



Efficiency of Different Bio Stimulants on Chilli Crop under Prayagraj Agro Climatic Conditions

Anjali Yadav^{a++*}, Devi Singh^{a#} and C. John Wesley^{a†}

^a Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP), India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted on "Production of Chilli Crop under Prayagraj Agro Climatic Conditions: Role of Bio Stimulants as plant growth regulators" to observed the effect of bio stimulants on growth parameters. The objective of the study is the effects of different doses bio stimulants and its role in growth, yield and quality of Chili variety TMPH-409. The experiment was laid in the randomized block design with 13 treatments and 3 replications with different combination of bio-stimulants. Under this experiment, 13 treatments were taken including control. Different bio stimulants used comprised of BIOSTAR, TERMINATOR33, STRICKER and OPERA, virtue all four at different doses of 2 mL, 2.5 mL, 3mL, 3.5 mL, 4 mL and 4.5 mL and mix with water. From the above experimental finding it may be concluded that the T₉(STRICKER – 3 mL/ L water) was found to be the best in the term of growth, yield and quality. The highest net return was found in the T₉ (STRICKER – 3 mL/ L water) and the highest benefit cost ratio was found in the treatment T₉ with 1.88 and found the best treatment.

⁺⁺ M.Sc. (Ag.) Horticulture (Vegetable Science);

[#] Associate Professor of Horticulture;

[†] Assistant Professor of Geospatial Technology;

*Corresponding author: E-mail: anjaliyadav141178@gmail.com;

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1. INTRODUCTION

Chili (*Capsicum annuum* L.) is a hot-tasting tropical berry with chromosome number $2n=2x=24$, belongs to the family Solanaceae, native of Peru and Mexico. Pungency in chili is present in placenta and pericarp of fruit due to alkaloid capsaicin. It is also used for industrial purpose for extraction of oleoresin [1].

In India, dried chilli producing states are Andhra Pradesh, Telangana, Tamil Nadu, Karnataka and Madhya Pradesh. Karnataka covers an area of 65,331 hectares with a production of 173712.14 tonnes and an average productivity of 2658.95 kg/ha. Major chilli cultivating districts in Karnataka are Haveri, Dharwad, Belgaum, Kolar, Chikkaballapur and Shivamogga [2].

Bio-stimulants are classified in to eight categories viz., humid substance, complex organic materials, beneficial chemical elements, inorganic salts (including phosphide), seaweed extracts, chitin & chitosan derivatives, anti-transparent and free amino acids and other N-containing, a critical analysis is needed for these bio stimulants - biosynthesis, where possible, effectiveness and their application on other plants as well [3](Xylia et al., 2022). Bio-stimulants are designated for use on a plant, seeds or root area and increase the effectiveness of nutrients use, tolerance for abiotic stress and/or the quality of yield, the action of which is not dependent on the contents of nutrients [4,5].

A large number of microorganisms present in rhizosphere have been considered to be important in sustainable agriculture because of their bio control potential and ability to promote plant growth. Bacteria that inhabit the rhizosphere and are beneficial to plants are termed Plant Growth Promoting Rhizobacteria (PGPR). PGPR exhibit direct and indirect mechanisms as plant growth promoters and biological control agents. Direct mechanisms by PGPR include enhanced nutrient mobility, nitrogen fixation, de-nitrification, siderophore and phytohormone production. Indirect mechanisms of PGPR include production of antibiotics, viz. 2,4-Diacetyl phloroglucinol (DAPG), phenazine, pyoluteorin and pyrrolnitrin against pathogenic fungi and bacteria, reduction of iron available to phytopathogens in the rhizosphere, synthesis of fungal cell wall lysing enzymes [6].

2. MATERIALS AND METHODS

2.1 Experimental Site and Location

The experiment was conducted during kharif season of the year 2022 at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. The experimental site is located in the sub-tropical region which is located at 25° . 271 N latitude, 81° . 561 E longitude and 98 m above the mean sea level.

