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Research Paper

Effect of Foliar Application of Biostimulants on Growth, Yield and Quality Parameters of Chilli (*Capsicum annuum* L.)

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A B S T R A C T

A field experiment was conducted during the year 2020 at the farmer's field near Panruti, Cuddalore district, Tamil Nadu to study the effect of foliar application of biostimulants on growth, yield and quality parameters of chilli (*Capsicum annuum* L.), in a Randomized block design with three replications and eight treatments consisted of potassium humate and biostimulants such as T_1 - control, T_2- panchagavya@ 3%, T_3- sea weed extract @ 3%, T_4- fish amino acid @ 3%, T_5- potassium humate @ 0.5%, T_6- potassium humate @ 0.5% + panchagavya @ 3%, T_7- potassium humate @ 0.5% + sea weed extract @ 3%, T_8 - potassium humate @ 0.5 % + fish amino acid @ 3%. The treatments were applied at 30, 60 and 75 DAT. Studies revealed that the growth, yield and quality characters of chilli differed significantly due to foliar application of biostimulants. Among the different treatments, application of potassium humate @ 0.5% + fish amino acid@ 3% recorded significantly highest a growth characters such as plant height, number of leaves plant^{-1}, number of branches plant^{-1}, canopy volume, chlorophyll content in the leaves, net photosynthetic rate and total dry matter production. Similarly, the yield attributing characters such as days to first flowering, days to 50% flowering, number of flowers plant^{-1}, fruit set percentage, number of fruits plant^{-1}, fruit length, fruit girth, fruit volume, pericarp thickness, single fruit weight, fruit yield plant^{-1}, fruit yield plot^{-1} and total fruit yield (36.07 t ha^{-1}) were also recorded the highest in this treatment. The quality parameters of ascorbic acid content of green chilli fruits (197.41 mg g^{-1}) and capsaicin content of dry chilli fruits (0.92 %) showed better resulted in growth, yield and quality parameters of chilli. It could be concluded that foliar application of potassium humate @ 0.5 % + fish amino acid @ 3% at 30, 60 and 75 DAT can be applied to enhance growth, yield and quality parameters of chilli var. Indus 13.

***Key words*:** Chilli, Biostimulants, Fish amino acid, Potassium humate

Chilli (*Capsicum annuum* L.) is a member of the family Solanaceae. It is one of the most valuable commercial vegetable crops grown in India. It is one of the most important nutritious vegetables which is rich source of vitamin A and C with plenty of minerals. Both green and dried chillies are the important components of our routine diet which give the required pungency, colour, taste and flavor to our dishes. The principal colouring matter is capsanthin, the carotenoid pigment which contributes about 35 percent to the total pigments [1]. The pungency in chilli is due to an alkaloid capsaicin [2]. This has high medicinal value especially anti-cancerous and instant pain relief. Organic biostimulants are such molecules useful in increased productivity of crops. These biostimulants applied in small amounts, can promote plant growth, development, flowering, increase yield and support plants to overcome from stress by acting directly or indirectly on plant physiology [3].

Foliar application of nutrients is proved to be the best techniques to achieve the hidden hunger in chilli due to rapid and efficient absorption of nutrients in need. Foliar nutrients usually penetrate the cuticle of the leaf and enter the cells. Potential components considered through foliar nutrition in present study are potassium humate along with action of biostimulants. Hence, potassium humate, panchagavya, sea weed extract and fish amino acid were considered as sources of foliar nutrition for chilli. Potassium humate as organic acid also play an important role which promotes physical and chemical characters of the soil through the vigour of these materials with soil mineral [4-5] and promote plant vigour, growth and yield [6]. Fish amino acid is liquid organic manures made from fish waste. Fish amino acid is of great value to both plants and microorganisms in their growth, because it contains various nutrients and types of amino acids. Foliar application or a soil drenching of fish amino acid could maximize uptake and minimize runoff or leaching, providing just enough N to the plants for the production of chlorophyll to maintain plant health [7], the blend of five products obtained from cow viz. ghee, milk, curd, cow dung and cow' s urine had relevance in the divine scripts of Indian wisdom (Vedas). Panchagavya was considered as an important one that enhanced the biological efficiency of crop plants and improved the quality of horticulture produce [8]. Liquid extracts obtained from sea weeds have recently gained

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importance as foliar sprays for many crops including vegetables [9]. Seaweed extract contains major and minor nutrients, amino acids, vitamins and growth promoting substance [10]. It has been reported that biostimulants are used to enhance the growth and yields of plants [11] develop tolerance to environmental stress [12], increase nutrient uptake from soil [13]. Hence, the present study was conducted to know the effect of foliar application of biostimulants on plant growth, yield, quality and biochemical parameters on chilli under field condition.

