



Response of Capsicum (*Capsicum annuum* L.) Hybrids to Micro-nutrients under Protected Conditions

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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

The field experiment was carried out during *rabi* season of 2021-22 and 2022 at Vegetable Research Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur to find out the response of capsicum hybrids to micronutrients under protected conditions. The experiment was laid out in Split Plot Design (SPD) with 15 treatment combinations and replicated thrice. The experiment comprised three hybrids *viz.*, Indira, Swarna and Bomby and five levels of micronutrients *viz.*, control (no micronutrients application), soil application of Zn, Fe & B, fertigation of EDTA of Zn & Fe and solubor at 15 days interval, foliar application of vegetable special @ 5g/lit at 15 days interval and foliar application of chelated combo micronutrients @ 1g/lit at 15 days interval. Recommended package of practices for the crop were followed except treatments. Results of the experiment revealed that the hybrid Indira recorded significantly highest plant height (91.30 and 94.89 cm), number of branches (11.87 and 12.30), stem girth (4.31 and 4.60 cm), number of leaves (102.94 and 106.43), internode length (13.82 and 14.01 cm), number of flowers per plant

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(38.22 and 38.36), fruit set (55.10 and 55.44%), no. of fruits per plant (20.99 and 21.22), fruit weight per plant (3.69 and 3.74 kg) and fruit yield per 1000 m² (70.36 and 71.35 q) while fruit length (11.45 and 11.71 cm), fruit diameter (10.54 and 10.66 cm), weight of placenta (18.51 and 18.71g) and average weight of fruit (193.31 and 195.90g) were significantly highest in Swarna. In case of micronutrients, foliar application of vegetable special @ 5g/at 15 day recorded significantly highest value of plant height (93.72 and 96.77cm), no. of branches (12.66 and 13.39), stem girth (4.75 and 5.12 cm), no. of leaves (105.52 and 108.68), internode length (14.75 and 15.04cm), no. of flowers per plant (41.34 and 41.95), fruit set (56.66 and 57.45%), no. fruits per plant (20.56 and 20.73), fruit length (11.85 and 12.07cm), fruit diameter (10.62 and 10.80cm), weight of placenta (18.31 and 18.46g), average fruit weight (189.03 and 191.33g), fruit weight per plant (4.12 and 4.17 kg) and fruit yield (78.64 & 79.60q/1000 m²). Hence, hybrid Indira and foliar application of vegetable special @ 5g/at 15 days may be recommended for higher productivity from capsicum crops under protected conditions.

Keywords: *Capsicum hybrids; growth; micronutrients; yield.*

1. INTRODUCTION

Capsicum (*Capsicum annum* L.) is rich in vitamin A (8493 IU), vitamin C (283 mg) and minerals like calcium (13.4 mg), magnesium (14.9 mg) phosphorus (28.3 mg) and potassium, (263.7 mg) per 100 g fresh weight. From every 100 g of edible portion of capsicum, 24 kcal of energy, 1.3 g of protein, 4.3 g of carbohydrate, 0.3 g of fat along with dietary fiber, phytochemicals, etc. are provided [1]. The optimum temperature required by the capsicum plant is 20 to 25°C during the day and 18 to 20°C at night. If temperature exceeds 35°C or falls below 12°C, fruit set is affected. Among the various protected structures, polyhouse production has been proven as a more profitable protected technique for capsicum cultivation [2,3-6]. More [7] stated that greenhouses protected the crops from extremely high temperatures and high rainfall to facilitate timely harvest as per demand and good quality of produce. Generally, the main purpose of growing high value crops in protected conditions is to give blemish free high-quality material as it is easy to control diseases and pests throughout the year. Micronutrients are needed in very little quantity but are very important for proper growth of plants (Mousavi, 2011). Zinc and boron are responsible for the enhancement of photosynthesis (Gupta, 1993). Zinc is also responsible for many enzymatic activities i.e. aldolase, peptidase, isomerase and phosphohydrolase etc. [8,9-12]. Boron deficiency can cause small fruit size and sterility in plants. The degeneration of tissues and disintegration of cambium cells may also be due to a deficiency of boron [13]. The external supply of inputs has become important because of poor fertility status of the soil which is not able to meet the entire nutrient requirement of the crop [14,15,16].

In order to enhance the quality production and productivity per unit area of vegetable crops, protected cultivation technologies may be opted. Protected cultivation offers several advantages to producing vegetables of high quality and yields, thus using the land and other resources more efficiently [17,18-21]. Protected cultivation is more sustainable as the effect of climate is minimized [22]. Protected cultivation of high-value crops offers higher productivity which in turn increases the profitability of the farm [23,24-28]. Therefore, the current study included hybrids and the application of micro-nutrients under protected conditions to study its influence on productivity of capsicum in central plain zone of Uttar Pradesh.

