An Asian Journal of Soil Science
Volume 12 | Issue 2 | December, 2017 | 283-289 | e ISSN–0976–7231 ■ Visit us : www.researchjournal.co.in

Research Article
DOI : 10.15740/HAS/AJSS/12.2/283-289

Effect of foliar application of humic acid fortified with zinc and boron on growth and yield of capsicum

S.N. AVINASH, C. A. SRINIVASAMURTHY AND S. BHASKAR

Received : 23.09.2017; **Revised :** 09.11.2017; **Accepted :** 19.11.2017

MEMBERS OF RESEARCH FORUM:

Corresponding author :
S.N. AVINASH, Department of Soil Science and Agricultural Sciences, University of Agricultural Sciences, GKVK, BENGALURU (KARNATAKA) INDIA
Email: avinashsn0005@gmail.com

Co-authors :
C.A. SRINIVASAMURTHY, Central Agricultural University IMPHAL (MANIPUR) INDIA
Email: casmurthy@yahoo.com

S. BHASKAR, Indian Council of Agricultural Research, NEW DELHI, INDIA
Email: drbhaskar63@gmail.com

Summary
A field experiment was conducted during *Kharif* 2015 in a farmer's field to study the effect of foliar spray of humic acid fortified with zinc and boron on growth and yield of capsicum. The experiment was laid out in Randomized Complete Block Design with 16 treatment combinations. The results revealed that significantly higher plant height, total number of branches plant^{-1}, number of leaves per plant^{-1}, SPAD meter reading, dry matter production plant^{-1}, Number of fruits plant^{-1}, yield plant^{-1}, per cent fruit set, weight of ten fruits, fruit yield (54.23 t ha^{-1}) were recorded in treatment receiving RDF + FYM applied to soil and 3 foliar sprays of zinc fortified humic acid extracted from poultry manure at 0.50 per cent and it was at par with the treatment receiving RDF + FYM applied to soil and 3 foliar sprays of zinc fortified humic acid extracted from coffee pulp at 0.50 per cent.

Key words : Humic acid, Zinc, Boron, Capsicum, Poultry manure, Coffee pulp

How to cite this article : Avinash, S.N., Srinivasamurthy, C.A. and Bhaskar, S. (2017). Effect of foliar application of humic acid fortified with zinc and boron on growth and yield of capsicum. *Asian J. Soil Sci.*, **12** (2) : 283-289 : **DOI : 10.15740/HAS/AJSS/12.2/283-289.**

Introduction

Soil health is a crucial factor for realizing higher yield of crops. Excessive application of chemical fertilizers may affect soil health and sustainable productivity. So addition of organic manures, which can supplement nutrient requirement of crops to some extent, release nutrient in a gradual and controlled way and enhance production of crops without much impact on the environment. Humus is the end product of the microbial decay of organic matter. Humus contains both humic and non-humic substances. Humic substances (HS) are the largest constituent of soil organic matter (~60%), known to contain complex and heterogeneous mixture of polydispersed materials. Humic substances have positive effects on plant physiology by improving soil structure and fertility and by influencing nutrient uptake and root architecture and they have been shown to contain auxin and an "auxin-like" activity but the biochemical and molecular mechanisms underlying these events are only partially known. The addition of HS stimulate nutrient uptake, cell permeability and seems to regulate mechanisms involved in plant growth stimulation.

There are three main fractions of humic substances namely humic acid (HA), fulvic acid (FA) and humin. Humic acid is the most complex form of organic material and it is a ready source of carbon and nitrogen and known as the black gold of agriculture and is increasingly becoming popular for use in agriculture. It is a composite of smaller units such as aliphatic and aromatic groups, oils, phenolic esters, fatty acids, alkanes, tannins, monosaccharides and polysaccharides (Harper *et al*., 2000).

Now-a-days, humic acid is extracted on a large scale from various sources and their exact composition varies from one source to another. Among them poultry manure, coffee pulp and press mud etc., are the main sources to extract humic acid. Although poultry manure is a nitrogen rich material and of economically important as nutrient source and energy source. In spite of this, poultry manure is a good organic nutrient source due to its high carbon, low C: N ratio and it supplies primary, secondary and micronutrients for crop production. It contains higher amounts of nitrogen and phosphorus compared to other bulky organic manures and is a good source of nutrients.

