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Impact of bio stimulants on growth parameters of capsicum (*Capsicum annum* L.)

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Abstract— *In recent years, there has been a growing interest in the cultivation and consumption of peppers, prompting efforts to identify optimal conditions for their growth and development. This study aimed to assess the impact of biostimulants on the growth and yield of capsicum. The experiment involved twelve treatments, including an absolute control, and was designed using a Randomized Block Design with four replications. The underlying hypothesis suggested that biostimulants could enhance the yield of pepper fruits. The study was conducted in a polyhouse at the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar, during the Rabi seasons of 2022-23 and 2023-24, using the PSM-1 variety as the experimental material. The result showed that treatment T_3 (RDF + Seaweed extract 2.5 ml/L) recorded highest plant height (103.22 cm), leaf area (370.63 cm²) and no. of branches per plant (11.63).*

Keywords— ***Biostimulants, Capsicum, Growth, Yield, Polyhouse***

I. INTRODUCTION

Capsicum (*Capsicum annum* L.) commonly known as bell pepper, sweet pepper or shimla mirch is a tropical and subtropical vegetable and spice from family Solanaceae with chromosome no. 2n = 24 and is popular for its delicious taste, pleasant flavor and nutritional quality. Bell pepper is a native to Mexico with secondary centre of origin in Gautemala (Heiser and Smith, 1953). In India, it was introduced by the Britishers in the 19th century in Shimla Hills (Singh *et al*., 1993). Globally, *Capsicum annuum* is the most widely cultivated species, along with four other domesticated species: *C. baccatum*, *C. chinense*, *C. frutescens*, and *C. pubescens*. It is extensively grown worldwide due to its high consumption, nutritional benefits, and commercial value for both farmers and consumers in developed and developing nations. Conservation of chilli biodiversity and sustainable cultivation practices hold immense importance given the crop's global significance.

Biostimulant is a substance or microorganism applied to plants to enhance nutrient efficiency, abiotic stress tolerance and overall crop quality (Sun *et al.*, 2023). Major categories of biostimulants include humic and fulvic acids, protein hydrolysates and nitrogen-containing compounds, seaweed extracts, botanicals, chitosan and other biopolymers, inorganic compounds, and beneficial fungi and bacteria (Du Jardin, 2015). These biostimulants improve plant growth, resilience and productivity by promoting natural physiological processes. Despite significant advancements in improving bell pepper quality through mineral nutrition, research on the application of biostimulants for the same purpose remains limited.

Chitosan, a biodegradable derivative of chitin found in fungal walls and crustacean shells, enhances plant growth, pest resistance, stress tolerance, and post-harvest quality. It improves traits like plant height, leaf area, chlorophyll content, and photosynthesis in crops (Lustriane *et al.*, 2018; Malerba *et al.*, 2016), and supports soil microbiota diversity for better nutrient absorption (Rabbi *et al.*, 2016). Humic acid, an organic compound,

promotes nutrient uptake, root growth, and stress tolerance. Polyamines like putrescine regulate growth and stress responses, extending shelf life and maintaining fruit texture through foliar application (El-Tohamy *et al.*, 2008; Khosroshahi *et al.*, 2007). Salicylic acid (SA) regulates growth, stress tolerance, and post-harvest decay in crops like strawberries and tomatoes (Kazemi, 2014; Asghari *et al.*, 2009), boosting yield and quality at low concentrations (Canakci, 2011). Seaweed extracts, rich in plant growth regulators (auxins, cytokinins), improve growth, flowering, yield, and shelf life (Yao *et al.*, 2020). Seaweed-derived gels and sprays enhance soil structure, water retention, and microbial activity, offering eco-friendly preservation and growth-promoting benefits (Thivy, 1961; Ramani *et al.*, 2020).

The present study aimed to determine the impact of biostimulants on growth and yield of capsicum.