MATERIALS AND METHODS

The study was conducted during 2020 at farmer's field at a village near Panruti, Cuddalore district, Tamil Nadu. The soil was sandy loam in texture, alkaline reaction (pH 7.2) low in nitrogen (190.00 kg ha^{-1}), phosphorus (14.09 kg ha^{-1}) and potassium (276.10 kg ha^{-1}) respectively. The chilli var. Indus 13 seedlings prepared in portray were transplanted in 45 days. The seedlings were planted in the beds width/length measuring (0.8 to 25m) with a spacing of (row to row) × 0.45 cm (plant to plant). Four different plant growth stimulants namely panchagavya, seaweed extract, fish amino acid to each @ 3% and potassium humate @ 0.5% along with control (distilled water) were imposed in eight treatments in Randomized block design (RBD) with three replications. The experiment comprised eight treatments viz. T_1- control, T_2- panchagavya @ 3%, T_3- seaweed extract @ 3%, T_4- fish amino acid @ 3%, T_5- potassium humate @ 0.5% T_6- potassium humate @ 0.5% + panchagavya @ 3%, T_7- potassium humate @ 0.5% + seaweed extract @ 3%, T_8- potassium humate @ 0.5% + fish amino acid @ 3% to the beds and the biostimulants were foliar sprayed at 30, 60 and 75 days after transplanting. Five randomly selected plants from each treatment were tagged to recorded different growth, flowering, yield parameters. The data recorded were analyzed by adopting the standard procedure for [14] and using AGRISTAT software. The quality of capsaicin content and ascorbic acid on chilli fruits were estimated following the standard methods of biochemical analysis [15].

RESULTS AND DISCUSSION

Growth parameters

The result revealed that the growth characters were significantly influenced (Table 1) as a result of foliar application of plant growth substances. Significantly higher plant height (131.36 cm), number of leaves $plant^{-1}$ (419.83), number of branches $plant^{-1}$ (142.84), canopy volume (221.12 cm^3), chlorophyll content in the leaves (14.36 mg g^{-1}), net photosynthetic rate (94.42) and total dry matter production (14163.22 kg ha^{-1}) were observed in the treatment with potassium humate @ 0.5% + fish amino acid @ 3% (T_8) spray at 30, 60 and 75 days. However, this treatment was closely followed by the treatment (T_6) with potassium humate @ 0.5% + panchagavya @ 3% in respect of these growth characters. The increment in growth parameters may be due to the reason that potassium humate which contains many elements necessary to the development of plant life [16] and 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 [17]. 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 [18].

Table 1 Effect of foliar application of biostimulants on growth parameters of chilli (*Capsicum annuum* L.)

Treatment	Plant height (cm)	No. of leaves $plant^{-1}$	No of branches $plant^{-1}$	Canopy volume (cm^3)	Chlorophyll content in the leaves (mg g^{-1})	Net photosynthetic rate (µ molCO_2 m^{-2} s^{-1})	Total dry matter production (kg ha^{-1})	Days to 1st flowering	Days to 50% flowering	No. of flowers $plant^{-1}$
T_1	111.74	365.49	123.64	186.76	9.34	81.02	7308.24	35.47	51.91	86.02
T_2	117.28	381.01	129.13	196.61	10.79	84.87	9703.17	33.8	49.82	90.93
T_3	114.52	373.25	126.38	191.68	10.07	82.95	8468.67	34.64	50.86	88.42
T_4	122.73	396.54	134.62	206.34	12.22	88.69	11110.50	32.15	47.72	95.93
T_5	120.02	388.7	131.87	201.53	11.5	86.77	10493.25	32.98	48.76	93.38
T_6	128.56	412.07	140.09	216.21	13.65	92.52	13676.87	30.51	45.61	101.19
T_7	125.66	404.31	137.39	211.42	12.93	90.6	12468.45	31.33	46.67	98.49
T_8	131.36	419.83	142.84	221.12	14.36	94.42	14163.22	29.69	44.56	103.89
S.Ed	2.39	7.72	2.62	4.01	0.23	1.72	238.05	0.65	0.95	2.00
CD(p=0.05)	5.02	16.23	5.51	8.43	0.49	3.62	500.15	1.36	2.01	4.21
CV %	2.31	2.29	2.35	2.32	2.38	2.32	2.47	2.45	2.36	2.33

The foliar application of potassium humate and fish amino acid may has played an important role in metabolism, promotion to plant growth, physiological, biochemical processes and cell division. The earlier study made by [19] in sweet pepper, [20] in chilli, [21] in radish, [22] in brinjal also endorsed the findings of the present study. The early flowering (29.69 days to first flowering and 44.56 day to 50% flowering) and number of flowers $plant^{-1}$ (103.89) recorded in plants treated with potassium humate @ 0.5% + fish amino acid @ 3% (T_8) might be due to early completion of vegetative growth and better nourishment of plants. Increased vegetative growth, higher biomass production and early flowering of chilli with potassium humate treatment [23].