Coffee pulp is one of the principal by-product of wet processed coffee which constitutes almost 40 per cent of the wet weight of the coffee berry, rich in carbohydrates, proteins, amino acids, minerals and appreciable quantities of tannins, polyphenols, caffeine and potassium (Bressani, 1979). Coffee pulp is a rich source of nutrient containing about 2.05 per cent N, 0.56 per cent P and 2.56 per cent K in composted pulp. The use of this as organic material helps to improve soil properties thus, increasing yield and it also helps to reduce the need to buy inorganic fertilizers, thus, saving the farmers money (Preethu *et al.*, 2007).

Capsicum (*Capsicum annuum* L.) belongs to the family Solanaceae and it is commonly known as sweet pepper, Shimla mirch, bell pepper or green pepper. In India, it is grown in an area of 32,150 ha with an annual production and productivity of 1,825 lakh MT and 5.68 MT ha^{-1} respectively (NHB, 2014-15). Capsicum attained a status of high value and low volume crop in India in recent years and occupies a place of pride among vegetables in Indian cuisine, because of its delicacy and pleasant flavour coupled with rich content of ascorbic acid along with other vitamins and minerals (Kurubetta and Patil, 2009).

Micronutrients have received a great deal of importance in crop production during recent years because of the wide spread occurrences of their deficiencies in different parts of the country. The foliar application of micronutrients (Zn and B) are known to increase total sugars (TS), reducing sugar (RS), non-reducing sugar (NRS), ascorbic acid (AA) and TSS/acid ratio of papaya fruit (Singh *et al*., 2002). Zinc is involved in regulating the protein and carbohydrate metabolism (Swietlik, 1999). There is also concern that B is one of the micronutrients responsible for the changes in number of metabolic pathways such as carbohydrate metabolism, nitrogen metabolism and phenol metabolism in plants (Marschner, 1995; Dordas and Brown, 2005).

In order to enhance the yield and quality of capsicum, humic acid can be an option and used as a supplement to chemical fertilizers. Fortification of humic acid can enhance fertilizer value of humic acid. Thus, including fortified humic acidin a liquid foliar application is the main benefit that the plant will be able to absorb and utilize the nutrients in solution many times and more effectively. For this reason, it is an obvious complement to any foliar programme.

Resource and Research Methods

The open field study was performed during the late *Kharif* and early *Rabi* season of 2015 in a farmer's field. Raised bed of 4.0 m length and 0.60 m width 25 cm height were prepared leaving a space of 40 cm between two beds as path to enable easy cultural operations like weeding, spraying, harvesting etc. The capsicum seedlings were purchased from commercial seedling production nursery (35 days old seedlings) and were planted in rows 100 cm apart with an intra-row spacing of 40 cm.

Prior to planting FYM (25 t ha^{-1}), recommended dose of fertilizer 150: 100: 150 kg N, P_2O_5 and K_2O kg ha^{-1} was applied to the crop. A basal dose of 15-15-12 kg ha^{-1} NPK was supplied in the form of urea, single super phosphate and muriate of potash before transplanting. The remaining dose of fertilizers were supplied through fertigation using water soluble fertilizers starting from 21 days after transplanting to 110 DAT for a 4 month duration crop thus, requiring (two splits $week^{-1}$) 26 fertigations. The water soluble fertilizers used were 19:19:19, potassium nitrate and calcium nitrate. Mulching was done to reduce weed problem in the beds. However, standard cultural practices were applied homogeneously through all the plots.

A composite soil sample was collected from experimental site before the start of experiment and was analysed for physical and chemical properties (Table A).