II. MATERIALS AND METHODS

The present research experiment was conducted at Polyhouse of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar during *Rabi* season of 2022-23 & 2023-24 by using capsicum *cv.* PSM-1. The experiment was conducted at polyhouse located near Ram Dhan Seed Farm (RDS), CCS Haryana Agricultural University, Hisar, which is located in semi-arid, subtropical climate zone at 29° 09' to 14.28" north latitude and 75° 43' to 02.84" east longitude at an elevation of 215 m above mean sea level on South western border of Haryana state. The field experiment was laid out in Randomized Block Design (RBD) by using four replication of each twelve biostimulants treatments. Treatments details are:

T_1: RDF (Control)

T_2: 87.5 % RDF

T_3: RDF + Seaweeds extract (2.5 ml/L)

T_4: 87.5 % RDF + Seaweeds extract (2.5 ml/L)

T_5: RDF + Salicylic acid (2 g/L)

T_6: 87.5 % RDF + Salicylic acid (2 g/L)

T_7: RDF + Chitosan 0.5 %

T_8: 87.5 % RDF + Chitosan 0.5 %

T_9: RDF + Putrescine 0.1 g/L

T_{10}: 87.5 % RDF + Putrescine 0.1 g/L

T_{11}: RDF + Humic acid (5 ml/L)

T_{12}: 87.5 % RDF + Humic acid (5 ml/L)

The observation for plant growth and yield attributes wer recorded on randomly selected plant five competetive plant per treatment in each replication. Observation recorded are plant height (cm) at harvest, leaf area (cm^2) and no. of branches per plant, The experiment was laid out in Randomized Block Design with four replication. The data obtained from the experiment conducted in RBD were analyzed as per standard methods suggested by Panse and Sukhatme (1967). The data observed for various characters during the study were statistically analyzed following the technique of analysis of variance (ANOVA).

III. RESULT AND DISCUSSION

Plant height (cm)

Plant height is a critical growth parameter and a vital indicator of plant development. It is closely associated with lateral branch formation, flower and fruit production, and ultimately crop yield. This parameter not only influences plant architecture but is also an essential agronomic trait contributing to overall productivity. In the study, the pooled plant height over two years ranged from 87.20 cm to 103.22 cm. The tallest plants (103.22 cm) were recorded in treatment T_3 (100% RDF + Seaweed extract at 2.5 ml/L), comparable to T_{11} (100% RDF + Humic acid). The shortest plants (87.20 cm) were observed in treatment T_2 (87.5% RDF). The enhanced plant height in 100% RDF treatments is attributed to increased nitrogen and phosphorus levels, promoting cell division and elongation. Optimal nitrogen availability in the root zone supports better nutrient uptake and vegetative growth, consistent with the findings of Fawzy *et al.* (2012). Seaweed extract application likely boosted plant height due to its rich content of growth-promoting substances, including auxins, gibberellins, cytokinins, micronutrients, vitamins, and amino acids (Hamed *et al.*, 2018). These results align with studies by Sridhar and Rengasamy (2012), Ozbay and Demirkiran (2019), Vijayakumar *et al.* (2019), Ashour *et al.* (2021), and Azzam *et al.* (2022) on capsicum. Humic acid also significantly influenced plant height by improving soil fertility and nutrient availability. Its application enhanced plant growth and yield, particularly in vegetable crops, while mitigating stress-related damage (Doran *et al.*, 2003).

Leaf area (cm^2)

The pooled value of both the years of experimental study, significantly the maximum leaf area (370.63 cm^2) was recorded in treatment T_3 (RDF + Seaweed extract 2.5 ml/L), whereas, the minimum leaf area (285.10 cm^2) was observed in treatment T_2 (87.5 % RDF). In this present study, leaf area was significantly increased in the bell

pepper plants with 100% RDF along with foliar application of various biostimulants.

The increase in leaf area is a positive indication of response of growth factors in many of the nutritional investigation and also directly indicates the increase in photosynthetic activity of a plant producing more of photosynthates and more metabolic activity. Their combination produced more leaf area due to proper utilization of nutrition. The leaf area increased gradually with 100% RDF at all the growth stages due to better N and K nutrients availability and absorption by the plants resulted in more number of leaves and higher leaf area. These findings were in agreement with Mounika (2016) in paprika, Nanda and Mahapatra (2004) in tomato and Sahoo *et al*. (2002) in tomato, Santos *et al*. (2003) in capsicum.

Expanding the leaf area often through a higher concentration of such seaweed extract possibly due to micronutrients in the supplement, which include potassium, improves the plant's metabolism, the production of amino acids and proteins, as well as the emergence of photosynthetic pigments that further improved the performance of the leaf area (Kularathne *et al*., 2021). These results are also in accordance with Sridhar and Rengasamy (2012); Ozbay and Demirkiran (2019); Vijayakumar *et al*. (2019) and Azzam *et al*. (2022) in capsicum.

