Original Research Article

EFFECT OF DIFFERENT BIO STIMULANTS ON GROWTH, YIELD AND QUALITY OF CHILLI (*Capsicum annuum L.*) UNDER PRAYAGRAJ AGRO CLIMATIC CONDITIONS

ABSTRACT

An experiment was carried out to study the "Effect of different bio stimulants on growth, yield and quality of chilli (*Capsicum annuum L*) under prayagraj agro climatic conditions" during August, 2022 to January 2023 at Horticulture Research Farm, Department of Horticulture, Naini Agriculture Institute, SHUATS. The experiment had eleven treatments replicated thrice in Randomized block design, it was concluded that the application of bio stimulants treatments rendered their significant effect on almost all the growth and yield characters as well as quality of chilli. The treatment T_7 i.e. application of bio stimulant product Cheetha @ 3 ml/l was found superior in terms of plant height (64.39 cm), plant spread (61.5cm), number of branches (8.11), number of flowers per cluster (11.77), number of fruits per plant (79.33), fruit length (12.77cm), fruit girth (2.47cm), fruit weight(4.29g), fruit yield per plant(395.67g), fruit yield per plot(2.37 kg), fruit yield per hectare (14.67t/ha) ,TSS(4.97),Ascorbic acid content (144.67 mg/100g)and minimum days taken for first flowering (51.67 days) and for 50% flowering(56.67 days). Among the different treatments the highest Gross return (Rs/ha) (2,93,000), Net return (Rs/ha) (1,67,137), benefit cost ratio (2.32) was also obtained from treatment (T7), that is Cheetha @ 3 ml/l.

Key words: *Chilli, Bio stimulants, growth, yield, quality*

1. INTRODUCTION

Chilli (*Capsicum annuum L*) is one of the most important vegetable as well as spice crop belongs to the family Solanaceae, grown for its fruit. It is widely cultivated all over the world and is thought to be the native of Peru and Mexico. Chilli is famous for its pleasant aromatic flavour, pungency and high colouring substance, which is also a rich source of vitamin A and C with plenty of minerals. The substance that is responsible for pungency in chilli is capsaicin and the bright red colour at the ripening stage is due to the pigment capsanthin. Capsaicin, the compound which has potential health benefits, including pain relief, improved digestion, and boosting metabolism. Chillies are one of the major spices exported by India. Heat and climate change can pose challenges for chilli cultivation, leading to problems such as fruit drop.

Bio stimulants are substances or microorganisms that, when applied to plants or soil, enhance plant growth, stress tolerance and crop quality. They provide a complementary approach to conventional fertilizers and pesticides, promoting sustainable and environment friendly agricultural practices. Bio stimulants work through multiple mechanisms, including promoting root development, improving nutrient availability, enhancing stress tolerance and stimulating beneficial microbial activity in the soil. They do not provide direct nutrition to the plants rather act as enhancer, stimulating various physiological and metabolic processes within plants. Bio stimulants can positively influence the quality and marketability of agricultural products.

Bio stimulants based on amino acids and humic acids have been applied in horticulture for many years. Humic substances with its auxin activity induce hormonal effect on catalytic activity, cell permeability and increase nutrient uptake and dry matter yield (Eshwar *et al.*,2017). Amino acids play a vital role in plant nutrition by facilitating nutrient absorption, increasing nutrient availability and enhancing plant metabolism. Plant extract bio stimulants promote plant growth, development and overall health of plants.

Considering the significance of plant extract bio stimulants in agriculture and horticulture, the goal of this study was to identify the significance of different bio stimulants on improving the growth, yield and quality of chilli.