Fortification of humic acid :

Humic acid extracted from poultry manure and coffee pulp was fortified with zinc @ 50 ppm using zinc sulphate and boron @ 25 ppm using borax. Foliar spray

Table A : Initial soil properties of the experimental plot

Parameters	Values
Physical properties	
Texture	Sandy loam
Bulk density (Mg m^{-3})	1.51
Maximum water holding capacity (%)	34.6
Chemical properties	
pH	5.93
Electrical conductivity (dS m^{-1})	0.067
Organic carbon (%)	0.41
CEC [c mol (p^+) kg^{-1}]	10.64.
Available nitrogen (kg ha^{-1})	213.70
Available phosphorus (kg ha^{-1})	47.40
Available potassium (kg ha^{-1})	183.96
Exchangeable calcium [c mol (p^+) kg^{-1}]	3.5
Exchangeable magnesium [c mol (p^+) kg^{-1}]	1.2
Available sulphur (mg kg^{-1})	17.56
Exchangeable sodium [c mol (p^+) kg^{-1}]	0.23
DTPA-Iron (mg kg^{-1})	17.64
DTPA-Copper (mg kg^{-1})	0.68
DTPA-Manganese (mg kg^{-1})	15.04
DTPA-Zinc (mg kg^{-1})	0.44
Available boron (mg kg^{-1})	0.39

solutions were prepared by dissolving calculated quantities of humic acid, zinc sulphate and borax in water. The three foliar sprays were given to respective treatments at 15 interval starting from 45 DAT to 75 DAT.

Growth and yield parameters in capsicum:

Plant growth characteristics :

Plant height (cm),
Number of branches per plant
Number of leaves per plant
SPAD chlorophyll
Dry matter production per plant.

Yield and its components :

Number of fruits per plant
Yield per plant (kg)
Yield per hectare (t)
Per cent fruit set
Weight of ten fruits.

Fruit parameters :

Fruit length (cm)
Fruit breadth (cm)
Pericarp thickness (cm).

Statistical analysis and interpretation of data :

The analyses and interpretation of the data was done using the Fisher's method of analysis and variance technique as given by Panse and Sukhatme (1967). The level of significance used in 'F' and 't' test was 5 per cent probability and wherever 'F' test was found significant, the 't' test was performed to estimate critical differences among various treatments.

Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Plant growth parameters :

The plant growth aspects were determined with regard to plant height, total number of branches $plant^{-1}$, number of leaves per $plant^{-1}$, SPAD chlorophyll and dry matter production per plant (Table 1). The results revealed that significantly higher plant height was observed in the treatment which received RDF + FYM + zinc fortified humic acid extracted from poultry manure at 0.50 per cent followed by RDF + FYM + zinc fortified humic acid extracted from coffee pulp at 0.50 per cent. On the other hand significantly higher number of branches was observed in RDF + FYM + zinc fortified humic acid extracted from poultry manure at 0.50 per cent (Table 1). Whereas, the treatment RDF + FYM + boron fortified humic acid extracted from poultry manure at 0.50 per cent and RDF + FYM + zinc fortified humic acid extracted from coffee pulp at 0.50 per cent were at par with each other.

Regarding number of leaves per plant significantly higher number of leaves was observed in RDF + FYM + zinc fortified humic acid extracted from poultry manure at 0.50 per cent. Whereas, RDF + FYM + zinc fortified humic acid extracted from coffee pulp at 0.50 per cent, RDF + FYM + boron fortified humic acid extracted from poultry manure at 0.5 per cent and RDF + FYM + boron fortified humic acid extracted from coffee pulp at 0.50 per cent were at par with each other (Table 1). This might be due to better cell division, cell elongation and increased physiological processes in capsicum upon application of fortified humic acid along with chemical fertilizers and FYM. Thus, it is attributed to the addition of nutrients from humic acid which supplies essential elements which are required for plant growth and development due to better utilization of nutrients from the crop plants.

In case of SPAD meter reading significantly higher SPAD meter reading (Table 1) was observed in the treatment received RDF + FYM + zinc fortified humic acid extracted from poultry manure at 0.50 per cent followed by treatment receiving RDF + FYM + zinc fortified humic acid extracted from coffee pulp at 0.50 per cent. The highest dry matter production was observed RDF + FYM + zinc fortified humic acid extracted from poultry manure at 0.50 per cent followed by RDF + FYM + zinc fortified humic acid extracted from coffee pulp at 0.50 per cent which were at par each other. Similar observations were recorded by Ferrara *et al.* (2012) who reported that foliar application of humic acid exhibited an increase in shoot growth, increase in nitrogen and chlorophyll content in the leaves and higher SPAD values.

