Production of Chilli Crop under Prayagraj Agro Climatic Conditions: Role of Bio Stimulants as plant growth regulators

Abstract

Anexperiment 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 stimulantson 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 T_9 (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 T_9 (STRICKER – 3 mL/ L water) and the highest benifit cost ratio was found in the treatment T_9 with **1.88** and found the best trestment.

Keywords:TMPH-409, Bio Stimulants, Chili crop, yield, growth

1. Introduction

Chili (*Capsicum annuum* L.) is a hot-tasting tropical **berry** with chromosomenumber2n=2x=24,belongstothefamilySolanaceae,native ofPeruandMexico.Pungencyin chili is present in placenta and pericarp of fruit due to alkaloid capsaicin. It is also used forindustrial purpose for extraction of oleoresin. **(Paul *et al.*,2013)**.

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 productionof 173712.14 tonnes and an average productivity of 2658.95 kg/ha. Major chilli cultivatingdistrictsinKarnatakaareHaveri,Dharwad,Belgaum,Kolar,C hikkaballapuraandShivamogga**(Bindu andNayak, 2021).**

Bio-stimulants are classified in to eight categories *viz.*, humid substance, complexorganicmaterials,beneficialchemicalelements,inorganicsalts(includingphosphide),seaweed extracts, chitin &chitosan derivatives,anti-transparent and free amino acids andother N-containing,a critical analysis is needed for these bio stimulants - biosynthesis, where possible, effectiveness and their application on other plants as well**(Khalil *et al.*, 2022, Xylia *et al.*, 2022)**. Bio-stimulants are designated for use on a plant, seeds or rootarea and increase the effectiveness of nutrients use, tolerance for abiotic stress and/or thequalityofyield,theactionofwhichisnotdependentonthecontentsofnu trients**(Sankhabar *et al.*, 2017, Hassan *et al.*, 2023).**

A large number of microorganisms present in rhizosphere have been considered tobe important in sustainable agriculture because of their bio control potential and ability topromote plant growth. Bacteria that inhabit the rhizosphere and are beneficial to plants aretermed **Plant Growth Promoting Rhizobacteria** (PGPR). PGPRexhibit direct and indirect mechanisms as plant growth promoters and biological controlagents. 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-Diacetylphloroglucinol (DAPG), phenazine, pyoluteorin and pyrrolnitrin against pathogenic fungiand bacteria, reduction of iron available to phytopathogens in the rhizosphere, synthesis offungalcellwalllysingenzymes**(Jalili*etal.*,2012).**

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 25^0. 271 N latitude, 81^0. 561 E longitude and 98 m above the mean sea level.

3. Table 1. Details of treatmentcombination

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 $46^oC – 48^oC$ and seldom falls as low as $4^oC – 5^oC$. 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.

2.5 Statistical analysis The statistical analysis of the data was carriedout using STATISTICA (7.0) software for ANOVA test.

3. Results and Discussion

Crop growth parameters in chili were measured in terms of days to germinationplant 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 T_9(STRICKER – 3 mL/ L water) was 9.43. Theapplication 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 **(Surender *et al.*, 2020).**

MaximumheightwasreportedinSTRICKER – 3 mL/ L water (T_9) withanaverageheightof 113.87cmwassignificantlyhigherfromrestof treatments. Minimum plant height 104.60 cm was recorded (T_0). 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 **(Singh *et al.*, 2017).**

Maximumspreadwasreportedin STRICKER – 3 mL/ L water (T_9) withanaveragespreadof 94.45cmwhichwassignificantlyhigherfromrestof treatments. Minimum plant spread 58.56 cm was recorded (T_0) (**Singh *et al.*, 2017**).

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 (T_9) (12.64) and least number of primary branches per plant was recorded in control (T_0) (11.04). Favorable weather and moisture of the soil are the important parameters affectingthe number of branches per plant. It was concluded that a greater number of branches were recordedinbio stimulantstreatedplotsascomparedtocontrol.Itmightbeduetofavorable 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(**Singh *et al.*, 2017).**

Theleaf area index of 56.03 was recorded with the STRICKER – 3 mL/ L water (T_9) applicationwhichwas significantlyhigher as comparedtorest of treatments. Minimum value of leaf area index 36.98 was reported (T_0) 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 (T_9)(**Singh *et al.*, 2012).**

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**(Tamilselvi and Vijyaragavan 2014).**

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 weretaken forthe Days to 50 % flowering whentheplantswerecontrol 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 (T_9) took 53.27 days followed by TERMINATOR33 – 3 mL/ L water (T_6) 52.33 days after transplanting **(Tamilselvi and Vijyaragavan 2014).**

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 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 (T_9). The present study finds support of (**Ashrafuzzaman 2011)** 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 (T_9) 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. Maximumfruit yield per plant i.e.,203.90 g was obtained in STRICKER – 3 mL/ L water (T_9) which was significantly higher from rest of thetreatments and the minimum fruit yield per plant that is 139.85 g recorded from the plot which was kept control (T_0).

The data showed in the table 4 that maximum yield of 22.67 (q/ha) with the treatment (T_9) was reported using bio stimulants were followed by treatment (T_6) with the value of 22.33 (q/ha). Minimum fruit yield of chili was recorded in weedy check (T_0) (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 **(Singh *et al.*, 2019).**

Among the various treatments STRICKER – 3 mL/ L water (T_9) 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 (T_6) (138.38) and (T_8) (137.99). Minimum amount of vitamin-C was reported in control treatment (T_0) (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. **(Rouphael *et al.*, 2018).**

There were significant differences between the treatments at Initial and other replication. Among the treatments used bio stimulants and have highest TSS ^{0}B which were significantly superior to T_0 (Control) and other treatment. The maximum TSS value in chilli was recorded in T_9 with 4.85 ^{0}B and the minimum was recorded in T_0 (Control) with 3.34 ^{0}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. **(Rouphael *et al.*, 2018).**

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 Ist 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 biostimulants 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 (^{0}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**

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 T_9 (STRICKER –3 mL/ L water) and highest B:C ratio was found in the same with 1.88.

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