2. MATERIALS AND METHODS

The field experiment was carried out during two consecutive *rabi* season of 2021-22 and 2022 at Vegetable Research Farm, Kalyanpur of C.S. Azad University of Agriculture & Technology, Kanpur under naturally ventilated poly house. Kanpur is situated at 25.26° to 26.50° north latitude and 79.31° to 80.34° longitudes with an altitude of 125.9 m above the mean sea level. The climate of Kanpur region is typically sub-humid and sub-tropical with extreme winter and summer. The average rainfall is 800-850mm, which mostly received from June to September.

The soil was sandy loam in texture and soil pH was 7.8, which showed slightly alkaline reaction. The soil was low in organic carbon (0.40%), low in available N (162.0 kg/ha), medium in available phosphorus (15.2 kg/ha) and low in available potassium (192 kg/ha) at initiation of experiment. The experiment was laid out in split plot design (SPD) with 15 treatment combinations and replicated thrice. The experiment comprised

Table 1. Effect of hybrids and micronutrients on growth parameter of capsicum

Treatments	Plant height at 120 DAT (cm)		Number of branches/ plant at 120 DAT		Stem girth at 120 DAT (cm)		Number of leaves per/ plant at 120 DAT		Internode length at 120 DAT (cm)		Number of flowers/ plant	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
Capsicum hybrids												
Indira	91.30	94.89	11.87	12.34	4.32	4.61	102.94	106.44	13.82	14.01	38.23	38.36
Swarna	89.80	92.94	11.40	11.67	4.08	4.38	100.36	104.26	13.21	13.48	35.89	36.18
Bomby	88.72	91.43	11.15	11.55	4.01	4.30	99.11	102.41	12.94	13.21	35.51	35.78
SEm±	0.277	0.654	0.081	0.073	0.024	0.009	0.731	0.757	0.077	0.097	0.248	0.320
CD 5%	1.116	2.635	0.325	0.294	0.095	0.036	2.948	3.054	0.309	0.392	1.001	1.291
Micronutrients												
Control	83.45	86.48	9.84	10.21	3.04	3.23	96.25	99.75	11.62	11.79	28.67	28.78
Soil application of Zn, Fe & B	88.19	91.55	10.99	11.21	4.08	4.18	99.090	102.59	12.81	13.01	34.99	35.12
Fertigation of EDTA of Zn & Fe and solubor at 15 days interval	91.61	94.743	11.64	12.11	4.30	4.71	100.55	104.05	13.46	13.72	38.17	38.36
Foliar application of vegetable special @ 5g/lit at 15 days interval	93.73	96.78	12.67	13.39	4.75	5.13	105.52	108.69	14.75	15.04	41.34	41.95
Foliar application of chelated combo micronutrients @ 1g/lit at 15 days interval	92.74	95.89	12.22	12.49	4.52	4.88	102.61	106.78	13.97	14.26	39.55	39.68
SEm±	1.026	1.738	0.215	0.218	0.077	0.084	1.879	1.946	0.249	0.254	0.688	0.681
CD 5%	3.011	5.103	0.631	0.641	0.23	0.25	5.517	5.713	0.731	0.746	2.020	2.000

Table 2. Effect of hybrids and micronutrients on earliness in flowering and fruiting of capsicum

Treatments	Days to first flower appears (days)		Days to first fruit set (days)		Days to first harvest	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
Capsicum hybrids						
Indira	51.11	50.32	61.85	60.84	84.52	82.60
Swarna	52.68	51.81	63.36	62.78	90.63	89.71
Bomby	53.23	52.69	64.29	63.36	92.75	91.29
SEm±	0.382	0.375	0.465	0.381	0.655	0.533
CD 5%	1.538	1.512	1.876	1.535	2.640	2.148
Micronutrients						
Control	56.29	55.17	68.19	67.14	94.26	92.41
Soil application of Zn, Fe & B	53.79	52.63	65.20	64.48	91.35	90.09
Fertigation of EDTA of Zn & Fe and solubor at 15 days interval	51.87	51.48	62.32	61.06	88.47	86.67
Foliar application of vegetable special @ 5g/lit at 15 days interval	49.35	48.54	59.27	58.90	85.42	84.51
Foliar application of chelated combo micronutrients @ 1g/lit at 15 days interval	50.41	49.78	60.83	60.05	86.99	85.66
SEm±	0.976	0.963	1.178	1.162	1.665	1.570
CD 5%	2.866	2.828	3.458	3.410	4.890	4.609

Table 3. Effect of hybrids and micronutrients on yield attributes and yield of capsicu