2. MATERIALS AND METHODS

A field experiment entitled “Effect of different bio stimulants on growth, yield and quality of chilli (*Capsicum annuum L*) under prayagraj agro climatic conditions” was carried out in the Department of Horticulture, Naini Agricultural Institute, Sam Higgin Bottom University of Agriculture, Technology and Sciences during 2022-2023. The experiment was laid out in randomized block design with eleven treatments in three replications. The experiment included application of bio stimulant products having different dominant compositions such as Escort (natural plant extract and oligosaccharides), Cheetha (humic acid and amino acid) and Baanam (carbonates)in chilli crop. Treatments were given with concenterations of Escort @ 1, 1.5, 2 and 2.5 ml per litre, Cheetha @ 2, 2.5 and 3 ml per litre and Baanam @ 2, 2.5 and 3 ml per litre at 45 ,60 and 75 DAT whereas water was

sprayed on control plants. All the package of practices were followed as per recommendation to raise a quality crop. Five plants were selected randomly from each treatment per replication and the observations were recorded on growth, yield and quality parameters on these plants. Data on various parameters were recorded and stastically analysed by applying the technique of analysis of variance using Randomized Block Design. The level of significance was kept at 5% ($p < 0.05$).

3. RESULTS AND DISCUSSION

Data in Table 1 indicated significant ($p \leq 0.05$) differences regarding the vegetative parameters like plant height, plant spread and number of branches treated with different concentrations of bio stimulants.

Plants attained maximum height (64.39 cm) when treated with Cheetha @ 3 ml/l followed by that of 2.5 ml/l (62.5 cm) concentrations. Plants grown in control were (42.78 cm) tall. Cheetha is a bio stimulant product which has a dominant composition of humic acid and amino acid. The increment in plant height may be due to enhancement in photosynthetic and other metabolic activities which promote to various plant metabolites responsible for cell division and quicker multiplication of cells in the shoot apex due to the auxin type of activity of humic acid on plant growth. Similiar findings were also reported by Fathima et al., (2013) in chilli and Kumar et al., (2015) in okra.

A similar trend was observed regarding the plant spread parameter where maximum plant spread (61.5 cm) was observed when Cheetha @ 3ml/l was applied followed by that of 2.5 ml/l (59.67 cm) concentrations. Plants in control treatment were 43 cm. Significant increase in plant spread by the application of bio stimulant might be due to humic acid which stimulates plant growth by accelerating cell division, promote synthesis of chlorophyll, sugar, amino acids in plants and enhance the uptake of nutrients which aid in photosynthesis. Similiar findings were also reported by Fathima et al., (2013) in chilli, Kumar et al., (2015) in okra.

Maximum number of branches per plant (8.11) was counted in Cheetha @ 3 ml/l treatment followed by those of Cheetha @ 2.5 ml/l (7.55) concentrations. Plants in control treatment produced minimum number of branches per plant (4.33). The possible reason could be that the foliar application of commercial bio stimulant product Cheetha, which is composed of humic acid might influenced the vegetative growth by encouraging cell division and elongation that increased number of branches. 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) in cucumber. Similar findings were also reported by Fathima et al., (2013) in chilli, Kumar et al., (2015) in okra.

Minimum days to flower initiation was recorded in treatment T_7 – Cheetha @ 3 ml/l (51.67) and followed by the treatment T_6-Cheetha @ 2.5 ml/l (52.66) whereas the maximum days to flower initiation was recorded in T_0 – Control (58.33). The humic acid present in the bio stimulant used to ameliorate or reduce the negative effect of stress.

Significant superiority over control might be due to increased photosynthetic activity, hormonal activity and uptake of nutrients resulting in early flowering as reported by Patel et al., (2018) in bhindi. These findings are in conformity with those of Ghorbani (2010).

Minimum days to 50% flowering was recorded in treatment T_7- Cheetha @ 3 ml/l (56.67) and followed by the treatment T_6 – Cheetha @ 3 ml/l (58.66) whereas the maximum was in the treatment T_0 – Control (66.67).

Number of flowers per cluster were recorded with significant differences among different treatments. Number of flowers per cluster due to the influence of different concentrations of bio stimulants was recorded maximum in T_7-Cheetha @ 3 ml/l (11.77) followed by those of Cheetha @ 3 ml/l (11) concentrations. Plants in control treatment produced minimum number of flowers per cluster (6.66). The improvement in number of flowers per cluster as a result of application of bio stimulant might be due to the presence of humic acid which enhanced photosynthetic and other metabolic activities. It promotes hormonal activity, promoting the growth of more flowers in each cluster. These findings are in conformity with those of Fathima et al., (2013) in chilli, Kumar et al., (2015) in okra.

