

Original Research Article

Response of capsicum (*Capsicum annuum* L.) hybrids to micro-nutrients under protected conditions

ABSTRACT

The field experiment was carried out during *rabiseason* 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 (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 day may be recommended for higher productivity from capsicum crop under protected conditions.

Keywords: Capsicum hybrids, Growth, Micronutrients and Yield

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 (Sreedhara *et al.*, 2013). 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 setting is affected. Among the various protected structures, polyhouse production had been proven as more profitable protected technique for capsicum cultivation (Aruna and Sudagar, 2010). More (1990) started that greenhouse protected the crops from extreme high temperature 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 enhancement of photosynthesis (Gupta, 1993). Zinc is also responsible for many enzymatic activities i.e. aldolase, peptidase, isomerase and phosphohydrolase *etc.* (Rawat and Mathpal, 1984). Boron deficiency can cause small fruit size and sterility in plants. Degeneration of tissues and disintegration of cambium cells may also be due to deficiency of boron (Agarwal, 2018). 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 (Rajiv and Tomar, 2022).

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 produce vegetables of high quality and yields, thus using the land and other resources more efficiently (Rajiv and Kumari, 2023). Protected cultivation is more sustainable as the effect of climate is minimized (Pachiyappan *et al.*, 2022). Protected cultivation of high-value crops offers higher productivity which in turn increases the profitability of the farm (Prakash *et al.*, 2022). Therefore, the current study included hybrids and application of micro-nutrients under

protected conditions to study its influence on productivity of capsicum in central plain zone of Uttar Pradesh.

MATERIAL 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 25.26⁰ to 26.50⁰ north latitude and 79.31⁰ to 80.34⁰ 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 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 60×60 cm spacing in zigzag manner on 18th October and 20th October during 2021-22 and 2022-23, respectively. Bed size of 0.90m (width) × 4.20m (length) with height of 15 cm was maintained in the experiment. A total number of beds (plots) were 15×3= 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.

RESULT AND DISCUSSION

Effect of capsicum hybrids on growth parameters, yield attributes and fruit yield

The entire growth parameters, yield attributes and fruit yield were influenced significantly by hybrids during both the years of capsicum experimentation (Table 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 to the vigour of the individual plant governed by the genetical factors. These findings are in accordance with the results of Malshe *et al.* (2016) and Manoj and Venugopal (2018).

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 concerned, 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 (2012) and Behera and Chitdeshwari (2021).

Effect of micronutrients on growth parameters, yield attributes and fruit yield

The growth parameters, yield attributes and fruit yield were influenced significantly by micronutrients during both the years of capsicum experimentation (Table 1, 2 and 3). The foliar application of vegetable special @ 5g/lit at 15 day interval recorded significantly highest growth

parameters viz., 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) and no. of flowers per plant (41.34 and 41.95). It was followed by foliar application of chelated combo micronutrients @ 1g/lit at 15 days interval and fertigation of EDTA of Zn & Fe and solubor at 15 days interval in all above growth parameters. However, foliar applications of vegetable special @ 5g/lit and chelated combo micronutrients @ 1g/lit were found statistically at par with each other in terms of plant height, no. of branches, stem girth and no. of leaves. The significant improvement in growth parameters might be due to availability of sufficient micronutrients. These results are corroborated to findings documented by Irfan *et al.*, (2020) and Malik *et al.* (2020).

In case of earliness in flowering and fruiting, foliar application of vegetable special @ 5g/lit at 15 day interval recorded significantly earliest first flower appears (49.35 and 48.54 days), first fruit set (59.27 and 58.90 days) and first fruit harvest (85.42 and 84.51 days) during both the years (Table 2). It was followed by foliar application of chelated combo micronutrients @ 1g/lit at 15 days interval and fertigation of EDTA of Zn & Fe and solubor at 15 days interval in all above traits. However, foliar applications of vegetable special @ 5g/lit and chelated combo micronutrients @ 1g/lit were found statistically at par with each other in terms of earliness in flowering and fruiting. Abundant supply of micronutrients might have resulted in these parameters. The results are corroborated the findings of Kaur *et al.*, (2017) and Malik *et al.* (2020).

Similar to growth parameters, the foliar application of vegetable special @ 5g/lit at 15 day interval also produced significantly highest 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 per 1000 m² (78.64 & 79.60q) during both the years (Table 3). It was followed by foliar application of chelated combo micronutrients @ 1g/lit at 15 days interval and fertigation of EDTA of Zn & Fe and solubor at 15 days interval in yield attributed and fruit yield. However, foliar applications of vegetable special @ 5g/lit and chelated combo micronutrients @ 1g/lit were found statistically at par with each other in terms of fruit length, fruit diameter, weight of placenta and average fruit weight. The yield is largely governed by the yield attributes, hence

their better development reflected in the higher fruit yield. These results are corroborates to findings documented by Agrawal (2018), Kaur *et al.*, (2017) and Naik (2018).