Number of branches per plant

The number of branches per plant plays an important role in plant morphogenesis and is important agronomic characters that determine the fruit quality and yield. The effective branches also determine the number of flowers cluster or no. of fruits per plant that decide the total yield and quality of bell pepper fruit.

The pooled value of both the years of experimental study showed that for number of branches per plant was maximum (11.63) in treatment T_3 (100 % RDF + Seaweed extract 2.5 ml/L)**,** which was at par with treatment T_{11} (RDF + Humic acid), whereas the minimum (9.63) was observed in treatment T_2 (87.5 % RDF).

There was increase in branches per plant might be due to increase in nutrient use efficiency and synergistic effect of nitrogen and potash, there was increase in number of primary branches. Availability and uptake of nutrient and vigorous growth character facilitates a greater number of branches per plant and moreover potassium plays a major role in cell division and elongation and metabolism of carbohydrates and protein compounds (Gouthami *et al.*, 2022). Similar results were observed by Manna *et al*., (2012) with the application of Biozyme (seaweed extract) as foliar fertilizer increased the mean number of branches per plant of chilli. Thus, it is amply clear that the biozyme (seaweed extract) which consisted of precursors of auxin, enzyme, protein and micronutrients was responsible for the improved vegetative growth of chilli. These results are also in accordance with Sridhar and Rengasamy (2012); Vijayakumar *et al.* (2019); Ashour *et al.* (2021) and Azzam *et al.* (2022) in capsicum. Humic acid rises the chlorophyll and leaf N, P, K content and K concentration increased number of branches was also reported by Kazemi, M (2013) on cucumber. Similar findings were also reported by Fathima *et al*., (2013) in chilli, Kumar *et al*., (2015) in Okra.

Table 1: Effect of various biostimulants on plant height (cm), leaf area (cm^2) and no. of branches per plant of capsicum cv. PSM-1 under polyhouse

Treatments	Plant height (cm)			Leaf area (cm^2)			No. of branches per plant		
	2022-23	2023-24	Pooled mean	2022-23	2023-24	Pooled mean	2022-23	2023-24	Pooled mean
T_1	89.74	90.48	90.11	288.62	291.84	290.23	9.50	10.25	9.88
T_2	86.72	87.68	87.20	283.46	286.74	285.10	9.25	10.00	9.63
T_3	101.55	104.89	103.22	368.85	372.41	370.63	11.00	12.25	11.63
T_4	93.40	97.92	95.66	311.49	317.93	314.71	10.25	11.00	10.63
T_5	93.89	97.33	95.61	319.18	321.46	320.32	10.75	11.25	11.00
T_6	88.12	91.44	89.78	291.88	295.16	293.52	9.75	10.50	10.13
T_7	98.96	100.48	99.72	337.46	343.12	340.29	10.50	11.75	11.13
T_8	92.12	93.90	93.01	300.24	303.54	301.89	9.75	10.75	10.25
T_9	95.05	99.01	97.03	326.97	330.67	328.82	10.50	11.50	11.00
T_{10}	90.30	92.96	91.63	296.11	299.43	297.77	9.25	10.75	10.00

T_{11}	99.83	103.37	101.60	350.26	355.94	353.10	11.00	12.00	11.50
T_{12}	94.54	96.10	95.32	307.79	312.67	310.23	10.00	10.75	10.38
C.D.	2.46	2.76	1.70	9.26	9.61	7.79	0.31	0.34	0.20

IV. CONCLUSION

The study highlighted the positive effect of biostimulants on growth and parameters of capsicum. Plant treated with Seaweed extract recorded highest plant height (103.22 cm), leaf area (370.63 cm^2) and no. of branches per plant (11.63).

REFERENCES

[1] Asghari, M. R., Hajitagilo, R. and Jalilimarandi, R. (2009). Postharvest application of salicylic acid before coating with chitosan affects the pattern of quality changes in table grape during cold storage. *In 6th International Postharvest Symposium*, Antalya, Turkey (pp. 8-12).

[2] Ashour, M., Hassan, S. M., Elshobary, M. E., Ammar, G. A., Gaber, A., Alsanie, W. F., Mansour, A. T. and El-Shenody, R. (2021). Impact of commercial seaweed liquid extract (TAM®) biostimulant and its bioactive molecules on growth and antioxidant activities of hot pepper (*Capsicum annuum*). *Plants*, **10**(6): 1045.