The increase in dry matter production was observed with the soil application of RDF and foliar spray of fortified humic acid extracted from poultry manure and coffee pulp at different levels. Sladky and Tichy (1959) reported that spraying of humic acid to tomato plants resulted in increase in both fresh and dry weight of shoot. This is mainly because of direct and indirect benefits from the humic acid. Delfinea *et al.* (2005) revealed that foliar application of humic acid caused a transitional production of plant dry mass along with soil applied RDF. Similar results were reported by Thakur *et al*. (2013).

Yield and yield parameters :

Per cent fruit set :

Significantly higher per cent fruit set was recorded in RDF + FYM + zinc fortified humic acid extracted from poultry manure at 0.50 per cent followed by RDF + FYM + boron fortified humic acid extracted from poultry manure at 0.50 per cent and RDF + FYM + zinc fortified humic acid extracted from coffee pulp at 0.50 per cent but these were at par with each other (Table 2).

Ten fruits weight:

Significantly higher ten fruits weight (g) at 5th picking was observed with the treatment received RDF + FYM + zinc fortified humic acid extracted from poultry manure at 0.50 per cent compared to all the other treatments (Table 2). The treatment T_7 was at par with treatment

Table 1: Effect of RDF applied to soil and foliar spray of fortified humic acid on different plant growth parameters of capsicum

Treatments		Plant height (cm) at harvest	Total no. of branches plant^{-1}	Total no. of leaves plant^{-1}	SPAD meter reading at 90 DAT	Per cent fruit set	Dry matter production (kg ha^{-1})
T_1	RDF (150:100:150 kg NPK ha^{-1}) + FYM (25 t ha^{-1})	80.13	25.86	178.93	35.67	65.71	2630.33
T_2	T_1 + FS of unfortified HA extracted from PM @ 0.25 %	95.57	31.17	222.11	39.59	68.94	2817.08
T_3	T_1 + FS of unfortified HA extracted from PM @ 0.50 %	102.60	35.77	240.20	42.44	74.20	3019.58
T_4	T_1 + FS of unfortified HA extracted from CP @ 0.25 %	92.18	29.13	218.11	39.03	68.28	2801.25
T_5	T_1 + FS of unfortified HA extracted from CP @ 0.50 %	97.54	34.73	234.18	42.32	73.15	2981.08
T_6	T_1 + FS of zinc fortified HA extracted from PM @ 0.25 %	105.17	36.20	235.07	43.78	73.01	2951.58
T_7	T_1 + FS of zinc fortified HA extracted from PM @ 0.50 %	107.06	39.46	259.72	48.36	78.91	3151.83
T_8	T_1 + FS of zinc fortified HA extracted from CP @ 0.25 %	100.11	33.30	229.66	41.10	69.93	2919.50
T_9	T_1 + FS of zinc fortified HA extracted from CP @ 0.50 %	106.55	38.23	253.92	46.02	76.83	3121.33
T_{10}	T_1 + FS of boron fortified HA extracted from PM @ 0.25 %	96.83	33.57	225.20	41.53	71.91	2872.92
T_{11}	T_1 + FS of boron fortified HA extracted from PM @ 0.50 %	104.24	38.37	254.75	45.26	78.25	3077.08
T_{12}	T_1 + FS of boron fortified HA extracted from CP @ 0.25 %	94.61	32.20	221.45	39.90	69.33	2837.00
T_{13}	T_1 + FS of boron fortified HA extracted from CP @ 0.50 %	99.39	37.57	247.42	43.29	75.56	3063.42
T_{14}	T_1 + FS of 50 ppm zinc solution only	90.75	28.67	214.36	38.57	66.91	2719.08
T_{15}	T_1 + FS of 25 ppm boron solution only	88.34	29.77	214.12	37.01	67.66	2698.42
T_{16}	T_1 + FS of 50 ppm zinc and 25 ppm boron solution	92.84	30.23	215.71	38.69	67.96	2770.92
	S.E.±	1.60	0.85	4.21	0.57	0.93	34.63
	C.D. (P=0.05)	4.80	2.53	12.62	1.72	2.78	103.82