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.

REFERENCES

- Agarwal A (2018). Growing environments and micronutrients application influence on fruit and seed yield of *Capsicum annum*. *International Journal of Nutrition of Food Sciences* 5: 1-6.
- Aruna P and Sudagar IP (2010). Evaluation of capsicum varieties under polyhouse conditions. *The Asian J Horti* 4 (2): 336-37.
- Behera, P R and Chitdeshwari T. (2021). Response of Capsicum Hybrids to Zinc (Zn) Fertilization under Protected Cultivation. *CJAST*, 40(41): 1-10.
- Gupta UC (1993). Factors affecting Boron uptake by plants. In Boron and its role in crop production, ed. U. C. Gupta, 87-104. *Boca Raton, Fl.: CRC Press*.
- Irfan MA, Bakhtawar L, Laraib A, Shazia K, Rimsha A, Bilal MS, Nazar H (2020). Effect of foliar application of zinc and boron on growth and yield of Chilli (*Capsicum frutescens* L.) *International Journal of Agronomy and Agricultural Research (IJAAR)* 16(3):12-18.
- Kaur Rajneet, Singh SK and Raturi HC (2017). Effect of different level of fertigation and foliar application of nutrients on capsicum (*Capsicum annum* L. var. *grossum*) grown in soilless media under polyhouse condition. *Journal of pharmacognosy and phytochemistry*; 6(6): 1770-1773
- Malik AA, Narayan S, Magray MM, Shameem S, Hussain BS, Bangroo S (2020). Effect of foliar application of micronutrients on growth, yield, quality and seed yield of chilli (*Capsicum annum* L.) under temperate conditions of Kashmir Valley. *Int. J Chem. Stud.*; 8(4):2781-2784.
- Malshe KV, Palshetkar MG and Desai BG (2016). Comparative study of different capsicum varieties under open and protected conditions. *Plant Archives* 16(2): 931- 33.
- Manoj BV and Venugopal CK (2018). Evaluation of capsicum hybrids under protected condition. *J. Farm Sci.*, 31(1): 120-122.
- More TA, Chandra P, Majumdar G and Singh JK (1990). Some observations on growing cucumber under plastic greenhouse. Proc of XI Int Cong on the use of Plastics in Agric pp 49-55.
- Mousavi SR (2011). Zinc in crop production and interaction with phosphorus. *Australian Journal of Basic and Applied Sciences* 5(9): 1503-1509.

- Naik MR (2018). Influence of micronutrients and organics on growth and yield of capsicum cv. Solan Bharpur under shade net condition. *International Journal Current Microbial Applied Science* 7(5): 2166-2171.
- Pachiyappan P, Kumar P, Reddy KV, Kumar KNR, Konduru S, Paramesh V, Rajanna GA, Shankarappa SK, Jaganathan D, Immanuel S, Kamble AL, Selvakumar R, Immanuelraj KT, Manogaran BR, Perumal A, Maruthanayagam U and Niranjana S (2022). Protected Cultivation of Horticultural Crops as a Livelihood Opportunity in Western India: An Economic Assessment. *Sustainability*, 14(12): 1-17.
- Prakash P, Kumar P, Kar A, Singh AK and Ankukkani P (2022). Economic analysis of carnation (*Dianthus caryophyllus*) under protected cultivation in Maharashtra. *Indian Journal of Agricultural Sciences*, 92(4): 460–463.
- Rajiv and Kumari Meenakashi (2023). Protected cultivation of high value vegetable crops under changing climate. In: *Advances in research on vegetable production under a changing climate* Vol. 2, Advances in Olericulture, Springer Nature, Switzerland AG. pp 229-266.
- Rajiv and Tomar Saurabh (2022). Integrated use of organic and inorganic sources of nutrients in french bean (*Phaseolus vulgaris*). *Indian Journal of Agricultural Sciences*, 92 (4): 17-21.
- Rawat PS, Mathpal KN (1984). Effect of micronutrients on yield and sugar metabolism of some of the vegetables under Kumaon hill conditions. *Scientific Culture* 50: 243-244.
- Singh D and Singh H (2012) Effect of phosphorous and zinc nutrition on yield, nutrient uptake and quality of Chickpea. *Annals of Plant and Soil Research* 14: 71-74.
- Sreedhara D S, Kerutagi M G, Basavaraja H, Kunnal L B and Dodamani M T (2013). Economics of capsicum production under protected conditions in Northern Karnataka. *Karnataka J. Agric. Sci.* 26(2): 217-219.

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 capsicum

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

UNDER PEER REVIEW