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Bio-stimulants Influence on Growth and Yield of Aggregatum Onion

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ABSTRACT

Onion, being an edible vegetable crop, inclusion of any organic inputs without chemical usage in enhancing yield is booming strategy in view of consumer health. Accordingly, different bio-stimulants were tested to determine the influence on the growth and yield of aggregatum onion var. CO 4. The experiment consisted foliar spray of 0.1 percent seaweed extract (T1), 0.2 percent seaweed extract (T2), 0.3 percent seaweed extract (T3), 0.1 percent humic acid (T4), 0.2 percent humic acid (T5), 0.3 percent humic acid (T6), 0.1 percent fish amino acid (T7), 0.15 percent fish amino acid (T8), 0.20 percent fish amino acid (T9) and control (T10). Foliar spraying was performed three times at a 15-day interval at 30, 45 and 60 days after bulb sowing. The experiment was laid out in Randmized Block Design with three replications. At the 45th and 60th days, observations on growth and yield characteristics were made. The testing findings indicated that humic acid at a concentration of 0.3 percent produced the highest plant height (41.3 cm), neck thickness (1.067 cm), and dry matter (1.20g). Humic acid 0.3 percent had the highest average bulb weight (33.25g) and total yield (14.41 tonnes/ha). Seaweed extract at 0.3 percent had the second-best results in terms of plant height (38.30 cm), average bulb weight (29.00g), and bulb production (12.57 t/ha), but it outperformed fish amino acid and the control. The overall performance of several biostimulants shows that humic acid @ 0.3 percent foliar spray effectively enhances various growth parameters of aggregatum onion var. CO 4, resulting in increased yield.

***Key words**: Bio-stimulants, Seaweed extract, Humic acid, Fish amino acid, Onion, Growth, Yield.*

Introduction

Onion is an edible vegetable crop that is consumed both fresh and processed. Use of organic ingredients in their growth would be highly advantageous in reducing chemical toxicity. Additionally, numerous organic agriculture approaches have been shown to significantly increase the growth, productivity, and quality of various crops. In this context, the utilization of biostimulants for onion production enhancement *via* growth modification is critical. Al-Fraihat *et al.* (2018) studied the effect of onion as foliar spray under rainfed conditions and reported that humic acid spray @ 1000mg/l has significantly increased the bulb diameter (68%), bulb length (84%) and fresh weight of plant (63%) compared to untreated plants. Hidangmayum and Sharma (2017) reported that foliar spray of sea weed extract in onion at 5 treatments. Sea weed extract at 0.55% treatment showed the best results which increased the nutrient uptake efficiency and resulted in increased plant height of 55.20cm, average maximum number of leaves (9.08/plant) and plant growth rate (33.65g/m^2/day). They concluded that increase in concentration showed the decreasing trend. Amino acids play vital role in protein building of plant and human cells. There are many amino acids that are helpful in every response of the plants (Vranova *et al*., 2011). The potential benefits of using amino acids containing bio-stimulants are hormone stimulation, stress protection, gene regulation, nutrient acquisition and assimilation. With this background in mind, an investigation was conducted in Aggregatum onion var. CO 4 using three different biostimulants namely humic acid, seaweed extract, and fish amino acid at varying concentrations, to determine the effect on growth and yield parameters.

Materials and Methods

Experimental design and treatments

During the months of December to May 2020-2021, a field experiment was conducted with various concentrations of three different biostimulants at a farmer's holding in Tiruchengode, Namakkal district of Tamil Nadu which is situated at 11°4782'N latitude, 78°0755'E longitude at an average elevation of 224 m MSL. The treatments were as follows: 0.1 percent humic acid (T1), 0.2 percent humic acid (T2), 0.3 percent humic acid (T3), 0.1 percent seaweed extract (T4), 0.2 percent seaweed extract (T5), 0.3 percent seaweed extract (T6), 0.1 percent fish amino acid (T7), 0.15 percent fish amino acid (T8), 0.2 percent fish amino acid (T9), and control (T10). Plants were spaced 20 cm x 12 cm apart in a bed of 26.0 m x 1.20 m. Bio-stimulants were diluted in water at the given concentration of Sea weed extract (0.1, 0.2 and 0.3 per cent), Humic acid (0.1, 0.2, 0.3 per cent) and Fish Amino Acid (0.1, 0.15 and 0.2 per cent). These bio stimulants were further diluted with water directly to the required concentration at the time of application. Foliar spraying was performed three times at a 15-day interval beginning 30 days after bulb dibbling (30, 45 and 60 days after sowing of bulbs).

