



RESEARCH ARTICLE

Effect of biostimulants on growth, yield and quality of Bullet variety of chilli

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Abstract

Field experiment was undertaken at the Horticultural Research Station, Mondouri, of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, during the rabi season of 2022 -2023, with the aim to investigate the effect of biostimulants on the plant morphology, development, yield and fruit quality of the chilli variety Bullet. Hence, 6 different treatments of ECOHUME, along with STANOHUME were given as foliar spray during the experiment following Randomized Block Design with 4 replications. The results indicated that the treatment T2 (ECOHUME at 2 mL/L) significantly influenced on growth of chilli and revealed the maximum plant height, higher number of primary and secondary branches, earliness in flowering, early fruit initiation and fruit development, maximum number of fruits, highest fruit weight, highest yield and better cosmetic quality of fruit. Out of six treatments, the treatment T2 showed significant effects on most of the characters of Bullet variety of chilli and it emerged as a best treatment followed by T1(ECOHUME at 1 mL/L) which showed considerable effects though the higher doses of ECOHUME registered significant results in comparison with reference product. The foliar application of ECOHUME at 2 mL/L twice at 20 days after transplanting and 45 days after transplanting or during flower initiation stages may be recommended to get better results and it emerged as a better treatment to be used in the farmers' field after replicated field trial.

Keywords: biostimulants; chilli; ECOHUME; growth; quality; yield

Introduction

Chilli or hot pepper (*Capsicum annum* L.) is an important vegetable and spice crop. According to the Spices Board of India, red chillies account for about 34 % of India's total spice export value and India is the major producer, consumer and exporter of chilli. Chilli is consumed both as green fruits and as dried red fruits and is one of the major components of Indian cuisine, serving as a spice that imparts both pungency and colour to food preparations. Besides being a vital ingredient of Indian food, it occupies an important share in Indian economy. Chilli is cultivated year-round as a cash crop and used in both green and dried red stages for its pungency, flavour and colour. Nutritionally, it is a rich source of vitamin A, B6, C and K. Pungency in chillies is due to the presence of the alkaloid capsaicin, which has medicinal properties and helps prevent heart attacks by dilating blood vessels (1). Capsaicin has diverse prophylactic and therapeutic applications in both allopathic and ayurvedic medicine (2).

Despite its high nutritive value and wide acceptability among growers and consumers, India still lags behind in achieving optimum productivity in green and dry chilli owing to the use of local

unimproved cultivars along with improper production technologies and inputs as well as heavy infestations of insect-pests and diseases. Besides, globally, most chilli production is affected either by biotic factors, like bacteria, fungi, viruses and insects and pests or abiotic factors, such as temperature, moisture, light, pesticides and herbicides. The present production of chilli is insufficient to meet consumers' year round demand due to the yield gap for several reasons like biotic and abiotic stresses. Hence, to address the yield gap or to minimize the production gap different types of growth regulators, hormones, organic acids formulation including biostimulants are getting importance to increase the yield and quality of chilli. Nowadays, the application of various types of biostimulants in crops is gaining popularity due to their positive impact on improving growth, yield and quality while reducing production cost (3). Biostimulants are commercial products derived mainly from seaweed extracts, enzymes, hydrolysed proteins, humic substances and micronutrients and are rich in plant growth regulators such as auxins and cytokinins. Foliar application of biostimulants enhanced photosynthetic rate, plant growth, fruit yield and quality (3). Spraying of Biozyme with normal fertilizer impacted photosynthetically more efficient and increased total yield

of the crop (4). Biostimulants have potential to increase the use efficiency of natural resources in biotic and abiotic stress conditions and also to reduce the dependency of input of agrochemicals and have contributory effects on sustainable production systems (5).

In this regard, the present investigation was undertaken to study the effects of biostimulants on plant morphology, development and yield attributes in chilli.