received RDF + FYM + foliar spray of zinc fortified humic acid extracted from coffee pulp at 0.50 per cent. The positive effect on yield and yield parameters due to improvement in the availability of plant nutrients and balanced supply of nutrients through inorganic fertilizers and foliar spray of fortified humic acid extracted from poultry manure and coffee pulp that might have induced the cell division, expansion of cell wall, meristematic activity, enzymatic activity, photosynthetic efficiency, increased nutrient absorption and translocation, increase in physiological processes thus, resulting in better growth and development of crop, production of more number of flowers and fruits per plant and increased fruit weight which in turn improved all the growth parameters and yield influencing characters of capsicum.

Total number of fruits per plant :

The higher fruit number was recorded in the treatment received RDF + FYM + zinc fortified humic acid extracted from poultry manure at 0.50 per cent. However, treatment receiving RDF + FYM + boron fortified humic acid extracted from poultry manure at 0.50 per cent, RDF + FYM + zinc fortified humic acid extracted from coffee pulp at 0.50 per cent and RDF + FYM + boron fortified humic acid extracted from coffee pulp at 0.50 per cent were at par with each other (Table 2). Further, significantly lower number of fruits per plant was recorded in the treatment receiving RDF + FYM alone. Kaya *et al*. (2005) reported that seed pre-treatment with zinc + foliar spray of humic substances on common bean significantly increased the yield and yield components. Similar results were reported by Laila *et al*. (2013) and Rajpar Bhatti *et al*. (2011) and Moraditochaee (2012).

Fruit yield (kg plant^{-1} and t ha^{-1}) :

The higher fruit yield (kg plant^{-1} and t ha^{-1}) was noticed in the treatment which received RDF + FYM + zinc fortified humic acid extracted from poultry manure at 0.50 per cent (Table 2). Whereas, the treatment receiving RDF + FYM + boron fortified humic acid extracted from poultry manure at 0.50 per, RDF + FYM + zinc fortified humic acid extracted from coffee pulp at 0.50 per cent and RDF + FYM + boron fortified humic acid extracted from coffee pulp at 0.50 per cent were at par with each other.

Boron is an essential trace element for plants being involved in many enzymatic reactions and it also enhances the movement of sugar borate complex from leaves to fruit and ultimately increased fruit yield as reported by

Table 2 : Effect of RDF applied to soil and foliar spray of fortified humic acid on different yield parameters of capsicum

Treatments		10 Fruit weight (g) at 5th picking	Number of fruits plant^{-1}	Fruit yield (kg plant^{-1})	Total yield (t ha^{-1})
T_1	RDF (150:100:150 kg NPK ha^{-1}) + FYM (25 t ha^{-1})	1112.51	16.18	1.46	44.05
T_2	T_1 + FS of unfortified HA extracted from PM @ 0.25 %	1356.17	20.81	1.82	48.25
T_3	T_1 + FS of unfortified HA extracted from PM @ 0.50 %	1477.00	21.87	2.03	51.35
T_4	T_1 + FS of unfortified HA extracted from CP @ 0.25 %	1320.54	19.24	1.68	47.21
T_5	T_1 + FS of unfortified HA extracted from CP @ 0.50 %	1438.67	21.68	1.94	50.99
T_6	T_1 + FS of zinc fortified HA extracted from PM @ 0.25 %	1429.33	21.24	1.96	50.72
T_7	T_1 + FS of zinc fortified HA extracted from PM @ 0.50 %	1566.43	24.09	2.26	54.23
T_8	T_1 + FS of zinc fortified HA extracted from CP @ 0.25 %	1413.11	20.85	1.76	49.28
T_9	T_1 + FS of zinc fortified HA extracted from CP @ 0.50 %	1512.67	23.14	2.19	52.34
T_{10}	T_1 + FS of boron fortified HA extracted from PM @ 0.25 %	1396.75	20.86	1.89	50.29
T_{11}	T_1 + FS of boron fortified HA extracted from PM @ 0.50 %	1494.18	23.74	2.20	53.10
T_{12}	T_1 + FS of boron fortified HA extracted from CP @ 0.25 %	1383.84	20.19	1.73	48.78
T_{13}	T_1 + FS of boron fortified HA extracted from CP @ 0.50 %	1486.22	22.08	2.12	51.57
T_{14}	T_1 + FS of 50 ppm zinc solution only	1306.47	17.83	1.56	46.11
T_{15}	T_1 + FS of 25 ppm boron solution only	1293.50	16.42	1.61	45.54
T_{16}	T_1 + FS of 50 ppm zinc and 25 ppm boron solution	1328.00	18.20	1.63	47.18
	S.E.±	15.22	0.69	0.05	1.45
	C.D. (P=0.05)	45.64	2.06	0.15	4.34

