International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(4): 2781-2784

Received: 04-05-2020
Accepted: 08-06-2020

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Effect of foliar application of micronutrients on growth, yield, quality and seed yield of chilli (*Capsicum annuum* L.) under temperate conditions of Kashmir Valley

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DOI: https://doi.org/10.22271/chemi.2020.v8.i4ag.10064

Abstract
The present investigation was conducted during Kharif 2017 and 2018 at experimental field Division of Vegetable Sciences, SKUAST-Kashmir to assess the effect effect of foliar application of micronutrients on growth, yield, quality and seed yield of chilli (*Capsicum annuum* L). Under temperate conditions of Kashmir valley. The trail was carried out in chilli cv. kashmir long-1 consisting of 8 treatments. T_1=control, T_2=Feso$_4$ @0.2%, T_3=Ca NO_3, T_4=Boron @0.1%, T_5 =Mixture of all (T_2+T_3+T_4), T_6 (spray of T_5 except Feso$_4$@ 0.2%), T_7 (Spraying of T_5 except $CaNO_3$ @ 0.2%) and T_8 (spraying of T_5 without Boron@0.1%), replicated thrice with Randomized Block Design. The foliar application of the treatments was done at 60, 90 and 120 days after transplanting. Pooled analysis revealed that amongst the treatments, treatment T_5 (Spraying with mixture of all T_2+T_3+T_4) performed best in all growth attributing traits, yield attributing traits and seed yield *viz*. plant height (70.02.cm), no. of primary branches per plant (8.51),plant spread (36.13 cm), number of fruits per plant (47.80), dry fruit yield per ha (52.61 q ha^{-1}), average fruit weight (6.64 g), fruit length (10.52 cm),fruit width (1.36 cm) and seed yield (9.61 q ha^{-1}). As far as quality parameters are concerned oleoresin content (6.34%), vitamin c content (67.60 mg /100 g) were also found maximum in treatment T_5 (Spraying with mixture of all T_2+T_3+T_4) followed by treatment T_7 in most of the treatments.

Keywords: Chilli, seed yield, micronutrients, quality

Introduction
Chilli also known as hot pepper (*Capsicum annum* var. *annum* L.) is an important vegetable cum spice crop grown through out the world. It belongs to the family Solanaceae. South America is considered as the centre of origin of chilli (Shoemaker, 1953) [11]. The Portuguese introduced Capsicum from Brazil to India during 1584. They are broadly cultivated in tropical and sub-tropical countries like Africa, USA, Japan, Mexico, India, Turkey etc. Mixed stock of Capsicum species was introduced in India by the Portuguese during early 16th century, and Christian missionaries also introduced Capsicum species in the North-eastern states separately (Thamburaj and Singh, 2003) [15]. The nutritive value of chilli is excellent, chillies are rich in vitamins, especially in vitamin A and C. Each 100 grams of dried pods yield about 160 calories of energy through 36 gms carbohyderates, 18 gms proteins, 16 gms fats, 480 mg calcium, 3.1 mg, phosphorus, 31 mg iron, 2.5 mg niacin, 640 I.U. vitamin A and 40 mg vitamin C. India is largest producer, consumer and exporter of chilli. India ranks first in area, and next in production after china. In India, chilli is being grown in an area of 361.00 (000 ha) with a production of 3761.00(000 mt) and the productivity is 12.09 t ha^{-1}(Annoymous, 2017-18) [2]. In Jammu & Kashmir chilli is grown on an area of 309 ha with a annual production of 3592 mt and the productivity is 11.62 t ha^{-1} (Annoymous, 2017) [2]. In hilly areas of Kashmir chilli is sown in the month of april and transplanted in the month of may. Harvesting is done through pickings. Ten to twelve pickings are harvested within the season from July onwards and continues till September.

Productivity could be increased by use of suitable varieties, balanced nutrition, need based agronomic practices. Macro as well as micronutrients play a vital role in the physiology of

plants. Application of micronutrients *viz*., zinc, boron, calcium, magnesium, sulphur and organics *viz*., Vermicompost, Mycorrhiza and FYM bring profound changes in various metabolic processes within the plant system thereby influence the yield considerably. In recent years, the role of these micronutrients is gaining more importance particularly in chilli to boost not only the productivity but also to improve the seed quality. Seed is the primary input, without which, the increase in production of any vegetable crop cannot be expected. Micro-nutrients like calcium (Ca), Magnesium (Mg), Boron (B) and Iron (Fe) plays a major role in enhancing growth, yield and quality parameters of the chilli production. Application of Ca, S, B and Fe has been found effective in improving in growth, yield and quality parameters besides increasing seed yield (Meenakshi *et al.*, 2019) [9].

Materials and methods

A field experiment was conducted during Kharif, 2017, and 2018 at experimental field Division of Vegetable Sciences, SKUAST-Kashmir. The experiment was laid in a randomised block design with three replications. The seeds of chilli cv. Kashmir long-1 were sown in april. The seedlings were transplanted at a spacing of 60 × 45 cms after 30 days after sowing. Recommended package of practices were followed.