Materials and Methods

The field experiment was undertaken during the rabi season of 2022 to 2023 at Mondouri Horticultural Research Farm, Mondouri of Bidhan Chandra Krishi Viswavidyalaya, West Bengal following Randomized Block Design with four replications. The experiment field comes under the Gangetic alluvial plains of west Bengal and the type of the soil is sandy loam soil with near neutral pH with good drainage condition. A popular chilli variety of West Bengal namely Bullet was used for the present investigation and sprayed with biostimulants like ECOHUME and STANOHUME in six different doses namely T1 (ECOHUME at 1 mL/L of water) T2 (ECOHUME at 2 mL/L), T3 (ECOHUME at 3 mL/L), T4 (ECOHUME at 4 mL/L), T5 (STANOHUME at 2 mL/L) and T6 (Untreated Control) considering 500 L of water as the spray volume per hectare after transplanting. The first and second sprays were given at 20 and 45 days after transplanting (DAT), respectively, as foliar applications. One month old uniform and healthy seedlings of Bullet variety of chilli were transplanted in the main field in the afternoon hours with a spacing of 50cm x 50 cm. The trial was conducted with limited irrigation, minimal pesticides use and reduced fertilizers inputs ten random plants were selected from each replication for recording the data

and labelled as observational plants. Phytotoxicity effects including defoliation, stunted growth of plants, flower or fruit drop, poor fruit setting etc. also observed. Fruit quality was assessed visually on the basis of uniformity, shape, size, skin color, glossiness and fruit firmness. Various growth, yield and quality parameters were analysed statistically using OPSTAT.

Results and Discussion

The field experiment was framed to investigate the effect of biostimulants namely ECOHUME and STANOHUME with different treatments on plant morphology at primary and secondary branching, flowering, fruiting, number of economic picking of fruits during crop period at harvesting, total fruit yield, quality attributes of chilli and to assess the impact on flowering, fruit development and harvestable yield and quality of chillies. The details of experimental results are presented in Tables 1–3, while Fig. 1 and 2 illustrate the key traits to provide a clearer understanding of treatment effects.

Effect of biostimulants on plant morphology

The pre-treatment observations related to plant morphology was recorded just before the spraying of biostimulants at 20 days after transplanting (DAT) and post treatment effects were recorded 10 days after first spray or 30 DAT and 10 days after second spray or 55 DAT.

Plant height (cm)

It was observed that all treatments showed almost similar results before spraying of the test product and reference product at 20 DAT recorded no differences for plant height as expected.

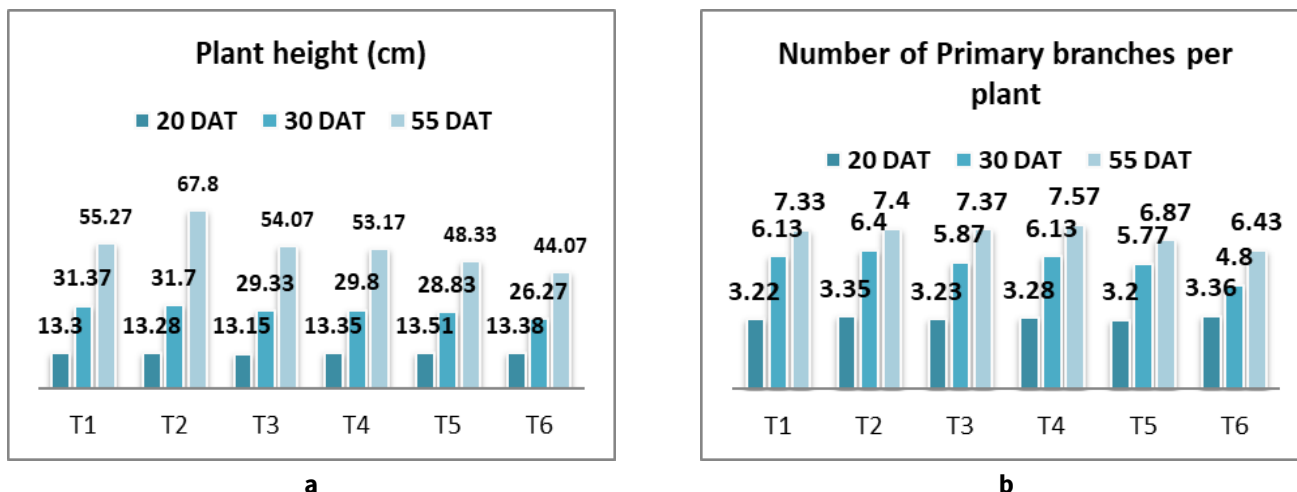


Fig. 1. Effect of biostimulants on Bullet variety of chilli: a- Plant height (cm); b- Number of primary branches per plant.