Pandita *et al*. (1976). Similar results were reported by Manas *et al*. (2014) and Sure *et al*. (2012).

Fruit yield and components:

Fruit length (*cm*) :

At 60 DAT, significantly maximum fruit length (9.59 cm) was noticed in T_7 receiving RDF + FYM + foliar spray of zinc fortified humic acid extracted from poultry manure at 0.50 per cent while it is minimum (7.34 cm) in T_1 treatment receiving only RDF + FYM. Whereas, the treatments receiving RDF + FYM + foliar spray of zinc fortified humic acid extracted from coffee pulp at 0.50 per cent (T_9: 9.40), RDF + FYM + foliar spray of boron fortified humic acid extracted from poultry manure at 0.50 per cent (T_{11}: 9.34) and RDF + FYM + foliar spray of boron fortified humic acid extracted from coffee pulp at 0.50 per cent (T_{13}: 9.26) were at par with each other (Table 3). Similar trend was noticed at 90 DAT and at harvest.

Fruit breadth (cm):

At 60 DAT the maximum fruit breadth was (8.52 cm) noticed in T_{11} receiving RDF + FYM + foliar spray of boron fortified humic acid extracted from poultry manure at 0.50 per cent while it is minimum (6.96 cm) in T_1 treatment receiving only RDF + FYM (Table 3). Whereas, the treatment receiving RDF + FYM + foliar spray of boron fortified humic acid extracted from coffee pulp at 0.50 per cent (T_{13}: 8.47) and treatment receiving RDF + FYM + foliar spray of zinc fortified humic acid extracted from poultry manure at 0.50 per cent (T_7: 8.42) were at par with each other. Similar trend was noticed at 90 DAT and at harvest.

Fruit pericarp thickness :

At 60 DAT, significantly higher pericarp thickness was (0.66 cm) noticed in T_{11} receiving RDF + FYM + foliar spray of boron fortified humic acid extracted from poultry manure at 0.50 per cent while it was lower (0.40 cm) in T_1 treatment receiving only RDF + FYM. Treatment T_{11} was at par with the treatment T_{13} receiving RDF + FYM + foliar spray of boron fortified humic acid extracted from coffee pulp at 0.50 per cent (T_{13}: 0.63) (Table 3). Similar trend was noticed at 90 DAT and at harvest.

The increase in fruit parameters is due to increased production and accumulation of carbohydrates as reported by Shahmaleki *et al*. (2014). Favorable effect of humic acid on vegetative growth leads to enhanced photosynthetic rate, better nutrient uptake from the soil

Table 3 : Effect of RDF applied to soil and foliar spray of fortified humic acid on fruit parameters of capsicum