Treatments	Number of fruits per plant		Fruit length (cm)		Fruit diameter (cm)		Weight of placenta (g)		Average fruit weight (g)		Fruit weight per plant(kg)		Fruit yield (q/1000m ²)	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
Capsicum hybrids														
Indira	20.99	21.22	11.01	11.22	9.60	9.79	17.15	17.20	176.31	179.83	3.69	3.74	70.36	71.35
Swarna	17.82	18.01	11.45	11.72	10.54	10.66	18.51	18.71	193.32	195.91	3.42	3.46	65.32	65.97
Bomby	17.51	17.62	10.38	10.64	8.97	9.30	14.84	15.00	146.99	149.03	3.38	3.41	64.48	65.06
SEm±	0.137	0.130	0.075	0.103	0.066	0.069	0.118	0.146	0.470	1.233	0.023	0.023	0.484	0.413
CD 5%	0.553	0.525	0.304	0.415	0.266	0.277	0.478	0.590	1.893	4.970	0.093	0.092	1.950	1.665
Micronutrients														
Control	17.45	17.59	9.56	9.80	8.33	8.53	15.00	15.22	151.30	152.88	2.94	2.99	56.12	57.01
Soil application of Zn, Fe & B	17.73	17.90	10.45	10.71	9.22	9.44	16.17	16.35	164.67	167.87	3.13	3.16	59.56	60.19
Fertigation of EDTA of Zn & Fe and solubor at 15 days interval	18.57	18.76	11.31	11.58	10.06	10.30	17.08	17.05	174.61	177.82	3.49	3.52	66.62	67.13
Foliar application of vegetable special @ 5g/lit at 15 days interval	20.56	20.73	11.86	12.07	10.63	10.80	18.32	18.47	189.03	191.33	4.12	4.17	78.65	79.60
Foliar application of chelated combo micronutrients @ 1g/lit at 15 days interval	19.57	19.77	11.55	11.79	10.29	10.52	17.61	17.77	181.43	184.71	3.81	3.85	72.66	73.36
SEm±	0.352	0.349	0.205	0.205	0.178	0.182	0.316	0.327	3.248	3.293	0.065	0.065	1.254	1.265
CD 5%	1.032	1.025	0.602	0.601	0.522	0.535	0.928	0.921	9.537	9.669	0.195	0.192	3.683	3.715

three hybrids viz., Indira, Swarna and Bomby and five levels of micronutrients viz., control (no micronutrients application), soil application of Zn, Fe & B, fertigation of EDTA of Zn & Fe and solubor at 15 days interval, foliar application of vegetable special @ 5g/lit at 15 days interval and foliar application of chelated combo micronutrients @ 1g/lit at 15 days interval. The plants were planted on beds at 60x60 cm spacing in zigzag manner on 18th October and 20th October during 2021-22 and 2022-23, respectively. Bed size of 0.90m (width) x 4.20m (length) with height of 15 cm was maintained in the experiment. A total number of beds (plots) were 15x3= 45. Recommended package of practices for the crop were followed except treatments. The five plants were selected randomly from each plot and tagged. The observations were recorded on growth parameters, yield attributes and fruit yield and analyzed by using statistical techniques.

3. RESULTS AND DISCUSSION

The entire growth parameters, yield attributes and fruit yield were influenced significantly by hybrids during both the years of capsicum experimentation (Tables 1, 2 and 3). Among hybrids, Indira recorded significantly highest growth parameters viz., plant height (91.30 and 94.89 cm), number of branches (11.87 and 12.34), stem girth (4.31cm and 4.60cm), number of leaves (102.94 and 106.41), internode length (13.82 and 14.01cm) and number of flowers (38.23 and 38.36) during both the years. It was followed by Swarna while Bomby was lowest in all the above growth parameters. However, capsicum hybrids Swarna and Bomby were found statistically at par with each other in terms of plant height, number of branches, number of leaves and internode length during both years while in terms of stem girth and number of flowers during first year only. This might be due the vigour of the individual plant governed by the genetical factors. These findings are in accordance with the results of Malshe et al. [29] and Manoj and Venugopal [30].

In case of earliness in flowering and fruiting, capsicum hybrid Indira recorded significantly earliest first flower appears (51.11 and 50.32 days), first fruit set (61.85 and 60.83 days) and first fruit harvest (84.52 and 82.59 days) during both the years (Table 2). It was followed by Swarna while Bomby was latest in these flowering and fruiting parameters. However, Swarna and Bomby were found statistically at

par with each other in terms of first flower appears, first fruit set and first fruit harvest during both the years.

In case of yield attributes and yield, Indira produced significantly highest number of fruits per plant (20.99 and 21.22), fruit weight per plant (3.69 and 3.74 kg) and fruit yield per 1000 m² (70.36 and 71.35 q). It was followed by Swarna while Bomby lowest in all these traits. However, Swarna and Bomby were found statistically at par with each other in terms of number of fruits per plant, fruit weight per plant and fruit yield per 1000 m² during both the years. As far as individual fruit trait is concern, the significantly highest value of fruit length (11.45 and 11.71 cm), fruit diameter (10.54 and 10.66 cm), weight of placenta (18.51 and 18.71g) and average weight of fruit (193.31 and 195.90g) were found in Swarna followed by Indira and Bomby (Table 2). It might be due to genetic makeup and environmental conditions. The results are in confirmation with the findings of Singh and Singh [31] and Behera and Chitdeshwari [32].

4. CONCLUSION

From the present findings, it can be inferred that the hybrid Indira and foliar application of vegetable special @ 5g/lit at 15 days interval was found suitable for realizing highest fruit yield of capsicum crop under protected conditions in central plain zone of Uttar Pradesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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