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Research Article

Effect of Humic Acid and Micro Nutrients on Growth and Yield of Poly House Grown Capsicum (*Capsicum annum* L.)

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Abstract

An experiment was conducted to study the response of growth and yield of poly house grown capsicum cultivar "Indira" (*Capsicum annum* L.) to different applications of humic acid and micro nutrients. There were seven treatments which laid out in completely randomized design with three replications. Analysis of variance showed there were significant differences for all the characters studied during experimentation. Among the different treatments applied, T_7 (RDF + soil application of humic acid 10 kg/ha + foliar application of humic acid 0.1 % + micronutrient mixture) was found statistically superior to enhance plant height (103.91cm), number of branches per plant (9.33), leaf area (391.30 cm^2), fruit weight (174.28 g), number of fruits per plant (22.07), volume of fruit (376.57 cc), specific gravity (0.58g/cc) and yield per plant (3.85 kg).

Keywords: Capsicum, humic acid, polyhouse, yield, micronutrients, protected cultivation

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Introduction

Capsicum (*Capsicum annuum* L.) also known as bell pepper, sweet paper or shimla mirch belong to family Solanaceae, sub-family Solanoideae and originate from Central and South America [1], 1995). The bell pepper and colored capsicum in India is under non-traditional category of vegetables [2]. The plant has a densely branched stem with white flowers bear the fruit which is green when unripe, changing to red, although some varieties may ripen to yellow, purple and brown. Capsicum is a high value vegetable crop both in domestic and overseas market due to more consumer preference and its use in various culinary products. One hundred gram of edible portion of capsicum provides 24 k Cal of energy, 1.3 g protein, 4.3 g carbohydrates and 0.3 g fat [3]. Quality production of capsicum is the need of the day as it remains in high demand with remunerative prices. This has led to production of capsicum under protected conditions as enterprises in urban and peri-urban area. Capsicum cultivation is becoming popular in polyhouses due to high yield potential and its evergreen demand. In polyhouse condition capsicum requires more nutrients as it produce high biomass due to vertical concept of harvesting and extended life cycle, it seems that there is urgent need to standardize doses of macro as well as micro nutrients, further looking to deteriorating health of soil, use of chemical fertilizers should be restricted. Humic acid improves soil fertility and increases the availability of nutrient elements by holding them on mineral surface. The humic substances are mostly used to remove or decrease the negative effects of chemical fertilizers from the soil and have a major effect on plant growth [4]. Yield and its quality depends upon availability of micronutrients, in case of polyhouse grown vegetable, availability of micronutrients become more important, where source of micronutrients is only artificial application and requirement of these nutrients are more as compare to open field cultivation. Looking to above facts, this experiment was laid out to assess the effects of humic acid and micronutrients applications on yield and quality of capsicum.

Materials and Methods

The experiment was conducted under naturally ventilated polyhouse at Hi-tech Horticulture Unit, Rajasthan College of Agriculture, Udaipur (Rajasthan) India during July, 2014 to March, 2015. The trial was laid out in Completely Randomized Design with three replications. The size of the polyhouse was 28m×32m (896 sq.m) covered with aluminate sheet and ultra violet stabilized low density polyethylene sheet having 200 micron thickness with provision of foggers. The experiment was comprised of seven treatments of different levels of RDF, humic acid and micronutrient application *i.e* T_1: RDF (nitrogen@120 kg/ha, phosphorus@80 kg/ha and potash @80 kg/ha),T_2: RDF+ humic acid 10 kg/ha as soil application, T_3: RDF+ humic acid 0.1 % as foliar spray, T_4: RDF+ humic acid 10 kg/ha as