Recorded observations

At the 45th and 60th days, growth and yield characteristics were monitored. To quantify the dry matter content of plants, complete plants were uprooted and left to dry naturally, and the weight of the entire plant was weighed at the 45th day and at harvest. The average bulb weight of each replication was determined using bulbs plucked from randomly five plants. Crop Growth Rate (CGR) explains the dry matter accumulated per unit land area per unit time (g m^{-2} day^{-1}) and was calculated by the method suggested by Watson (1956).

$$CGR = \frac{W_2 - W_1}{\rho\,(t_2 - t_1)}$$

Where, W_1 and W_2 are whole plant dry weight at time t_1 and t_2 respectively;

ρ is the ground area on which W_1 and W_2 are recorded. CGR of a species are usually closely related to interception of solar radiation.

Statistical analysis

Three replications of the experiment were done using a Randomized Block Design (RBD). The data for all parameters were analyzed statistically using the Panse and Sukhatme techniques (1985).

Results

Influence of bio-stimulants on growth parameters

The bio-stimulants exerted a significant impact on onion growth parameters such as plant height, number of leaves, dry matter content, and crop growth rate, as shown in Table 1. Regardless of the doses utilized, foliar spray of humic acid had a substantial influence on aggregatum onion than seaweed extract or fish amino acid. However, seaweed extract and fish amino acid outperformed the control in plant height measurements during both phases of crop growth. Among the treatments, humic acid at a concentration of 0.3 percent (T6) resulted in the most significant plant height (41.3 cm) at 60th day of observation. The control plot had the shortest plant height (36.4cm). On both occasions, humic acid at 0.3 percent recorded the maximum number of leaves (28 and 36 respectively) followed by fish amino acid at 0.2 percent (26.6 and 35 respectively). A foliar spray of humic acid at a concentration of 0.3 percent resulted in a considerable increase in dry matter content at harvest (1.20 g/plant). The control group had the lowest dry matter content on 45th and harvest days (0.58g, 0.62g). Compared to seaweed extract, humic acid and fish amino acid exhibited higher values for enhancing crop growth rate. Humic acid at a concentration of 0.3 percent resulted in the highest crop growth rate (0.57 g m^{-2} day^{-1}), followed by Fish amino acid at a concentration of 0.2 percent (0.48 g m^{-2} day^{-1}).

Table 1. Influence of bio-stimulants on growth parameters of aggregatum onion *var*. CO4

Treatment	Plant height (cm)		Number of leaves		Dry matter content (g per plant)		Crop growth rate (g m^{-2} day^{-1})
	45th Day	60th Day	45th Day	60th Day	45th Day	At harvest	
T_1 - Seaweed extract @0.1%	34.4	37.9	23.3	30.3	0.68	0.75	0.21
T_2 - Seaweed extract @0.2%	34.0	37.5	24.6	31.0	0.79	0.86	0.20
T_3 - Seaweed extract @0.3%	34.6	38.3	25.3	33.0	0.96	1.09	0.37
T_4 - Humic acid @0.1%	34.8	39.8	25.0	32.6	0.83	0.93	0.26
T_5 – Humic acid @0.2%	35.0	40.0	27.3	34.6	0.90	1.00	0.28
T_6 – Humic acid @0.3%	35.5	41.3	28.0	36.0	1.00	1.20	0.57
T_7 – Fish amino acid @0.1%	33.2	36.8	24.3	32.0	0.76	0.82	0.17
T_8 – Fish amino acid @0.15%	33.7	37.7	25.0	31.3	0.85	0.95	0.33
T_9 – Fish amino acid @0.2%	33.4	37.0	26.6	35.0	0.93	1.10	0.48
T_{10} – Control	32.9	36.4	24.0	29.0	0.58	0.62	0.10
SEm	0.152	0.166	0.475	0.70	0.008	0.007	0.032
CD (0.05)	0.452	0.495	2.106	0.928	0.024	0.022	0.096

