DAT	60 DAT	Harvest
T_1	Recommended Dose of fertilizer (RDF)	3.80	5.48	7.11	8.98
T_2	RDF + foliar application of water	3.73	5.62	7.16	9.04
T_3	RDF + foliar application of seaweed extract @ 0.25%	3.67	7.72	9.23	11.55
T_4	RDF + foliar application of pink pigmented facultative methylotrophic bacteria (PPFM) @ 2%	3.91	6.48	8.17	10.25
T_5	RDF + foliar application of moringa leaf extract @ 3%	3.95	7.65	9.18	11.45
T_6	RDF + foliar application of humic acid @ 0.5%	3.77	6.70	8.26	10.32
T_7	RDF + foliar application of vermiwash @ 3%	4.10	6.83	8.29	10.36
T_8	RDF + foliar application of 19:19:19 @ 0.5%	3.80	7.81	9.26	11.62
T_9	RDF + foliar application of urea @ 2%	3.80	6.62	8.20	10.28
S Em ±		0.22	0.27	0.29	0.36
CD (5%)		NS	0.81	0.88	1.09

Table 3: Effect of foliar application of biostimulants on dry matter of onion (kg ha^{-1}) at 20, 40, 60 DAT and harvest

Treatments		Dry matter (kg ha^{-1})			
		20 DAT	40 DAT	60 DAT	Harvest
T_1	Recommended Dose of fertilizer (RDF)	239	1728	5047	20238
T_2	RDF + foliar application of water	247	1752	5053	20568
T_3	RDF + foliar application of seaweed extract @ 0.25%	247	2052	7025	24460
T_4	RDF + foliar application of pink pigmented facultative methylotrophic bacteria (PPFM) @ 2%	247	1912	5865	21985
T_5	RDF + foliar application of moringa leaf extract @ 3%	246	2049	6986	24202
T_6	RDF + foliar application of humic acid @ 0.5%	245	1938	6048	22163
T_7	RDF + foliar application of vermiwash @ 3%	248	1956	6107	22391
T_8	RDF + foliar application of 19:19:19 @ 0.5%	246	2060	7058	24725
T_9	RDF + foliar application of urea @ 2%	245	1926	5905	22095
S.Em ±		9	65	259	449
CD (5%)		NS	194	777	1347

Conclusion

Results of this experiment reveled that application of RDF + foliar application of 19:19:19 @ 0.5%, followed by RDF + foliar application of seaweed extract @ 0.25% and RDF + foliar application of moringa leaf extract @ 3% improves the plant growth parameters of onion. Hence, The use of biostimulants, being eco-friendly and effective at low concentrations, offers a sustainable option when integrated with inorganic fertilizers.

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