soil application + humic acid 0.1 % as foliar spray, T_5: RDF+ humic acid 10 kg/ha as soil application + micronutrient mixture as foliar spray, T_6: RDF + humic acid 0.1% as foliar spray + micronutrient mixture as foliar spray and T_7: RDF+ humic acid 10 kg/ha as soil application + humic acid 0.1% as foliar spray + micronutrient mixture as foliar spray. The seedlings were raised on soil-less media (Mixture of vermiculite, perlite and cocopith) in plug trays having cells of 2" in size. Four weeks old seedlings at 4-5 true leaf stage were transplanted at 60 cm× 45 cm. All the cultural practices including irrigation and hoeing were carried out as per the standard commercial procedures. Spraying for pests and diseases were applied whenever it appeared necessary throughout the growing season. Plants were vertically trained as per standard procedure. Data on yield and yield contributing characteristics *viz.* plant height (cm), number of branches per plant, stem diameter (cm), number of fruits per plant, fruit weight (g), fruit length (cm), diameter of fruit (cm), volume of fruit (cc), specific gravity (g/cc), leaf area (cm^2), TSS (^oBrix), ascorbic acid (mg/100g pulp), moisture content (%) and yield per plant (kg) were recorded from randomly selected five tagged plants of each treatment in each replication and further analyzed. All data were subjected to analysis of variance to determine treatment effects.

Results and Discussion

Vegetative Characteristics

It is evident from the results (**Table 1**) that various treatments of humic acid and micronutrients and their combinations had significant effect on vegetative growth parameters like plant height, number of branches, leaf area and stem diameter of capsicum under polyhouse condition. Maximum plant height and number of branches were measured in the treatment T_7 (RDF *i.e.* nitrogen@120 kg/ha, phosphorus@80 kg/ha and potash @80 kg/ha + humic acid 10 kg/ha soil application + humic acid 0.1% foliar spray + micronutrients mixture). It was probably due to the favorable effect of humic substances which are mostly used to remove or decrease the negative effects of chemical fertilizers from the soil and have a major effect on plant growth and growth of new cell in the plant meristem. More plant height and number of branches were also observed in chilli [5], [6] and [7], whereas same trend was also observed in capsicum [8] and [9]. Leaf area is an important variable for most physiological and agronomic studies involving plant growth, light interception, photosynthetic efficiency, evapotranspiration and response to fertilizers and irrigation. Maximum leaf area was also reported in the treatment T_7 (RDF + Humic acid 10 kg/ha soil application + humic acid 0.1% foliar spray + micronutrients mixture). This significant increase may be due to dynamics of uptake of soil nutrients and soil physical conditions and have a major effect on plant growth and essential role of boron in the growth and development. These results were in conformation with the previous findings in chill and capsicum [5], [9] and [10].

Table 1 Effect of humic acid and micronutrient on plant height, no. of branches, stem diameter, fruit length, fruit diameter, fruit wt., fruit volume and specific gravity of capsicum under polyhouse condition

S. No.	Detail of Treatment	Plant Height (cm)	No. of Branches /plant	Stem Diameter (cm)	Fruit length (cm)	Fruit diameter (cm)	Fruit wt. (g)	Volume of fruit (cc)	Specific Gravity g/cc
1.	RDF (control)	86.50	5.57	1.33	9.45	7.75	148.02	292.33	0.53
2.	RDF+ HA 10 kg/ha (soil application)	91.63	6.83	1.28	10.27	8.01	154.00	296.33	0.54
3.	RDF+ HA 0.1 % (foliar spray)	93.47	7.60	1.28	10.47	7.67	157.27	305.87	0.55
4.	RDF+ HA 10 kg/ha + HA 0.1 % (foliar spray)	95.88	8.03	1.11	11.12	7.37	165.00	325.43	0.55
5.	RDF+ HA10 kg/ha + MN mixture (foliar spray)	97.39	8.80	1.34	11.62	8.10	176.08	351.60	0.56
6.	RDF + HA 0.1% + MN mixture (foliar spray)	100.79	9.07	1.25	11.18	8.13	171.92	328.83	0.57
7.	RDF+ HA10 kg/ha + HA 0.1%+MN mixture	103.91	9.33	1.20	11.45	7.89	186.33	376.57	0.58
8.	**SEm+**	1.6092	0.279	0.039	0.3636	0.0695	2.407	9.765	0.0082
9.	**CD 5%**	4.8811	0.846	0.119	1.1029	0.2107	7.3027	29.621	0.0249