The data regarding yield parameters like number of fruits per plant, fruit length, fruit girth, fruit weight, fruit yield per plant, fruit yield per plot, fruit yield per hectare is showed in the Table 2. Maximum number of fruits per plant was recorded in treatment T_7- Cheetha@ 3 ml/l (79.33) and followed by the treatment T_6 – Cheetha @ 2.5 ml/l (76.33) whereas the minimum number of fruits per plant was recorded in the treatment T_0 – Control (54.33). This might be due to accumulation of more photosynthates, amino acids and nitrates in the treated plants resulted in making the plants resistant to pests and diseases, subsequently produced more number of fruits per plant. These findings are comparable with that of Halime et al., (2011) in cucumber. Similar results were also reported by Fathima et al., (2013) in chilli, Manas et al., (2014) in chilli and Singh et al., (2017) in capsicum.

Fruit length was recorded with significant variations among different treatments. Maximum fruit length was recorded in treatment T_7- Cheetha@ 3 ml/l (12.77 cm) and followed by the treatment T_6 – Cheetha @ 2.5 ml/l (11.72 cm) whereas the shortest fruit length was recorded in the treatment T_0 – Control (9.33 cm). This might be due to the effect of humic acid which promotes root growth and development leads to better nutrient absorption and also promotes cell elongation and cell division, which leads to larger and longer fruits. These findings are in line with those of Ali et al., (2013) in tomato, Manas et al., (2014) in chilli and Kumar et al., (2015) in okra.

Maximum fruit girth was recorded in treatment T_7- Cheetha @ 3 ml/l (2.47 cm) and followed by the treatment T_6 – Cheetha @ 2.5 ml/l (2.23 cm) whereas the shortest fruit girth was recorded in the treatment T_0 – Control (1.02 cm). This might be due to the effect of humic acid in the bio stimulant applied that caused rapid multiplication of cells in the reproductive organs and more accumulation of photosynthates in fruits than

compared to absolute control. These findings are similar with those of Ali et al., (2013) in tomato, Dubey et al., (2013) and Manas et al., (2014) in chilli.

Fruit weight (g) was recorded with significant variations among different treatments. Maximum fruit weight was recorded in treatment T_7- Cheetha @ 3 ml/l (4.29 g) and followed by the treatment T_6– Cheetha @ 2.5 ml/l (4.14 g) whereas the shortest fruit weight was recorded in the treatment T_0 – Control (2.74 g). This might be due to humic acid lead to increased fruit weight through positive physiological effect such as impact of metabolism of plant cells, photosynthesis and increasing the concentration of leaf chlorophyll (Sure et al.,2012) in cucumber. These findings are in close conformity with Shehata et al., (2012) in cucumber, Ali et al., (2013) in tomato, Manas et al., (2014) in chilli and Singh et al., (2017) in capsicum.

Fruit yield per plant recorded in the treatment T_7 – Cheetha @ 3 ml/l (395.67g) was significantly higher than other treatments followed by the treatment T_6– Cheetha @ 2.5 ml/l (363.67g) whereas control has lower fruit yield per plant (185.33 g). This might be due to application of bio stimulant which has a dominant composition of humic acid to creating favourable conditions to facilitate nutrient uptake by roots, cause an increase in fruit weight (El-Nemr,2012). Similar results were reported by Dubey et al., (2013), Fathima et al., (2013) in chilli and Singh et al., (2017) in capsicum.

Fruit yield per plot was recorded with significant variations among different treatments. Highest fruit yield per plot was recorded in treatment T_7- Cheetha @ 3 ml/l (2.37 kg) and followed by the treatment T_6 – Cheetha @ 2.5 ml/l (2.11 kg) whereas the lowest fruit yield per plot was recorded in the treatment T_0 – Control (1.16 kg). This might be due to sufficient enhancement in fruit attributes like weight of fresh fruits, length and girth of fresh fruits, fruit yield per plant and ultimate result was the maximum yield of chilli per plot. Similar findings were reported by Fathima et al., (2013), Manas et al., (2014) in chilli and Singh et al., (2017) in Capsicum.