Treatments		Fruit length (cm)			Fruit breadth (cm)			Fruit thickness (cm)		
		60 DAT	90 DAT	At harvest	60 DAT	90 DAT	At harvest	60 DAT	90 DAT	At harvest
T_1	RDF (150:100:150 kg NPK ha^{-1}) + FYM (25 t ha^{-1})	7.34	7.99	6.72	6.96	7.48	6.06	0.40	0.41	0.39
T_2	T_1 + FS of unfortified HA extracted from PM @ 0.25 %	8.33	8.77	7.32	7.58	8.10	6.53	0.46	0.48	0.42
T_3	T_1 + FS of unfortified HA extracted from PM @ 0.50 %	9.12	9.66	8.10	8.13	8.58	7.14	0.57	0.60	0.51
T_4	T_1 + FS of unfortified HA extracted from CP @ 0.25 %	8.14	8.70	7.15	7.46	7.96	6.54	0.44	0.47	0.40
T_5	T_1 + FS of unfortified HA extracted from CP @ 0.50 %	8.86	9.30	7.77	8.09	8.51	7.01	0.56	0.58	0.51
T_6	T_1 + FS of zinc fortified HA extracted from PM @ 0.25 %	8.71	9.20	7.69	7.90	8.33	6.83	0.48	0.52	0.45
T_7	T_1 + FS of zinc fortified HA extracted from PM @ 0.50 %	9.59	10.59	8.46	8.42	8.72	7.38	0.60	0.63	0.53
T_8	T_1 + FS of zinc fortified HA extracted from CP @ 0.25 %	8.21	8.75	7.24	7.69	8.19	6.60	0.47	0.49	0.41
T_9	T_1 + FS of zinc fortified HA extracted from CP @ 0.50 %	9.40	9.92	8.27	8.23	8.64	7.27	0.58	0.61	0.52
T_{10}	T_1 + FS of boron fortified HA extracted from PM @ 0.25 %	8.51	9.05	7.39	8.03	8.40	6.97	0.53	0.55	0.47
T_{11}	T_1 + FS of boron fortified HA extracted from PM @ 0.50 %	9.34	9.85	8.20	8.52	8.88	7.60	0.66	0.70	0.58
T_{12}	T_1 + FS of boron fortified HA extracted from CP @ 0.25 %	8.29	8.80	7.39	7.73	8.27	6.68	0.49	0.52	0.44
T_{13}	T_1 + FS of boron fortified HA extracted from CP @ 0.50 %	9.26	9.77	8.18	8.47	8.80	7.52	0.63	0.66	0.58
T_{14}	T_1 + FS of 50 ppm zinc solution only	7.93	8.34	7.03	7.34	7.77	6.20	0.41	0.43	0.40
T_{15}	T_1 + FS of 25 ppm boron solution only	7.90	8.21	7.00	7.35	7.82	6.31	0.42	0.44	0.40
T_{16}	T_1 + FS of 50 ppm zinc and 25 ppm boron solution	8.09	8.49	7.13	7.38	7.87	6.44	0.44	0.46	0.41
	S.E.±	0.13	0.11	0.10	0.05	0.07	0.06	0.01	0.01	0.01
	C.D (P=0.05)	0.38	0.34	0.30	0.16	0.20	0.19	0.04	0.03	0.03

and increased accumulation and translocation of these metabolites/nutrients to fruit as a result of fruit size increase and also the role in retention of flower and fruits which might have increased the number of fruits besides improvement in the fruit size.

Literature Cited

Bressani, R. (1979). Antiphysiological factors in coffee pulp. Coffee pulp: composition, technology and utilization. I*nternat. Develop. Res. Centre Public*., **108** (e) : 83-88.

Delfinea, S., Roberto, T., Ersilio, D. and Arturo, A. (2005). Effect of foliar application of N and humic acids on growth and yield of durum wheat. *Agron. Sustain. Dev*., **25**: 183–191.

Dordas, C. and Brown, P. H. (2005). Boron deficiency affects cell viability, phenolics leakage and oxidative burst in rose cell cultures. *Pl. Soil*, **268** : 293–301.

Ferrara, G., Andrea, P., Pasquale, S., Enrico, F., Hussein, K. and Hassan, A.F. (2012). Preliminary study on the effects of foliar applications of humic acids on 'italia' table grape. *Sci. Hort.,* **66** : 191-200.

Harper, S.M., Kerven, G.L., Edwards, D.G. and Ostatek, B. Z. (2000) Characterization of fulvic and humic acids from leaves of *Eucalyptus camaldulensis* and from decomposed hay. *Soil Biol. Biochem*., **56**: 352-361.