Table 1. Details of treatment combination

Treatment Symbol	Treatment Combinations
T ₀	Control
T ₁	BIOSTAR – 3.5 Kg/Acre
T ₂	BIOSTAR – 4 Kg/Acre
T ₃	BIOSTAR – 4.5 Kg/Acre
T ₄	TERMINATOR33 – 2 mL/L water
T ₅	TERMINATOR33 – 2.5 mL/L water
T ₆	TERMINATOR33 – 3 mL/ L water
T ₇	STRICKER-2 mL/L water
T ₈	STRICKER – 2.5 mL/L water
T ₉	STRICKER – 3 mL/ L water
T ₁₀	OPERA – 2 mL/L water
T ₁₁	OPERA – 2.5 mL/L water
T ₁₂	OPERA - 3 mL/ L water

2.2 Climate Condition

The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and cold winter. The maximum temperature of the location reaches up to 46°C – 48°C and seldom falls as low as 4°C – 5°C . The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually. Prayagraj has a sub-tropical and semi- arid climate with rain mostly during July- September.

2.3 Statistical Analysis

The statistical analysis of the data was carried out using STATISTICA (7.0) software for ANOVA test.

3. RESULTS AND DISCUSSION

Crop growth parameters in chili were measured in terms of days to germination plant height (cm), plant spread at 30, 60, 90 DAT and at Harvest

are shown in Table 2. The maximum number of days taken to germination of plants with the treatment T₉ (STRICKER – 3 mL/ L water) was 9.43. The application of bio stimulants might have improved the soil physical and chemical properties and leading to the adequate supply of nutrients to the plant which might have promoted the early germination [7].

Maximum height was reported in STRICKER – 3 mL/ L water (T₉) with an average height of 113.87 cm was significantly higher from rest of treatments. Minimum plant height 104.60 cm was recorded (T₀). The mechanism of possible growth promoting effect, usually attributed to hormone like impact, activation of photosynthesis, acceleration of cell division, increase of permeability of plant cell membranes and improved nutrient uptake and finally the activation of biomass production. Moreover, humic acid contains a stable fraction of carbon, thus regulating the carbon cycle and released the nutrients which improved plant growth. Foliar application of fish amino acid might have improved the metabolic activity and cell division resulting in higher plant height, number of leaves and chlorophyll content [8].

Maximum spread was reported in STRICKER – 3 mL/ L water (T₉) with an average spread of 94.45 cm which was significantly higher from rest of treatments. Minimum plant spread 58.56 cm was recorded (T₀) [8].

The observation regarding flowering viz., Number of branches per plant, leaf area, number of days for flowering and days to 50% flowering were shown in Table 3. The highest number of primary branches per plant at harvest was observed in STRICKER – 3 mL/ L water (T₉) (12.64) and least number of primary branches per plant was recorded in control (T₀) (11.04). Favorable weather and moisture of the soil are the important parameters affecting the number of branches per plant. It was concluded that a greater number of branches were recorded in bio stimulants treated plots as compared to control. It might be due to favorable microclimatic conditions and soil moisture conservation with the use of bio stimulants which results in better vegetative growth leads to increase in number of branches per plant [8].

The leaf area index of 56.03 was recorded with the STRICKER – 3 mL/ L water (T₉) application which was significantly higher as compared to rest of treatments. Minimum value of leaf area index 36.98 was reported (T₀) which was significantly lower from rest of treatments. There was wide variation observed among the treatments in initiation of flowering in chilli. Among the bio stimulants treatments, minimum number of days taken by plants to reach a thesis stage after transplanting were recorded when the plants bio stimulants with STRICKER – 3 mL/ L water (T₉) [9].

It took about 45.37 days after transplanting which was significantly earlier from rest of treatments days after transplanting. Consistency in availability of nutrients through bio stimulants means might have supplemented the additional nutrient requirement caused due to early flowering coupled with concomitant increase in flower number and consecutive fruit development. Enhanced yield was observed in chilli due to the vegetative growth stimulation by application of bio stimulants resulted in a positive early in flowering, fruiting stages and increased total yield per plant [10].