Fruit yield per hectare was recorded with significant variations among different treatments. Highest fruit yield per hectare was recorded in treatment T_7- Cheetha @ 3 ml/l (14.65 t/ha) and followed by the treatment T_6 – Cheetha @ 2.5 ml/l (13.46 t/ha) whereas the lowest fruit yield per hectare was recorded in the treatment T_0 – Control (6.86 t/ha).

TSS and Ascorbic acid are important characters which decides the quality of chilli for commercial cultivation. Highest TSS was recorded in treatment T_7- Cheetha @ 3 ml/l (4.97) and followed by the treatment T_6 – Cheetha @ 2.5 ml/l (4.88) whereas the lowest TSS was recorded in the treatment T_0 – Control (3.82). This might be due to healthy growth of plant by the application of bio stimulant having a dominant composition of humic acid, which might have promoted the accumulation of sugars and organic acids, leading to increased TSS levels and improved the fruit quality. Similar findings were also reported by Aminifard et al., (2012) in chilli and Kazemi et al., (2013) in tomato.

Ascorbic Acid were recorded with significant variations among different treatments. The maximum ascorbic acid content (mg/100g) was recorded in treatment T_7- Cheetha @ 3 ml/l (144.67) and followed by the treatment T_6 – Cheetha @ 2.5 ml/l (143.33) whereas the minimum ascorbic acid content was recorded in the treatment T_0 – Control (130.33). Increase in ascorbic acid content by the application of bio stimulant composed of humic acid might be due to role of humic acid as nutrient availability enhancer which, improves the availability of phosphorus and potassium contents (Aghanifard et al., 2016). Similar results were also reported by Abdellatif et al., (2017) in tomato.

In case of economic parameter, Cheetha @ 3ml/l gained maximum gross returns(Rs/ha) (2,93,000), net return (Rs/ha) (1,67,137) and Benefit: Cost ratio (2.32).

Table 1: Effect of different bio stimulants on vegetative growth and flowering parameters of chilli under prayagraj agro climatic conditions.

	Growth parameters			Flowering parameters		
Treatments	**Plant height (cm)**	**Plant spread (cm)**	**No.of branches**	**Days to flower initiation**	**Days to 50 % flowering**	**No.of flowers per cluster**
T0 – Control	42.78	43	4.33	58.33	66.67	6.66
T_1- Escort @ 1 ml/l	59.77	55.67	6.67	54.11	60.33	9.66
T_2- Escort @ 1.5 ml/l	56.17	53	5.89	55	62.11	9.11
T_3- Escort @ 2 ml/l	56.05	52.67	5.67	55.11	62.89	8.99
T_4- Escort @ 2.5 ml/l	55.39	51.83	5.44	55.33	63.44	8.89
T_5- Cheetha @ 2 ml/l	60.66	57.17	7.11	53.33	59.67	10.55
T_6- Cheetha @ 2.5 ml/l	62.5	59.67	7.55	52.66	58.66	11
T_7- Cheetha @ 3 ml/l	64.39	61.5	8.11	51.67	56.67	11.77
T_8- Baanam @ 2 ml/l	54.27	50.33	5.33	56.11	63.78	8.66
T_9 -Baanam @ 2.5 ml/l	53.33	48.5	4.78	56.89	64.33	8.22
T_{10}- Baanam @ 3ml/l	58.33	53.67	6.33	54.33	61.66	9.44
F-Test	S	S	S	S	S	**S**
S.Ed	0.83	1.52	0.41	0.86	0.70	0.49
CD @ 5%	1.73	3.18	0.87	1.81	1.46	1.03

Table 2: Effect of different bio stimulants on yield parameters of chilli under prayagraj agro climatic conditions.