Kaya, M., Mehmet, A., Khalid, M. K., Cemalettin, Y. Ç. and Sebahattin, O. (2005). Effect of pre-sowing seed treatment with zinc and foliar spray of humic acids on yield of common bean (*Phaseolus vulgaris* L.). *Interna. J. Agric. Bio.,* **7** (6) : 156–162.

Kurubetta, Y. and Patil, A. A. (2009). Performance of coloured capsicum hybrids under different protected structures, *Karnataka J. Agric. Sci*., **22**(5): 1058-1061.

Laila, F. Hagagg, M. F., Shahin, M., Maha, A., Mahdy, H. A. and Eman S. El-Hady (2013). Effect of spraying humic acid during fruit set stage on fruit quality and quantity of Picual olive trees grown under Sinai condition. *J. Appl. Sci. Res.,* **9** (3) : 1484-1489.

Manas, D., Bandopadhyay, P. K., Chakravarthy, A., Pal, S. and Bhattacharya, A. (2014). Effect of foliar application of humic acid, zinc and boron on biochemical changes related to pungent pepper (*Capsicum annum* L.). *African J. Plant Sci.,* **8** (6) : 320-335.

Marschner, H. (1995). *Mineral nutrition of higher plants*. Academy Press, LONDON, UNITED KINGDOM.

Moraditochaee, M. (2012). Effects of humic acid foliar spraying and nitrogen fertilizer management on yield of peanut (*Arachis hypogaea* L.) in Iran. *J. Agric. & Biol. Sci.*, **7**(4): 289-292.

Pandita, M. L., Arora, S. K. and Singh, K. (1976). Effect of plant growth regulators on fruit set, early and total yield of tomato variety HS-101 (*Esculentum mill* L.) during summer season. *Haryana J. Hort. Sci*., **8** (4) : 112-116.

Panse, V. G. and Sukhatme, P. V. (1967). *Statistical methods for agricultural workers*. ICAR, NEW DELHI, INDIA.

Preethu, D.C., Bhanu Prakash, B. N., Srinivasamurthy, C.A. and Vasanthi, B.G. (2007). Maturity indices as an index to evaluate the quality of compost of coffee waste blended with other organic wastes. *Proceedings of the International Conference on Sustainable Solid Waste Manage,* Chennai, India. pp. 270-275.

Rajpar, Bhatti, M. B., Zia-Ul-Hassan, Shah, A. N. and Tunio, S. D. (2011). Humic acid improves growth, yield and oil content of brassica compestris L. *Pak. J. Agri. Sci.*, **27**(2): 125-133.

Shahmaleki, S. K., Golam, A. P. and Mahmood, G. (2014). Acid humic foliar application affects fruit quality characteristics of tomato (*Lycopersicon esculentum* cv. IZABELLA). *Agric. Sci. Dev.,* **3** (10): 312-316.

Singh, D. K., Paul, P. K. and Ghosh, S.K. (2002). Response of papaya to foliar application to boron, zinc and their combinations. Department of pomology and post-harvest technology. Uttar Banga Krishi Viswavidyalaya. Pundibari. Cooch behar (W. B.) INDIA.

Sladky, Z. and Tichy, V. (1959). Applications of humus substances to overground organs of plants. *Bio. Pl.,* **1**: 9-15.

Sure, S., Arooie, H., Sharifzade, K. and Dalirimoghadam, R. (2012). Responses of productivity and quality of cucumber to application of the two bio-fertilizers (humic acid and nitroxin) in fall planting. *Agril. J.,* **7**(6): 401-404.

Swietlik, D. (1999). Zinc nutrition in horticultural crops. *Hort. Rev.,* **23**: 109-178.

Thakur, H., Rekha, K. B., Babu, S.S.N. and Padmaja, G. (2013). Effect of humic substances on growth and yield of sunflower (*Helianthus annuus* L.). *J. Res. ANGRAU*., **41**(4): 106-108.

12th Year
★★★★★ of Excellence ★★★★★