[3] Azzam, E., El-Howeity, M., Galal, H. and Nofal, A. (2022). Biofertilizer efficiency of seaweed liquid extracts of marine green and red macro algae on growth and biochemical parameters of Hot Pepper (*Capsicum annuum* L.). *International Journal of Environmental Studies and Researches*, **1**(2): 237-249.

[4] Canakci, S. (2011). Effects of salicylic acid on growth, biochemical constituents in pepper (*Capsicum annuum* L.) seedlings. *Pakistan Journal of Biological Sciences*, **14**(4): 300-304.

[5] Doran, I., Akinci, C. and Yildirim, M. (2003). Effects of delta humate applied with different doses and methods on yield and yield components of Diyarbakir-81 wheat cultivar. In *5th Field Crops Congress. Diyarbaki, Turkey*, **2**:530-534.

[6] Du Jardin, P. (2015). Plant biostimulants: Definition, concept, main categories and regulation. *Scientia horticulturae*, *196*, 3-14.

[7] El-Tohamy, W. A.;H.M. El-Abagy and N.H.M. El-Greadly (2008). Studies on the effect of Putrescine, yeast and vitamin C on growth, yield and physiological responses of eggplant (Solanum melongena L.) under sandy soil conditions. Australian Journal of Basic and Applied Sciences, 2(2):296-300.

[8] Fathima, P. S. and Denesh, G. R. (2013). Influence of humic acid spray on growth and yield of chilli (*Capsicum annum* L.). *International Journal of Agricultural Sciences*, **9**(2):542-546.

[9] Fawzy, Z. F., El-Bassiony, A. M., Li YunSheng, L. Y., Ouyang Zhu, O. Z. and Ghoname, A. A. (2012). Effect of mineral, organic and bio-N fertilizers on growth, yield and fruit quality of sweet pepper. *Journal of Applied Sciences Research*, **8**(8): 3921-3933.

[10] Gouthami, B., Devi, M. U., Kumar A. K. and Ramulu, V. (2022). Growth parameters of capsicum (*Capsicum annuum* var. *grossum* L.) as influenced by different nitrogen and potassium fertigation levels under polyhouse. *Biological Forum – An International Journal*, **14**(2): 624-629.

[11] Hamed, S. M., Abd El-Rhman, A. A., Abdel-Raouf, N. and Ibraheem, I. B. (2018). Role of marine macroalgae in plant protection & improvement for sustainable agriculture technology. *Beni-Suef University Journal of Basic and Applied Sciences*, **7**(1): 104-110.

[12] Heiser, C. B. and Smith, P. G. (1953). The cultivated capsicum peppers. *Economic Botany*. **7**: 214-227.

[13] Karakurt, Y., Unlu, H., Unlu, H. and Padem, H. (2009). The influence of foliar and soil fertilization of humic acid on yield and quality of pepper. *Acta Agriculturae Scandinavica Section B–Soil and Plant Science*, **59**(3): 233-237.

[14] Kazemi, M. (2013). Effect of foliar application of humic acid and potassium nitrate on cucumber growth. *Bull. Environ. Pharmacol. Life Sci*, *11*, 3-6.

[15] Kazemi, M. (2014). Effect of foliar application of humic acid and calcium chloride on tomato growth. *Bulletin of Environment, Pharmacology and Life Sciences*, **3**(3): 41-46.

[16] Khosroshahi, M. R. Z., Esna-Ashari, M. and Ershadi, A. (2007). Effect of exogenous putrescine on post-harvest life of strawberry (*Fragaria ananassa* Duch.) fruit, cultivar Selva. *Scientia Horticulturae*, **114**(1): 27-32.

[17] Kumar, P., Rana, D. K., Singh, V. and Shah, N. (2015). Effect of humic acid on growth, yield and quality of okra (*Ablemoschus esculantus* (L.) Moench) *cv.* Arka Anamika under subtropical conditions of Garhwal Himalaya. *International Journal for Innovative Research in Science and Technology*, **1**: 2349-6010.

[18] Lustriane, C., Dwivany, F. M., Suendo, V. and Reza, M. (2018). Effect of chitosan and chitosan-nanoparticles on post-harvest quality of banana fruits. *Journal of Plant Biotechnology*, **45**(1): 36-44.