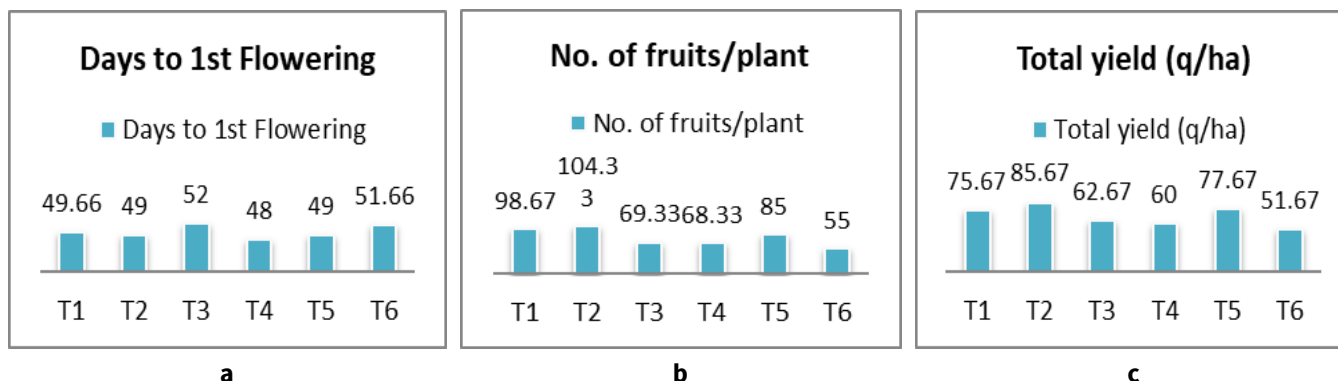


Fig. 2. Effect of biostimulants on Bullet variety of chilli: a- Days to 1st flowering; b- No. of fruits per plant; c- Total yield (q/ha).

Treatment effects at 30 days after transplanting after first spray

The plant height was significantly increased with the various treatments of biostimulants of ECOHUME and STANOHUME at 30 days after transplanting or 10 days after first spray. All the treatments showed significant positive results in plant height. The maximum plant height was recorded in the treatment T2 (ECOHUME at 2 mL/L; 31.70 cm) followed by T1 (ECOHUME at 1 mL/L; 31.37 cm), T4 (ECOHUME at 4 mL/L; 29.80 cm), T3 (ECOHUME at 3 mL/L; 29.33 cm) and T5 (STANOHUME at 2 mL/L; 28.83 cm) though all are statistically at par whereas significantly minimum plant height was recorded in untreated control (T6; 26.27cm).

Treatment effects at 55 days after transplanting after second spray

Significantly highest plant height was recorded in T2 (ECOHUME at 2 mL/L; 67.80 cm) followed by T1 (ECOHUME at 1 mL/L; 55.27 cm), T3 (54.07 cm) and T4 (53.17 cm) at 10 days after second spray or during flower initiation stage though T1, T3, T4 are statistically at par and the lowest height was recorded in untreated control (T6; 44.07 cm) followed by T5 (STANOHUME at 2 mL/L; 48.33 cm).

The treatment T2 (ECOHUME at 2 mL/L) was observed significantly superior result over all the treatments in plant height which influenced the plant morphology of chilli. It was observed that all the treatment registered significant positive effects on plant height over control. The initial growth response was modest; however, substantial improvement was observed after both foliar sprays. The second spray during flower initiation stages revealed the highest increased in plant height by the treatment of ECOHUME at 2 mL/L.

Number of primary branches per plant

The data related to the number of primary branches per plant of chilli presented in the Table 1 revealed the positive influenced with the different treatments of ECOHUME.