Treatments	No. of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Fruit yield per plant (g/plant)	Fruit yield per plot(kg)	Fruit yield per ha(t/ha)
T_0- Control	54.33	9.33	1.02	2.74	185.33	1.16	6.86
T_1- Escort @ 1 ml/l	71.67	10.89	1.81	3.83	302.33	1.8	11.19
T_2-Escort @ 1.5 ml/l	67	10.5	1.57	3.56	288	1.73	10.66
T_3-Escort @ 2 ml/l	65.33	10.27	1.56	3.43	281	1.69	10.40
T_4- Escort @ 2.5ml/l	63.33	10.16	1.54	3.31	273.33	1.67	10.12
T_5-Cheetha@ 2ml/l	73.67	11.11	1.98	4.07	340	2.04	12.59
T_6-Cheetha@2.5ml/l	76.33	11.72	2.23	4.14	363.67	2.11	13.46
T_7-Cheetha@3ml/l	79.33	12.77	2.47	4.29	395.67	2.37	14.65
T_8-Baanam@2ml/l	61	10.11	1.41	3.26	267.5	1.62	9.90
T_9-Baanam@2.5ml/l	59.33	10	1.28	3.22	261	1.56	9.66
T_{10}-Baanam@3ml/l	70	10.44	1.60	3.75	294	1.77	10.88
F-Test	S	S	S	S	S	S	S
S.ED	1.82	0.3	0.21	0.19	2.66	0.03	0.10
CD @ 5%	3.8	0.63	0.44	0.40	5.55	0.07	0.20

Table 3: Effect of different bio stimulants on quality parameters and economics of chilli under prayagraj agro climatic conditions

	Quality parameters		Economics		
Treatments	**TSS**	**Ascorbic acid**	**Gross Returns (Rs/ha)**	**Net Returns (Rs/ha)**	**Benefit Cost ratio**
T_0- Control	3.82	130.33	137200	20592	1.17
T_1- Escort @ 1 ml/l	4.7	139.67	223800	104107	1.86
T_2-Escort @ 1.5 ml/l	4.40	138.67	213200	91967	1.75
T_3-Escort @ 2 ml/l	4.37	138.33	208000	85222	1.69
T_4- Escort @ 2.5ml/l	4.14	138.17	202400	78077	1.62
T_5-Cheetha@ 2ml/l	4.71	142.67	251800	129022	2.05
T_6-Cheetha@2.5ml/l	4.88	143.33	269200	144877	2.16
T_7-Cheetha@3ml/l	4.97	144.67	293000	167137	2.32
T_8-Baanam@2ml/l	3.97	137.83	198000	75222	1.61
T_9-Baanam@2.5ml/l	3.88	137.33	193200	68877	1.55
T_{10}-Baanam@3ml/l	4.58	139	217600	91737	1.72
F-Test	S	S			
S.ED	0.14	1.34			
CD @ 5%	0.29	2.79			

4. CONCLUSION

From the present study it may be concluded that the treatment T7 i.e. application of Cheetha @ 3 ml/l which has a dominant composition of humic acid and amino acid, proved to be superior to other treatments in regarding all vegetative , flowering , yield and quality parameters like plant height, plant spread , number of branches , number of flowers per cluster , number of fruits per plant , fruit length , fruit girth , fruit weight, fruit yield per plant, fruit yield per plot, fruit yield per hectare ,TSS , Ascorbic acid and economics. Earliness in flowering is also observed in the treatment (T7), that is Cheetha @ 3 ml/l.

REFERENCES

Anbarasi. D and Venkatraman.M (2022); Effect of plant growth regulators on growth, yield and quality characters of chilli (*Capsicum annuum L*); *Annala of Plant and Soil Research.*,24(4):543-546.

Chethan Kumar S, Sahu G S, Tripathy P, Banshidhar Pradhan and Sunil Kumar Dash (2019); Studies on genetic variability in chilli (*Capsicum annuum L*) Germplasm; *Journal of Pharmacognosy and Phytochemistry.*,8(2):1992-1994

Chandramohan Reddy G, Hebbar S.S, Nair A K, Raghupathy H.B, Mallikarjuna Gowda A.P and Umesha K (2017); Growth and yield performance of hybrid hot pepper, chilli (*Capsicum annuum L*.) as influenced by fertigation and polyethylene mulching; *Journal of Horticultural Science,* Volume 11(2):151-155.

Diksha Pundir, Suneeta Singh and Anil Kumar Saxena (2020); Response of plant growth regulators (NAA) and (GA_3) on growth and yield attributes of chilli (*Capsicum annuum L*) at Dehradun valley region; *International Journal of Chemical Studies*., 8(5):556-559.

Fathima P.S and Denesh G.R(2013); Influence of humic acid spray on growth and yield of chilli (*Capsicum annuum L*), *International Journal of Agricultural Sciences.,* Volume 9, Issue 2,542-546.