Yield and quality parameters

The result revealed that the yield and quality characters were significantly influenced (Table 2) as a result of foliar application of fruit yield substances. Significantly increased higher fruit set % (76.38), number of fruits $plant^{-1}$ (79.36), fruit length (16.43 cm), fruit girth (4.26), fruit volume (33.92

cm^3), pericarp thickness (1.29 mm), single fruit weight (26.85 g), fruit yield $plant^{-1}$ (2.88 kg), fruit yield $plot^{-1}$ (144.30 kg) and total fruit yield (36.07 t ha^{-1}) were recorded with T_8- potassium humate @ 0.5% + fish amino acid @ 3% was spray to 30, 60 and 75 days. However, this treatment was closely followed by the treatment (T_6) potassium humate @ 0.5% + panchagavya @ 3% in respect of these yield characters. This trend in data on yield attributed also revealed potassium humate and fish amino acid as the better foliar nutrient source and biostimulants respectively for flowering and fruit yield of chilli. Consistency in availability of nutrients through foliar 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 foliar application of potassium humate or fish amino acid resulted in a positive early in flowering, fruiting stages and increased total yield per plant. Potassium humate is a commercial product containing many elements which improved the soil fertility and increased the availability of nutrient elements by holding them on mineral surface, consequently, affecting plant growth and yield [24]. Increment of humic substances increased organic matter in soil and reduced the negative effect of salt stress which increased yield of plants [25] on cowpea, [26] in peas. Fish amino acid foliar spray at flowering stage would have improved the metabolic activity and cell division resulting in higher plant height, more number of leaves, more chlorophyll content which consequently increased the photosynthetic activity which in total increased yield per plant [27].

Table 2 Effect of foliar application of biostimulants on yield and quality parameters of chilli (*Capsicum annuum* L.)

Treatment	Fruit set %	No. of fruits $plant^{-1}$	Fruit length (cm)	Fruit girth	Fruit volume (cm^3)	Pericarp thickness (mm)	Single fruit weight (g)	Fruit yield $plant^{-1}$ (kg)	Fruit yield $plot^{-1}$ (kg)	Total fruit yield (t ha^{-1})	Ascorbic acid (mg g^{-1})	Capsaicin content (%)
T_1	67.91	58.42	13.69	3.48	25.08	1.07	19.40	1.88	94.45	23.61	174.49	0.71
T_2	70.42	64.04	14.66	3.72	27.4	1.14	21.33	2.21	110.95	27.73	181.12	0.77
T_3	69.26	61.24	14.22	3.6	26.14	1.10	20.47	2.06	103.45	25.86	177.59	0.74
T_4	73.41	70.43	15.36	3.95	29.9	1.20	23.26	2.49	124.80	31.20	188.44	0.83
T_5	72.45	67.66	15.00	3.83	28.64	1.17	22.66	2.33	116.55	29.13	184.53	0.80
T_6	75.55	76.45	16.02	4.17	32.51	1.26	25.70	2.72	136.35	34.08	195.12	0.89
T_7	74.73	73.61	15.67	4.06	31.26	1.23	24.45	2.61	130.60	32.65	192.53	0.86
T_8	76.38	79.36	16.43	4.26	33.92	1.29	26.85	2.88	144.30	36.07	197.41	0.92
S.Ed	1.45	1.41	0.30	0.07	0.58	0.02	0.48	0.05	2.39	0.60	3.72	0.01
CD(p=0.05)	3.04	2.98	0.64	0.16	1.22	0.05	1.02	0.10	5.03	1.26	7.82	0.03
CV %	2.34	2.37	2.33	2.47	2.58	2.42	2.39	2.39	2.42	2.37	2.30	2.43

The same result has been shown by [28] in onion, [29] in okra. The quality parameters of ascorbic acid content of green chilli fruits (197.41 mg g^{-1}) and capsaicin content of dry chilli fruits (0.92%) were recorded with T_8- potassium humate @ 0.5% + fish amino acid @ 3% was spray to 30, 60 and 75 days. However, this treatment was closely followed by potassium humate @ 0.5% + panchagavya @ 3% (T_6). The potassium humate stimulants increased the hormonal activities of plant like ethylene which helped in ripening of fruits and formation of capsaicin, [30]. Potassium humate not only increased fruit yields but also improved fruit quality by increasing dry matter and vitamin C contents, as well as increasing sugar content and titrable activity levels of tomato [31]. Foliar application of potassium humate influenced the muskmelon fruit development and maturation which improved fruit quality by increasing sugar content, ascorbic acid and β-carotene levels. Furthermore, application of panchagavya at frequent interval had increased flowers in chilli which might be due to high amount of amino acid proline present in milk, an important constituent of panchagavya [32]. Higher amounts of endogenous proline increases contents of cytokinin and auxin which in turn contributes towards production of more number of flowers [33]. The increase in fresh weight might be due to the better efficiency of chlorophyll pigment, producing more photosynthetic [34] in okra. This might be due to hormonal effect of panchagavya along with increase in photosynthetic activity of plants which causes better source sink relationship in chilli. Similar results were obtained by [35] in chilli, [36-37], in chilli, [38] in tomato.

CONCLUSION

From the above results it may be concluded that foliar application of potassium humate @ 0.5% + fish amino acid @ 3% resulted in enhanced growth, yield and quality of chilli var. Indus 13.

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