All the treatments were applied as foliar spray at three stages of plant growth as 60, 90 and 120 days after transplanting. The plant protection measures were taken up to control pest and diseases as and when required along with intercultural operations. In each plot 10 plants were tagged for taking all observations. Plant height, was recorded at final pickings in cm. Number of primary branches and plant spread was measured at full vegetative stage. Number of fruits plant^{-1} were recorded by counting total no. of pickings. Fruit length and Fruit diameter were estimated using average of ten fruits from 10 tagged plants Fruit yield was estimated on per plot basis and convert ed in fruit yield per hectare in quintals.

Ascorbic acid (mg/100g) The ascorbic acid content of red ripe fruits from each treatment was determined by 2, 6 dichlorophenol indophenols visual titration method suggested by AOAC (1975) [1] and expressed in milligram per 100 g of fresh weight for all the treatment combinations in all replications. Oleoresin content was determined as outlined by Sadasivam and Manickam (2004) [10] wherein ten grams of dried powdered sample was eluted with 50 ml of acetone in chromatographic column. The slurry was collected in a pre-weighed beaker. Solvent was allowed to evaporate and weighed again. Difference in weight was calculated and expressed in per cent. Data recorded were tabulated and statistically analysed as per Gomez and Gomez, 1976. Significant difference between treatment means was tested through 'F' test and critical difference (CD) was worked out wherever 'F' value was found to be significant for treatment effect.

The treatment details are

$T_{1=}$	Control (no application)
T_2=	Spray of $Feso_4$ @ 0.2%,
T_3=	Spray of Ca NO_3 @ 0.2%
T_4=	Spray of Boron @ 0.1%,
T_5 =	Spray of Mixture of all ($T_{2+}T_{3+}T_4$),
T_6 =	Spray of T_5 except $Feso_4$ @ 0.2%),
T_7 =	Spraying of T_5 except $CaNO_3$ @ 0.2%) and
T_8 =	Spray of T_5 without Boron @0.1%

Results and discussion

1. Effect of foliar spray of micro-nutrients on growth, and yield related parameters of chilli. (Table-1 &Table -2)

The results of the present study showed that foliar application of micro-nutrients significantly affected the growth, attributes of chilli.

The effect of micro-nutrients on the growth parameters is described here as under:

As per table -1 pooled analysis revealed that treatment ($T_{5=}$ Mixture of all ($T_{2+}T_{3+}T_4$), recorded maximum plant height (70.02 cm), no of primary branches per plant (8.53) and plant spread (36.13 cm) which was significantly superior to rest of other treatment in case of plant height and number of primary branches per plant but the values are at par with rest of other treatments in case of plant spread where as control treatment recorded lowest plant height (48.44 cm), number of primary branches per plant (7.37) and lowest plant spread (31.26 cm).Further, As per table 2- pooled analysis of two years (2017 and 2018-) revealed that the no. of fruits per plant (47.80), average fruit weight (6.64 gm), fruit length (10.52 cm) and fruit diameter (1.36 cm) which was significantly superior to rest of other treatments where as control recorded lowest number of fruits per plant (32.42), average fruit weight (4.23 gm), fruit length (7.20 cm) and fruit diameter (0.81 cm) respectively which was significantly lower as compared to rest of other treatments (table-2). These results are in agreement with Dongre *et al.* 2000 [5] for average fruit weight. Foliar application of Boron increases weight. Boron play key role on accumulation of photosynthates that has correlation with fruit weight. Tamilselvi *et al.* 2012 reported that foliar application of iron combined with other micronutrients (Zn, Cu, Mn, B and Mo) significantly increased the number of fruits per plant, fruit setting percentage, single fruit weight, yield per plant and seed yield. Similar research findings were recorded by Hatwar *et al*., 2003 [7] in chilli, Verma *et al.*, in 2004 [16] in capsicum, and Basavarajeswari *et al.* 2008 [4] in tomato.

Table 1: Influence of micro-nutrients on growth parameters of Chilli (*Capsicum annum* L.)

	Plant Height (cm)			No. Of primary branches plant^{-1}			Plant Spread (cm)		
	(2017)	(2018)	pooled	2017	2018	pooled	(2017)	(2018)	pooled
T_1 =	47.92	48.97	48.44	6.83	6.86	6.84	26.95	27.34	27.14
T_2	57.81	58.66	58.23	6.88	7.00	6.94	32.43	32.34	32.38
T_3	59.50	61.15	34.38	7.09	7.20	7.15	34.38	34.38	34.38
T_4=	53.45	54.76	54.10	7.19	7.24	7.22	34.65	34.48	34.56
T_5 =	69.27	70.77	70.02	8.48	8.53	8.51	36.26	36.00	36.13
T_6 =	59.21	60.28	59.72	7.48	7.60	7.54	35.30	33.58	34.44
T_7 =	66.88	68.28	34.70	7.77	7.76	7.76	34.57	34.83	34.70
T_8 =	64.61	65.51	65.06	7.33	7.40	7.37	30.76	31.77	31.26
C.D≤.0.5	4.67	4.75	4.72	0.62	0.58	0.63	2.50	2.52	2.45

Table 2: Influence of micro-nutrients on yield related parameters of Chilli (Kharif 2019).