Gudapati Ashoka Chakravarthy and Krishna Mohan K (2023); Effect of bio stimulants on growth, development and yield of chilli (*Capsicum annuum L*.), *International Journal of Plant & Soil Science.,* Volume 35, No.6,172-176.

Holbesappa Kumbar, Chandini Raj A and Hore J.K (2017); Effect of bio fertilizers and inorganic fertilizers on growth and yield of chilli *(Capsicum annuum L*.), *International Journal of Current Microbiology and Applied Sciences*., 6(7): 1564-1568.

Katheek Bharadwaza R, Prasad V.M, Adinarayana M and Narayana Swamy G (2018); Evaluation of chilli (*Capsicum annuum L.)* genotypes for yield and yield attributes in Allahabad Agro-Climatic Conditions, *International Journal of Current Microbiology and Applied Sciences.,* Special issue -7:773-776.

Madhu Singh, Ameta K D, Dubey R B, Pareek S, N. L. Meena, Somendra Meena and Shankar Lal (2017); Effect of humic acid and micronutrients on growth and yield of polyhouse grown capsicum, *Chemical Science Review and Letters.,* 6(22),1189-1193.

Pankaj Kumar, Rana D.K, Vivek Singh and Naseeruddin Shah K.H (2015); Effect of humic acid on growth, yield and quality of okra (*Abelmoschus Esculentus (L.) Moench*) cv. Arka Anamika under subtropical conditions of Garhwal Himalaya, *International Journal for Innovative Research in Science and Technology*., Volume 1: 2349-6010.

Pankaj Maida, Bisen B.P and Umesh Dhakad (2020); Effect of different irrigation levels on growth and yield of chilli (*Capsicum annuum L*), *Bulletin of Environment, Pharmacology and Life Sciences.,* Volume 9 (5):18-22.

Prayaga Singh, Jain P K and Manoj Kumar Ahirwar (2019); Evaluation of different chilli genotypes for growth, phenological behaviour and physical fruit parameters in Kymore plateau region of Madhya Pradesh, *The Pharma Innovation Journal* ;8(10):264-267.

Sakthivel and Manivannan K (2021); Effect of foliar application of bio stimulants on growth, yield and quality parameters B of chilli (*Capsicum annuum L), Research Journal of Agricultural Sciences*, 12(2): 466-469.

Shankwar B, Nigam A.K, Vasure N and Vishwakarma D (2017); Effect of different plant growth regulators on growth of chilli (*Capsicum annuum L*) cv. PUSA JWALA; *Agriculture Update*.,1187-1189.

Sam Ruban J, Priya M.R, Barathan G and Suresh Kumar S M (2019); Effect of foliar application of bio stimulants on growth and yield of brinjal (*Solanum melongena*); *Plant Archives*., vol.19 No.2, 2126-2128.

Saritha Sahu, Vijay Kumar and Sharma H. G (2019); Effect of plant growth regulators on growth and yield of chilli, *Journal of Pharmacognosy and Phytochemistry.*, 8(6): 2122-2132.

Shailaja Nimmala, Kolape S.S and Archana Tathe (2021); Effect of levels of fulvic acid through foliar sprays on yield and quality of green chilli; *International Journal of Chemical Studies*.,9(1):793-797.

Saraswathi T and Praneetha S (2013); Effect of bio stimulants on yield and quality in tomato, *Journal of Horti.Science*., vol.8(1):107-110.

Surendar P, Sekar K, Sha K and Kannan R (2020); Effect of plant growth regulators on growth of chilli (*Capsicum annuum L*), *Plant Archives*., Volume 20,1544-1546

Thouti pavani, Deshmukh P Wand Oguboyana Srikanth Yadav (2022); Effect of foliar application of humic acid on yield parameters and quality of chilli, *Journal of Pharmacognosy and Phytochemistry.*, 11(3):235-239.

Yatagiri N, Sanap P.B and Telugu R.K (2017); Growth, Flowering, Behaviour and Physical Fruit Parameters of chilli (*Capsicum annuum L*) genotypes in coastal Maharashtra, *International Journal of Current Microbiology and Applied Sciences.*,6(7):2230-2237.