[19] Malerba, M. and Cerana, R. (2016). Chitosan effects on plant systems. *International Journal of Molecular Sciences*, **17**(7): 996.

[20] Manna, D., Sarkar, A. and Maity, T. K. (2012). Impact of biozyme on growth, yield and quality of chilli (*Capsicum annuum* L.). *Journal of Crop and Weed*, **8**(1): 40-43.

[21] Mounika, D. (2015). PAPRIKA (*Capsicum annuum.* L) response to fertigation levels of nitrogen and potassium (Doctoral dissertation, Professor Jayashankar Telangana State Agricultural University. Hyderabad).

[22] Nanda, S. (2004). Integrated Effect of Bioinoculation and Chemical Fertilization on Yield and Quality of Tomato (*Lycopersicon Esculentum* M.) (Doctoral dissertation, Orissa Univesrity of Agriculture and Technology; Bhubaneswar).

[23] Ozbay, N. and Demirkiran, A. R. (2019). Enhancement of growth in ornamental pepper (*Capsicum annuum* L.) Plants with application of a commercial seaweed product, stimplex®. *Applied Ecology & Environmental Research*, **17**(2).

[24] Panse, V.G. and P.V. Sukhatme, (1967). Statistical Methods for Agricultural Workers. 2nd Endorsement, *ICAR Publication, New Delhi, India*, 381-384.

[25] Rabbi, S. F., Rahman, M., Mondal, M. M. A., Bhowal, S. K. and Haque, A. (2016). Effect of chitosan application on plant characters, yield attributes and yield of mungbean. *Research Journal of Agricutural And Environmental Management*, **5**(3): 95-100.

[26] Ramani, S., Banu, A. and Ashwini, M. A. (2020). Effect of seaweed coating on quality characteristics and shelf life of tomato (*Lycopersicon esculentum* Mill). *Food Science and Human Wellness*, **9**(2): 176-183.

[27] Sahoo, D., Mahapatra, P., Das, A. K. and Sahoo, N. R. (2002). Effect of nitrogen and potassium on growth and yield of tomato (*Lycopersicon esculentum*) var. Utkal Kumari. *Haryana Journal of Horticultural Science*, **31**(3/4): 264-266.

[28] Santos, R. F., Klar, A. E., Frigo, E. P. and Correa, M. M. (2003). Application of different nitrogen and potassium doses on pepper crop grown under plastic tunnel and field conditions. *IRRIGA*, **8**(3): 250-263.

[29] Singh, D. P., Anand, N. and Deshpande, A. A. (1993). Improvement of bell pepper. In: KL Chadha and G Kalloo (eds.), Advances in Horticulture. New Delhi: MPH, **5**: 87-104.

[30] Sridhar, S. and Rengasamy, R. (2012). The effects of Seaweed Liquid Fertilizer of Ulva lactuca on *Capsicum annum*. *Algological Studies*, **138**(1): 75.

[31] Sun, W., & Shahrajabian, M. H. (2023). The application of arbuscular mycorrhizal fungi as microbial biostimulant, sustainable approaches in modern agriculture. *Plants*, *12*(17), 3101.

[32] Thivy, F. (1961). Seaweed manure for perfect soil and smiling fields. *Salt Research Industry*, **1**(17): 1-4.

[33] Vijayakumar, S., Durgadevi, S., Arulmozhi, P., Rajalakshmi, S., Gopalakrishnan, T. and Parameswari, N. (2019). Effect of seaweed liquid fertilizer on yield and quality of *Capsicum annum* L. *Acta Ecologica Sinica*, **39**(5): 406-410.

[34] Yao, Y., Wang, B., Chen, M., Zhang, S. and Ma, J. (2020). Seaweed extract improved yields, leaf photosynthesis, ripening time, and net returns of tomato (*Solanum lycopersicum* Mill.). *American Chemical Society Omega*, **5**(8): 4242-4249.

[35] Yusuf, R., Syakur, A., Awalni, F. and Kalaba, Y. (2021). Combinations of seaweed extract and NPK on vegetative growth of chili growing under glasshouse condition. In *IOP Conference Series: Earth and Environmental Science* (Vol. 694, No. 1, p. 012034). IOP Publishing.