Biostimulants effect on yield attributes

Polar and equatorial diameter of the bulb

Humic acid, seaweed extract, and fish amino acid foliar spray increased polar and equatorial diameter. The treatments greatly enlarged the bulb's polar diameter (Table 2). The treatment with Humic acid at 0.3 percent resulted in the largest polar diameter (28.66 mm), followed by Humic acid at 0.2 percent (27.40 mm). The maximum diameter (26.03 mm) was achieved with a 0.3 percent concentration of seaweed extract, while the highest was achieved with a 0.15 percent concentration of fish amino acid (23.43 mm). Control had the smallest polar diameter (21.26 mm). Similarly, humic acid at a concentration of 0.3 percent produced the largest equatorial diameter (34.16 mm), followed by 0.2 percent (33.46 mm). 0.3 percent seaweed extract scored the highest (32.06 mm), followed by 0.2 percent (31.40 mm). The highest concentration of fish amino acid was 0.15 percent (29.76 mm). The control bulb had the most minor equatorial diameter (27.60 mm).

Average bulb weight

Humic acid at a concentration of 0.3 percent resulted in the most significant average bulb weight of 33.25g. 0.3 percent seaweed extract recorded 29.00 g, followed by 0.2 percent seaweed extract (28.47g). In comparison to the other two biostimulants, fish amino acid had the lowest weight. The T_9 - 0.2 percent fish amino acid treatment resulted in a bulb weight of 25.00 g. The control group had the small-

Table 2. Influence of bio-stimulants on yield and yield-related parameters of aggregatum onion *var*. CO4

Treatment	Polar diameter of the bulb (mm)	Equatorial diameter of the bulb (mm)	Average bulb weight (g)	Total bulb yield /ha (Tonnes)	Percent increase of yield over control
T_1 - Seaweed extract @0.1%	24.03	30.66	26.50	11.48	11.92
T_2 - Seaweed extract @0.2%	25.06	31.40	28.47	12.34	20.23
T_3 - Seaweed extract @0.3%	26.03	32.06	29.00	12.57	22.48
T4 - Humic acid @0.1%	27.10	33.00	29.88	12.95	26.21
T_5 – Humic acid @0.2%	27.40	33.46	30.62	13.27	29.31
T_6 – Humic acid @0.3%	28.66	34.16	33.25	14.41	40.43
T_7 – Fish amino acid @0.1%	22.10	28.00	24.09	10.44	1.72
T_8 – Fish amino acid @0.15%	23.43	29.76	25.65	11.12	8.33
T_9 – Fish amino acid @0.2%	23.00	29.20	25.00	10.83	5.59
T_{10} – Control	21.26	27.60	23.67	10.26	-
SEm	0.223	0.236	0.249	0.108	
SEd	0.315	0.334	0.352	0.152	
CD (0.05)	0.668	0.702	0.739	0.320	

est average bulb weight (23.67g) (Table 2).

Total bulb yield

The maximum total bulb production was obtained with humic acid at 0.3 percent (14.41 t/ha), then at 0.2 percent and 0.1 percent (13.27 t/ha and 12.95 t/ha, respectively). In sea weed extract, the maximum bulb production (12.57 t/ha) was obtained using 0.3 percent seaweed extract, followed by 0.2 percent (12.34 t/ha). Among the fish amino acid treatments, T_8 had the greatest overall bulb yield of 11.12 t/ha. Nevertheless, the aggregate study demonstrated that all three biostimulants outperformed the control. The humic acid foliar spray produced higher yields than the other two biostimulants and the control (Table 2).

The percent improvement in bulb yield above control was calculated and summarized in Table 2. Humic acid at 0.3 percent increased yield the most (40.43 percent), followed by humic acid at 0.2 percent. Among the three seaweed extract treatments, 0.3 percent resulted in a 22.48 percent increase in yield above control. Fish amino acid produced significantly closer and smaller percentage increases in yield above control.

The effects of biostimulants on bulb total yield

Regardless of the doses of biostimulants used in the experiment, when total yield per hectare was compared, it was found that humic acid exceeded the other two biostimulants (Fig. 1). Humic acid produced the highest average bulb production per hectare (13.54 t/ha), followed by seaweed extract (12.13 t/ha) and fish amino acid (10.79 t/ha).