	No. of Fruits/plant			Average Fruit Weight grm			Fruit Length (cm)			Fruit Width (cm)		
	2017	2018	pooled	2017	2018	pooled	2017	2018	pooled	2017	2018	pooled
T_1 =	32.00	32.85	32.42	4.42	4.03	4.23	7.17	7.23	7.20	0.80	0.82	0.81
T_2	35.27	36.79	36.03	5.00	4.24	4.62	7.48	7.70	7.60	0.85	0.88	0.86
T_3	39.75	41.02	40.38	5.10	5.14	5.12	7.88	8.04	7.96	0.88	0.91	0.89
T_4=	32.81	34.67	33.74	4.50	5.35	4.93	7.97	8.10	8.03	0.97	1.00	0.98
T_5 =	47.28	48.31	47.80	6.76	6.52	6.64	10.52	11.01	10.52	1.34	1.38	1.36
T_6 =	42.07	43.12	42.60	6.16	5.49	6.34	8.80	9.92	10.77	1.29	1.32	1.31
T_7 =	44.82	45.32	45.07	6.48	5.90	6.19	10.01	10.04	10.02	1.29	1.33	1.30
T_8 =	42.60	43.53	43.06	6.26	4.95	5.61	9.83	10.15	10.00	1.30	1.33	1.32
C.D≤.0.5	2.95	2.50	2.70	0.44	0.66	0.55	0.45	0.56	0.46	0.10	0.11	0.10

2. Effect of foliar application micronutrients on fruit dry yield, quality attributes and seed yield of chilli (*Capsicum annum* L.). (Table -3)

Pooled analysis revealed that as per table-2 the treatment T_5 (Mixture of all ($T_{2+}T_{3+}T_4$), ($Feso_4$ @0.2%, Ca NO_3, and Boron @0.1%, at 60, 90 and 120 days after transplanting recorded significantly maximum dry fruit yield (52.61 q ha^{-1}) which was significantly superior to rest of all treatments. Further pooled analysis revealed maximum seed yield (9.61 q ha^{-1}), Oleoresin content (6.34%) and Vitamin C content (67.60 mg/100 gms) respectively and values were significantly superior as compared to all other treatment but at par with treatment T_7 in case of seed yield and to treatment T_6 and T_7 in case of oleoresin content. Pooled analysis revealed that control treatment recorded significantly lower values of dry fruit yield (52.61 q ha^{-1}), seed yield (4.85 q ha^{-1}),oleoresin content (4.00%) and Vitamin C content (51.84 mg /100 g) as compared to rest of all other treatments as compared to rest of all other treatments. This may due role of micronutrients such Bo, Ca and Iron as micronutrients are essential for growth and development of plants and are required by plants in very small quantities for improving plant growth, development and reproduction due to enzymatic action (Angmi *et al*., 2016). Micronutrients also play an active role in the plant metabolic process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity and nitrogen fixation (Ballabh *et al*., 2013) [3]. And therefor regulate quality parameters as well (table-3). Similar reports were given by Tamilselvi *et al*. (2012), Shukha *et al.* (2012), Kumari *et al*., 2012 [8] in tomato.

Table 3: Influence of micro-nutrients on dry fruit yield, quality and seed yield of Chilli (Kharif 2019)

	Seed yield (q/ha)			Oleoresin (%)			Vitamin C (mg/100gm)			Dry fruit yield q ha^{-1}		
	(2017)	(2018)	pooled	2017	2018	pooled	2017	2018	pooled	2017	2018	pooled
T_1 =	4.96	4.75	4.85	3.96	4.02	4.00	51.35	52.33	51.84	39.05	40.08	39.56
T_2	5.66	5.63	5.64	4.15	4.24	4.20	54.81	56.21	55.51	44.17	43.82	44.00
T_3	5.87	5.84	5.85	5.03	5.13	5.08	55.58	57.03	56.54	46.76	46.53	46.64
T_4=	4.85	4.88	4.87	4.95	5.35	5.15	57.37	58.45	57.91	46.80	46.56	46.68
T_5 =	9.61	9.62	9.61	6.18	6.51	6.34	66.82	68.37	67.60	52.04	52.17	52.61
T_6 =	5.95	6.10	6.02	5.38	5.49	5.43	60.87	62.58	61.72	47.74	47.64	47.69
T_7 =	8.57	8.70	8.63	5.83	5.89	5.86	62.02	63.58	62.80	50.15	49.37	49.76
T_8 =	7.81	7.75	7.78	4.89	4.94	4.92	57.97	59.70	58.83	47.84	46.47	47.15
C.D≤.0.5	2.10	0.15	1.67	0.67	0.66	0.63	3.45	3.69	3.22	2.62	2.07	2.16

Conclusion

The results can be summarised as, the foliar application of treatment T5 (mixture of T2 @$Fes0_4$ @0.2%,T_3 CaNO3 and T_4= Boron @0.1% required maximum values of growth, fruit yield, yield related parameters, quality and seed yield and therefore can be recommended for cultivation based on research from other different climatic regions and soils.

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