At 30 days after transplanting

It was observed that there was no significant variation in number of primary branches of chilli at 20 days after transplanting or before spraying of ECOHUME whereas, considerable effects were recorded after first and second spray of ECOHUME. Significantly higher number of primary branches were recorded in T2 (ECOHUME at 2 mL/L; 6.40) followed by T1 (ECOHUME at 1 mL/L; 6.13) and T4 (ECOHUME at 4 mL/L) though they are statistically similar. Significantly, lower number of primary branches were recorded in T6 (4.80) or untreated plot followed by T5 (STANOHUME at 2 mL/L; 5.77). The study revealed that the treatments T1 (ECOHUME at 1 mL/L), T2 (ECOHUME at 2 mL/L) and T4 (ECOHUME at 4 mL/L) recorded

the significant positive effects in comparison to the reference product treatments.

At 55 days after transplanting

The highest number of primary branches (7.57) was recorded in T2 (ECOHUME @2 mL/L), followed by T3 (ECOHUME at 3 mL/L; 7.37), T1 (ECOHUME at 1 mL/L; 7.33) and T5 (STANOHUME at 2 mL/L; 6.87), while the lowest number of primary branches was observed in the control plot (T6; 6.43). It was observed that the spraying of ECOHUME with higher doses have significant positive effects in increasing the number of primary branches which contributed the plant morphology.

Number of secondary branches per plant

At 30 days after transplanting

Significantly maximum number of secondary branches was recorded in T2 (ECOHUME at 2 mL/L; 2.00) followed by T1 (ECOHUME at 1 mL/L; 1.80) and T4 (ECOHUME at 4 mL/L; 1.80) which are though statistically similar and minimum number of primary branches was recorded in untreated plot of T6 (0.87) followed by T5 (STANOHUME at 2 mL/L; 1.53).

At 55 days after transplanting

The maximum number of secondary branches per plant were recorded in T2 (ECOHUME at 2 mL/L; 10.67) followed by T1 (ECOHUME at 1 mL/L; 8.87) and T3 (ECOHUME at 3 mL/L; 8.33). The minimum numbers of secondary branches were recorded in untreated control plot or T6 (4.47) which is significantly lower over all the treatments.

It was observed that the treatments of ECOHUME and STANOHUME have significant positive effects on branch proliferation of chilli which leads to the growth of plants by increasing the source area. In earlier, several researchers also reported positive effects of biostimulants on plant growth particularly in height, number of primary and secondary branches in chillies in various studies (6-10).

Number of days to 1st flowering

The average number of days taken appearance of the first flower was calculated from the date of transplanting and is presented in Table 2.

Significant minimum number of days were recorded in T4 (ECOHUME at 4 mL/L; 48 days) followed by T2 (ECOHUME at 2 mL/L; 49 days), T5 (STANOHUME at 2 mL/L; 49 days) and T1 (ECOHUME at 1 mL/L; 49.66 days) whereas, the untreated control plot plants taken longer time to flowering (51.66 days) followed by T3 (ECOHUME at 3 mL/L; 52 days) though they are statistically similar means there is no significant differences.

The results indicated that the treatments T2 (ECOHUME at 2 mL/L), T4 (ECOHUME at 4 mL/L along with T5 (STANOHUME at 2 mL/L)

Table 1. Effects of biostimulants on plant morphology of Bullet variety of chilli

Treatment	Plant height (cm)			Number of primary branches per plant			Number of secondary branches per plant	
	20 DAT	30 DAT	55 DAT	20 DAT	30 DAT	55 DAT	30 DAT	55 DAT
T1 (ECOHUME at 1 mL/L)	13.30	31.37	55.27	3.22	6.13	7.33	1.80	8.87
T2 (ECOHUME at 2 mL/L)	13.28	31.70	67.80	3.35	6.40	7.40	2.00	10.67
T3 (ECOHUME at 3 mL/L)	13.15	29.33	54.07	3.23	5.87	7.37	1.60	8.33
T4 (ECOHUME at 4 mL/L)	13.35	29.80	53.17	3.28	6.13	7.57	1.80	7.97
T5 (STANOHUME at 2 mL/L)	13.51	28.83	48.33	3.20	5.77	6.87	1.53	6.67
T6 (Untreated control)	13.38	26.27	44.07	3.36	4.80	6.43	0.87	4.47
S.E.m(±)	0.175	1.243	1.940	0.156	0.450	0.258	0.475	0.679
CD at 5 %	NS	3.92	6.11	NS	1.42	0.81	1.50	2.14