Yield Characteristics

The data presented in Table 1 and **Table 2** clearly showed that the effect of humic acid and micronutrients had significantly influenced all the yield attributes studied in capsicum. Results showed that the treatment T_7 (RDF+ humic acid 10 kg/ha soil application + humic acid 0.1% foliar spray + micronutrients mixture) exhibited highest fruit weight and maximum number of fruits per plant. This significant increase was probably due to humic substances as it has direct action on the plants and role of zinc in nitrogen metabolism and increases the synthesis of auxin which promotes the cell size. Furthermore, it acts as a catalyst in the oxidation and reduction process. These findings are quite analogous with the finding in chilli and capsicum [11], [12], [13] and [14]. Maximum fruit length was reported in the treatment T_5 (RDF + Humic acid 10 kg/ha soil application + micronutrients mixture foliar spray) which might be due to involvement of zinc in cell division and cell expansion, involvement of boron on synthesis of metabolites and rapid translocation of photosynthetic and mineral iron from other parts of the plant to developing fruit. Similar trend was also observed in capsicum [8] and [15], Maximum fruits diameter was obtained in treatment T_6 (RDF+ Humic acid 0.1% foliar spray + micronutrients mixture), this might be due to zinc and boron as these act as catalyst in the oxidation and reduction process and in sugar metabolism which might have increased fruit diameter. Similar trend was seen in capsicum [8] and [9], whereas maximum yield per plant was recorded in treatment T_7 (RDF+ humic acid 10 kg/ha soil application + humic acid 0.1% foliar spray + micronutrients mixture). This increment in yield might be due to application of humic acid and micronutrients and their interactive effects. Similar results have been also observed in capsicum [16] and [7]. Volume of fruit was also found maximum for the same treatment *i.e.*T_7, increased volume of fruit might be due to combined effects of humic acid and micronutrients. These results are in accordance with the findings in bell pepper [11] and [15].

Table 2 Effect of humic acid and micronutrient on leaf area, TSS, ascorbic acid, moisture, no. of fruits, yield per plant and yield per 1000 sq. meter of capsicum under polyhouse condition.

S. No.	Detail of Treatment	Leaf area square (cm)	TSS (^{0}Brix)	Ascorbic acid (mg/100 g pulp)	Moisture Content (%)	Number of fruits / plant	Yield (kg/ plant)	Yield (qt/1000 sq.m.)
1.	RDF (control)	308.10	7.40	86.93	86.00	20.53	3.03	121.53
2.	RDF+ HA 10 kg/ha (soil application)	325.00	7.80	94.03	88.00	21.60	3.32	133.04
3.	RDF+ HA 0.1 % (foliar spray)	342.46	7.50	93.99	91.00	22.32	3.50	140.08
4.	RDF+ HA 10 kg/ha + HA 0.1 % (foliar spray)	357.17	4.60	94.36	93.67	22.86	3.77	150.89
5.	RDF+ HA10 kg/ha + MN mixture (foliar spray)	362.70	6.13	95.70	96.00	23.50	4.13	165.51
6.	RDF + HA 0.1% + MN mixture (foliar spray)	371.63	7.00	95.53	92.00	24.15	4.15	166.11
7.	RDF+ HA10 kg/ha + HA 0.1%+MN mixture	391.30	7.30	97.07	96.00	25.35	4.71	188.37
8.	**SEm+**	4.6280	0.066	1.0388	0.8819	0.575	0.062	2.4830
9.	**CD 5%**	14.038	NS	NS	NS	1.744	0.18	7.5314

Quality Parameter

Effects of various treatments of humic acid and micronutrients and their combinations had non significant effect on quality parameter like TSS, ascorbic acid, moisture content except specific gravity in capsicum under polyhouse condition. Maximum values for these traits were recorded for treatment by T_7 (RDF + humic acid 10 kg/ha soil application + humic acid 0.1% foliar spray + micronutrients mixture) having value of 058 g/cc. This might be due to type of soil and the content of humic compounds in soil may have a decisive effect, the higher the content of humic compounds in soil, the stronger antioxidant activity, which might have increased specific gravity in fruit. These results are in accordance with the findings in capsicum [14] and [15].

Conclusion

Based on the above findings, it could be recommended that capsicum crop yields maximum with bigger sized fruits with treatment T_7 *i.e.* RDF + humic acid 10 kg/ha as soil application + humic acid 0.1% as foliar spray + micronutrient mixture as foliar spray (0.5% Zn + 0.2% Boron + 0.5% Mn) for sustaining the higher growth, fruit yield and quality under polyhouse condition.

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