Days to 50 % flowering represents the number of days taken by plants to reach fruit setting stage, it was noticed that minimum number of days were taken for the Days to 50 % flowering when the plants were control 50.33 days after transplanting with other treatment significantly from rest of treatments. The further perusal of the data revealed application the maximum number of days were taken by plant to reach days to 50 % flowering by the application STRICKER – 3 mL/ L water (T₉) took 53.27 days followed by TERMINATOR33 – 3 mL/ L water (T₆) 52.33 days after transplanting [10].

The observation regarding flowering viz., fruit length(cm), fruit width (cm), fruit weight(cm), fruit diameter (cm), number of fruits per plant, yield per plant (g), yield per ha (q), TSS and Ascorbic acid were shown in Table 3. Maximum fruit length(cm) was observed (7.44 cm), maximum fruit width (cm) was observed 2.086 cm and minimum width observed with control treatment (1.984 cm), maximum fruit weight was observed 3.14 cm and

Table 2. Effect of different bio stimulants on plant growth regulators on growth of chilli (*Capsicum annum* L.)

Sr. no.	Treatments	Days to Germination	Plant height (cm)				Plant Spread (cm)			
			30 DAT	60 DAT	90 DAT	At HARVEST	30 DAT	60 DAT	90 DAT	At HARVEST
T ₀	CONTROL	8.18	20.60	58.27	86.00	104.60	20.49	36.28	52.28	78.56
T ₁	BIOSTAR – 3.5 Kg/Acre	8.33	21.53	63.87	86.43	106.00	21.31	37.29	53.29	80.58
T ₂	BIOSTAR – 4 Kg/Acre	8.34	21.87	63.90	87.93	107.47	21.52	38.56	54.56	80.58
T ₃	BIOSTAR – 4.5 Kg/Acre	8.83	23.27	66.20	91.20	110.07	24.12	43.37	58.44	86.46
T ₄	TERMINATOR 33 – 2 mL/L water	8.51	22.27	65.40	89.33	108.93	22.94	40.23	56.04	83.12
T ₅	TERMINATOR 33 – 2.5 mL/L water	8.87	23.60	66.47	91.87	110.53	25.17	48.93	59.37	89.98
T ₆	TERMINATOR 33 – 3 mL/ L water	9.05	24.73	70.40	97.47	113.51	26.59	53.53	64.93	94.02
T ₇	STRICKER-2 mL/L water	8.54	22.60	65.73	90.13	109.81	23.56	41.99	56.23	83.86
T ₈	STRICKER – 2.5 mL/L water	9.01	24.33	68.67	94.00	113.21	26.17	51.58	63.29	93.06
T ₉	STRICKER – 3 mL/ L water	9.43	24.80	72.87	99.20	113.87	28.88	57.29	67.58	94.45
T ₁₀	OPERA – 2 mL/L water	8.41	22.13	65.27	88.07	107.51	22.19	40.04	55.01	82.74
T ₁₁	OPERA – 2.5 mL/L water	8.73	23.13	66.20	90.80	109.93	23.61	42.44	57.99	86.08
T ₁₂	OPERA - 3 mL/ L water	8.93	23.73	67.00	92.00	111.37	25.22	49.01	59.53	90.88
F-Test		NS	S	S	S	S	S	S	S	S
S. Ed. ±		0.12	0.36	1.03	1.12	0.75	0.52	1.36	1.36	1.37
CD at 5%		0.08	0.23	0.67	0.73	0.49	0.34	0.88	0.88	0.89
CV		5.10	5.59	5.61	4.43	2.48	7.80	10.96	8.39	5.70

Table 3. Effect of different bio stimulants on plant growth regulators on growth of chilli (*Capsicum annum* L.)