Table 2. Effect of biostimulants on flowering, fruiting and yield characters of Bullet variety of chilli

Treatment	Days to 1 st flowering	Days to 1 st fruiting	Days to fruit maturity	No. of fruits per plant	Average weight of 50 fruits (g)	No. of economic picking	Total yield (q/ha)
T1 (ECOHUME at 1 mL/L)	49.66	22.67	33.67	98.67	293.33	7.33	75.67
T2 (ECOHUME at 2 mL/L)	49.00	22.00	33.00	104.33	361.67	8.33	85.67
T3 (ECOHUME at 3 mL/L)	52.00	24.33	35.00	69.33	193.33	7.33	62.67
T4 (ECOHUME at 4 mL/L)	48.00	22.67	33.00	68.33	178.33	6.67	60.00
T5 (STANOHUME at 2 mL/L)	49.00	24.33	35.33	85.00	276.67	7.33	77.67
T6 (Untreated control)	51.66	26.00	36.00	55.00	115.00	5.00	51.67
S.E.m(±)	0.780	0.869	0.558	3.618	6.540	0.422	2.689
CD at 5 %	2.46	2.74	1.76	11.40	16.79	1.33	8.28

L) showed earliness for flowering which is highly desirable trait in chilli. The observed earliness in higher doses of ECOHUME might be due to physiological stress and slight stunting during the initial growth stages. The duration of flowering is also an important trait influencing fruit yield.

Number of days to 1st fruiting

The average number of days taken to 1st fruiting was calculated from the date of flowering and anthesis and it was observed that the appearance of the first fruit in the chilli plant varies significantly with the different doses of ECOHUME treatment. The average minimum days taken to 1st fruiting recorded in T2 (ECOHUME at 2 mL/L; 22 days) followed by T1 (ECOHUME at 1 mL/L; 22.67days) and T4 (ECOHUME at 4 mL/L; 22.67days). Significantly maximum number of days taken to 1st fruit appearing in the (T6; 26days) of untreated plot followed by T5 (TANOHUME at 2 mL/L) and T3 (ECOHUME @ 3 mL/L).

Number of days to fruit maturity

The number of days taken to harvestable or economic or edible fruit maturity of chilli is calculated from the date of anthesis or flowering. The average minimum number of days taken to fruit maturity was recorded in T2 (ECOHUME at 2 mL/L; 33days) and T4 (ECOHUME @ 4 mL/L) treatment followed by T1 and they are statistically at par, whereas, the maximum number of days was recorded in untreated control (T6; 36days) to reach fruit maturity followed by T5 (STANOHUME @ 2 mL/L). The treatments registered significant positive effects for fruit development and maturity of chilli.

Total number of fruits per plant

The data revealed that the highest number of fruits per plant was recorded in T2 (ECOHUME @ 2 mL/L; 104.33) followed by T1 (ECOHUME at 1 mL/L; 98.67) and T5 (STANOHUME at 2 mL/L; 85.00). The lowest number of fruits per plant was recorded in untreated control (T6; 55.00) followed by T4 (ECOHUME at 4 mL/L; 68.33) though the all the treatments showed significant positive effects by different doses of ECOHUME.

Fruit weight (g)

The average fruit weight of 50 fruits showed significant positive effects from different biostimulant treatments. The treatment T2 (ECOHUME @ 2 mL/L; 361.67 g) registered significantly higher average fruit weight of 50 fruits followed by T1 (ECOHUME at 1 mL/L;

293.33 g), T5 (STANOHUME at 2 mL/L; 276.67) though the treatment T1 and T5 are statistically at par whereas, the lowest fruit weight (115.00 g) was recorded in untreated control plot followed by T4 (ECOHUME @ 4 mL/L; 178.33 g) indicated the significant positive effects on average fruit weight of chilli.