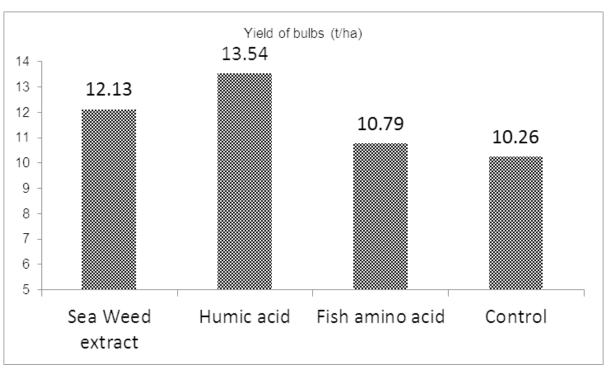

Fig. 1. Comparision of bio-stimulants on total bulb yield ofaggregatum onion var. CO4

Discussion

Onion is a voracious feeder and requires continual nutrition during its growth. While organic manures are a safer alternative to artificial fertilizers, they cannot provide vital nutrients in an absorbable and soluble form (Chen, 2006). To offset this disadvantage, biostimulants are extremely advantageous since they stimulate beneficial bacteria and aid in root absorption efficiency. Additionally, they encourage root growth and the development of beneficial microbial communities (Chen and Aviad, (1990); Chen, 2006; Vessey, 2003). Biostimulants are the natural and synthetic precursors to plant hormones that contain auxins, gibberellins, and cytokinin. They aid in the plant's resistance to biotic and abiotic stress.

The biostimulants utilized considerably raised the plant height of onion. Among the biostimulants, humic acid was found to improve onion plant height at high doses significantly. According to Al-Fraihat *et al*. (2018), humic acid treatment increases plant height due to the presence of auxin molecules. Humic acid therapy activated the H+ – ATPase in the plasmatic membrane, acidifying the apoplast and enzymes that act directly on the cell wall, allowing increased flexibility and cell elongation. Humic acid's ability to boost bulb production may be attributed to systems involved in physiological respiration, protein synthesis, photosynthesis, water and nutrient intake, cationic exchange capacity, enzyme activity, and antioxidant metabolism (Klein *et al*., 2014). Shehata *et al*. (2017) discovered that after humic acid treatment, bulb diameter was increased, and bulb weight loss was minimal. Humic acid improves bulb quality and decreases the percentage of bulbs that decay (Neri *et al*., 2002). They observed that extended administration of Humic acid, i.e., late treatment, improved the quality of strawberries by lowering the quantity of deformed and decaying fruits. The results of humic acid treatments indicated that size expansion is primarily due to auxin-induced quicker mitotic cell division and subsequent centripetal cytokinesis in growing berries (Kumar *et al*., 2002).

Seaweed extract treatments significantly influenced the growth, yield, and quality characteristics of aggregatum onion in this study. Because seaweed extract includes various components, including macro and microelements, amino acids, vitamins, cytokinin, auxins, and abscisic acid (ABA)-like growth factors, it has a beneficial effect on the cellular metabolism of treated plants, resulting in increased growth and crop output. These hormones are critical for increasing cell size and division, and they work in tandem because cytokinin is beneficial for shoot creation and auxin is helpful for root growth. According to Abbas *et al*. (2020), seaweed extract improved plant height, leaf length, and leaf blade. Additionally, the presence of betaines increases the number of leaves. By controlling osmotic adjustment and promoting ion homeostasis, betaines serve a critical function in avoiding chlorophyll breakdown and safeguarding the thylakoid membrane.

The use of fish amino acids (FAA) increased onion output substantially. FAA may have promoted several growth responses, increasing onion bulb yield. In FAA, nitrogen is a crucial macronutrient, contributing for up to 90% of the total (Benedict *et al*., 2011). Rafque and Muhsi (2004) elucidated that foliar application of fish amino acids would have resulted in creating a potent protein hydrolase, a ready-to-use building block of protein synthesis. Johari *et al*. (2020) in okra and Ramesh *et al*. (2020) in amaranthus found similar findings. FAA improved onion development, perhaps because of improved cell ultrastructure, particularly plastids in mesophyll tissue, which boosted photosynthetic efficiency and synthesized more assimilates needed for cell formation (Kandil *et al*., 2013).

Conclusion

In a comparison of three bio-stimulants in onions, humic acid is found to have the most potent effects compared to the other two bio-stimulants and the control. This might be because plants treated with humic acid demonstrated improved physiology in respiration and photosynthetic activity, resulting in increased plant vigor and an excellent supply to sink during bulbing. Similarly, seaweed extracts at low concentrations yielded comparable effects. Auxins included in humic acid and seaweed extracts would have stimulated cell division, increasing plant height and root properties. Whereas the presence of cytokinin might account for the improved yield features of Seaweed Extract. While fish amino acid improved leaf development and vegetative characteristics, they also caused premature maturity. The size and color of the bulbs produced were deplorable.