Sr. no.	Treatments	Number of branches per plant				Leaf area index	Days to 1 st flowering	Days to 50% flowering
		30 DAT	60 DAT	90 DAT	At harvest			
T ₀	CONTROL	2.04	5.13	9.10	11.04	36.98	45.37	50.33
T ₁	BIOSTAR – 3.5 Kg/Acre	2.11	5.33	9.16	11.06	39.92	45.67	50.80
T ₂	BIOSTAR – 4 Kg/Acre	2.14	5.53	9.71	11.57	41.09	45.80	50.93
T ₃	BIOSTAR – 4.5 Kg/Acre	2.72	6.24	10.44	11.97	50.23	46.33	51.60
T ₄	TERMINATOR 33 – 2 mL/L water	2.49	5.56	10.34	11.67	42.11	46.07	51.13
T ₅	TERMINATOR 33 – 2.5 mL/L water	2.86	6.26	10.53	12.01	50.87	46.53	51.80
T ₆	TERMINATOR 33 – 3 mL/ L water	3.74	6.53	11.74	12.62	54.23	47.07	52.33
T ₇	STRICKER-2 mL/L water	2.67	5.80	10.39	11.76	45.00	46.27	51.40
T ₈	STRICKER – 2.5 mL/L water	3.43	6.46	11.41	12.39	51.67	46.67	52.00
T ₉	STRICKER – 3 mL/ L water	3.77	6.86	12.81	12.64	56.03	47.67	53.27
T ₁₀	OPERA – 2 mL/L water	2.16	5.53	9.83	11.62	41.98	46.07	50.93
T ₁₁	OPERA – 2.5 mL/L water	2.72	6.21	10.39	11.94	45.34	46.27	51.40
T ₁₂	OPERA - 3 mL/ L water	3.07	6.33	10.78	12.33	51.23	46.53	51.93
F-Test		S	S	S	S	S	S	S
S. Ed. ±		0.18	0.16	0.30	0.14	1.76	0.18	0.23
CD at 5%		0.12	0.11	0.19	0.09	1.15	0.12	0.15
CV		23.59	9.74	10.21	4.29	13.61	1.42	1.61

Table 4. Effect of different bio stimulants plant growth regulators on growth of chilli (*Capsicum annum* L.)

Sr. no.	Treatments	Fruit length (cm)	Fruit Width (cm)	Fruit weight (g)	Fruit diameter (cm)	No. of fruit/plant	Yield/plant (gm)	Yield/ha. (q/ha)	Ascorbic acid (mg/100gm)	TSS (^o Brix)
T ₀	CONTROL	7.14	1.98	2.62	0.59	67.71	139.85	15.16	131.33	3.34
T ₁	BIOSTAR – 3.5 Kg/Acre	7.16	1.96	2.63	0.58	71.55	144.53	15.39	131.95	3.51
T ₂	BIOSTAR – 4 Kg/Acre	7.20	1.97	2.80	0.58	74.35	150.72	16.63	132.84	3.97
T ₃	BIOSTAR – 4.5 Kg/Acre	7.24	1.98	3.01	0.59	77.48	157.92	19.66	137.02	4.14
T ₄	TERMINATOR 33 – 2 mL/L water	7.22	1.97	2.86	0.59	76.22	154.22	17.59	134.39	4.04
T ₅	TERMINATOR 33 – 2.5 mL/L water	7.28	1.98	3.04	0.59	81.08	164.30	20.59	137.45	4.14
T ₆	TERMINATOR 33 – 3 mL/ L water	7.32	1.99	3.13	0.60	86.12	173.54	22.33	138.38	4.40
T ₇	STRICKER-2 mL/L water	7.23	1.97	2.92	0.59	76.26	154.77	17.89	135.62	4.06
T ₈	STRICKER – 2.5 mL/L water	7.29	1.99	3.11	0.59	84.35	170.97	21.10	137.99	4.21
T ₉	STRICKER – 3 mL/ L water	7.44	2.09	3.14	0.60	101.88	203.90	22.67	140.95	4.85
T ₁₀	OPERA – 2 mL/L water	7.22	1.97	2.82	0.59	74.53	150.89	17.19	133.01	4.01
T ₁₁	OPERA – 2.5 mL/L water	7.23	1.98	2.96	0.59	76.51	157.55	18.68	135.75	4.07
T ₁₂	OPERA - 3 mL/ L water	7.28	1.99	3.05	0.59	83.51	168.37	20.75	137.59	4.17
F-Test		S	S	S	S	S	S	S	S	S
S. Ed. ±		0.02	0.01	0.03	0.00	2.66	5.06	0.57	0.79	0.10
CD at 5%		0.01	0.01	0.02	0.00	1.73	3.29	0.37	0.51	0.07
CV		1.08	1.84	4.06	1.00	12.07	11.34	10.87	2.10	9.17