Number of economic picking

The data indicated that highest average number of pickings was recorded in T2 (ECOHUME at 2 mL/L; 8.33) followed by T1 (ECOHUME at 1 mL/L; 7.33), T3 ECOHUME at 2 mL/L; 7.33) and T5 (STANOHUME at 2 mL/L; 7.33) though T1, T3, T5 are statistically similar. The average lowest number of picking (5) was recorded in untreated control. The numbers of economic picking have direct positive effect on total yield of chilli.

Total yield per hectare (q)

All treatments except the control registered significantly higher fruit yield per hectare. The maximum yield/ha was recorded in the treatment T2 (ECOHUME at 2 mL/L; 85.67q/ha) followed by T5 (STANOHUME at 1000 mL/ha; 77.67q/ha), T1 (ECOHUME at 500 mL/ha; 75.67q/ha) and lowest yield was recorded in T6 (untreated plot; 51.67q/ha). It was clearly indicated from the present evaluation of chilli that the ECOHUME has significant positive effects on yield parameters and total yield of chilli.

Earlier findings also revealed the significant positive impacts on growth, yield and quality of chillies in different studies (6-10) and corroborate with the present results of foliar application of humic acid based biostimulants (11, 12).

Fruit quality

From the visual observation of chilli fruits (Table 3) considering the uniformity in shape, size, color of skin, glossiness etc. the treatment T2 (ECOHUME at 1000 mL/ha), T1 (ECOHUME at 1000 mL/ha) and T3 (ECOHUME at 1000 mL/ha) showed significant variation in appearance of fruit size, skin color which recorded bold size, green and brown color patch in fruits compared to normal fruits and light green and brown skin color of treatments in the treatment like T6 of untreated control and T5 (STANOHUME at 2 mL/L).

Phytotoxicity effects of biostimulants

It was observed that there were no abnormal growth effects or physiological disorder, defoliation etc but initial growth was stunted

Table 3. Effects of biostimulants on cosmetic quality of Bullet variety of chilli

Treatment	Fruit quality		
	Fruit size	Skin colour	Fruit uniformity
T1 (ECOHUME at 1 mL/L)	Bold	Green & Purple Brown patch	Uniform
T2 (ECOHUME at 2 mL/L)	Bold	Green & Purple Brown patch	Uniform
T3 (ECOHUME at 3 mL/L)	Bold	Green & Brown patch	Uniform
T4 (ECOHUME at 4 mL/L)	Normal	Green & Brown patch	Uniform
T5 (STANOHUME at 2 mL/L)	Normal	Light green & Brown patch	Uniform
T6 (Untreated control)	Normal	Light green & Brown patch	Not uniform

in the treatment T4 (ECOHUME at 4 mL/ha) and it was recovered in later stages of plant growth.

Conclusion

Significant treatment effects of biostimulants were observed on various growth stages of plants. The treatment T2 (ECOHUME at 2 mL/L) recorded the maximum plant height, highest number of primary and secondary branches and showed earliness in flowering, fruit set and fruit development. It also produced the maximum number of fruits, highest fruit weight, total yield and better quality of fruit. Based on the present findings, treatment T2 (ECOHUME at 2 mL/L) had significant positive effects on most growth and yield parameters of chilli and emerged as the best treatment, followed by T1 (ECOHUME at 1 mL/L). However, higher doses of ECOHUME slight phytotoxic effects initially in comparison with other treatment of biostimulants. The foliar application of ECOHUME at 2 mL/L twice at 20 DAT and 45 DAT or flower initiation stages may be recommended to get better results and it emerged as a best treatment may be validated with the trial in farmers' field in replicated manner.

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Authors' contributions

CK and BC supervised the study, conducted the investigation and prepared the manuscript. PB, PS, SM¹ and SM² collected the review data. PC and PKT were involved in text editing. All authors read and approved the final manuscript [SM¹- Sanjita Marandi, SM²- Sourav Mollick].

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

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