References

Abbas, M.J., Anwar,M., Zafar-ul-Hye, R.I., Khan, M., Saleem, A.A., Rahi, S., Danish and Datta, R. 2020. Effect of seaweed extract on productivity and quality attributes of four onion cultivars. *Horticulture*. 6(2): 28-32.

Al-Fraihat, A.H., Al-Tabbal, J.A., Abu-Darwish, M.S., Alhrout, H.H. and Hasan, H.S. 2018. Response of onion (*Allium cepa*) crop to foliar application of humic acid under rain-fed conditions. *International. Journal of Agriculture and Biology*. 20(5): 1235-1241.

Benedict, C.N., Theresa, A.B., Cosico, M.G.M., Pamela and Antonieta, J.A. 2011. Fish Amino Acid. In choosing material for Fish Amino Acid. Agricultural Training Institute.www.e-extension.gov.ph, accessed on 16, September, 2020

Chen, J.H. 2006. The combined use of chemical and organic fertilizers and/or biofertilizer for crop growth and soil fertility. *International workshop on sustained management of the soil-rhizosphere system for efficient crop production and fertilizer use* (Vol. 16, No. 20, pp. 1-11). Held in October, 2006 at Land Development Department, Bangkok, Thailand.

Hidangmayum, A. and Sharma, R. 2017. Effect of different concentrations of commercial seaweed liquid extract of *Ascophyllum nodosum* as a plant bio stimulant on growth, yield and biochemical constituents of onion (*Allium cepa* L.). *Journal of Pharmacognosy and Phytochemistry*. 6(4): 658-663.

Johari, J., Nor Mutalib, Asila Ismail, Zalina Ismail, Fazhana Latif, Zahidah Che Man, Shaibatul Islamiah Tang and Jing. 2020. Effects of Fish Amino Acid (FAA) application on growth and development of okra (*Abelmoschus esculentus*) at different sampling times. *Journal of Vocational Education Studies*. 3(2): 128-135.

Kandil, A.A., Sharief, A.E. and Fathalla, F.H. 2013. Onion yield as affected by foliar application with amino and humic acids under nitrogen fertilizer levels. *Crop Production*. 2(2) : 62-72.

Klein, O.I., Isakova, E.P. and Deryabina, Y.I. 2014. Humic substances enhance growth and respiration in the *Basidiomycetes trametes* Maxima under carbon limited conditions. *Journal of Chemitry and Ecology*. 40: 643–652.

Kumar, A.R., Sathiamoorthy, S. and Subbiah, A. 2002. Effect of plant growth regulators on yield parameters, yield and quality of black pepper (*Piper nigrum* L.) var. Panniyur 1. *Journal of Spices and Aromatic Crops*. 11: 125-128.

Neri, D., Lodolini, E.M., Savini, G., Sabbatini, P., Bonanomi, G. and Zucconi, F. 2002. Foliar application of humic acids on strawberry cv. Onda. *Acta Horticulture*. 297-302.

Panse, V.G. and Sukhatme, P.V. 1985. *Statistical Methods for Agricultural Workers*. Indian Council of Agriculture Research, New Delhi.

Rafque, A.K.M.A. and Muhsi, A.A.A. 2004. Effect of micronutrient supplement in growth and development of okra. *Bangladesh Journal of Botany*. 33(2): 129-131.

Ramesh, T., Rathika, S., Murugan, A., Soniya, R.R., Mohanta, K.K. and Prabharani, B. 2020. Foliar spray of fish amino acid as liquid organic manure on the growth and yield of Amaranthus. *Chemical Science Review and Letter*. 9: 511-515.

Shehata, S.A., Abdelgawad, K.F. and El-Mogy, M.M. 2017. Quality and shelf-life of onion bulbs influenced by bio-stimulants. *International Journal of Vegetable Science*. 23(4): 362-371.

Vessey, J.K. 2003. Plant growth promoting rhizobacteria as biofertilizers. *Plant and Soil*. 255(2): 571-586.

Vranova, V., Rejsek, K., Skene, K.R. and Formanek, P. 2011. Non-protein amino acids: plant, soil and ecosystem interactions. *Plant and Soil*. 342(1): 31-48.

Watson, D.J. 1956. Leaf growth in relation to crop yield. In: The growth of leaves (Ed. F.L. Milthorpe) Button Worths Scientific publications, London, pp. 178-190.