minimum fruit weight observed with control treatment (2.62 cm) and maximum fruit diameter was observed in (0.600 cm) were found in STRICKER – 3 mL/ L water (T₉). The present study finds support of [11] who reported that fruit length, fruit width and number of seeds per fruit of chilli were statistically similar over the bio stimulants treatments.

The maximum number of fruits (101.88) were recorded in (T₉) which was significantly higher from rest of the treatments and minimum number of fruits per plant i.e., 67.71 recorded in the control treatment which was lower significantly. Maximum fruit yield per plant i.e., 203.90 g was obtained in STRICKER – 3 mL/ L water (T₉) which was significantly higher from rest of the treatments and the minimum fruit yield per plant that is 139.85 g recorded from the plot which was kept control (T₀).

The data showed in the Table 4 that maximum yield of 22.67 (q/ha) with the treatment (T₉) was reported using bio stimulants were followed by treatment (T₆) with the value of 22.33 (q/ha). Minimum fruit yield of chili was recorded in weedy check (T₀) (15.16). The popularity of bio stimulants in agriculture is associated with the possibility of obtaining higher yields without the need to discontinue the production of ecological crops. According to numerous scientific studies, bio stimulants have a positive effect on yielding plants. The yield is usually determined as the amount of fruit obtained from one plant or plot. The yield depends on the type of bio stimulant used, the dose, the method of application, and the plant variety. Increased yield is often associated with improving the quality of vegetables or fruit. This is particularly important in organic farming, where artificial fertilizers cannot be used [12].

Among the various treatments STRICKER – 3 mL/ L water (T₉) led to maximum increase in ascorbic acid content of 140.95 mg/100g on an average which is significantly higher from rest of treatments and followed by (T₆) (138.38) and (T₈) (137.99). Minimum amount of vitamin-C was reported in control treatment (T₀) (131.33) which was significantly. Similar finding of using these bio stimulants, fruit taste values improved significantly, as evidenced by the increase in the level to an average of Ascorbic acid content [13].

There were significant differences between the treatments at Initial and other replication. Among the treatments used bio stimulants and have

highest TSS °B which were significantly superior to T₀ (Control) and other treatment. The maximum TSS value in chilli was recorded in T₉ with 4.85 °B and the minimum was recorded in T₀ (Control) with 3.34 °B. Bio stimulants can affect a number of the chemical properties of fruits and vegetables, including dry mass, acidity or vitamin content. The chemical composition of the fruit directly affects their palatability. It is assumed that fruits with a content of dissolved solids (SSC) above 12°Brix are characterized by an excellent taste. In the first year of using bio stimulants containing the biopolymers of polysaccharides, humic and fulvic acids as well as carboxylic acids, the average value of SSC in apricots stood at 10.7°Brix. In the second year of using these bio stimulants, fruit taste values improved significantly, as evidenced by the increase in the SSC level to an average of 14.1°Brix [13,14].

4. CONCLUSION

The experimental finding concluded that, the application of T₉ (STRICKER –3 mL/ L water) was found to best in terms of growth, yield and quality. The highest net return was found in the T₉ (STRICKER –3 mL/ L water) and highest B:C ratio was found in the same with 1.88.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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