

IMPACT OF MICRONUTRIENT (ZINC) FOLIAR SPRAY ON FRUIT YIELD OF CHILLIES *CAPSICUM ANNUUM* L.

Muhammad Waseem Kalroo, Amir Muhammad Laghari, Muhammad Siddique Depar, Ali Sher Chandio, Attaullah Khan Pathan, Hamz Ali Samoon and Beahri Lal Meghwar

ABSTRACT

The experiment was conducted to examine the effect of different levels of chelated Zinc (Zinc sulphate) on the growth and fruit yield of chilli in a field trial was conducted at farmer's field near Umerkot during the year 2012-2013. Foliar zinc was applied at the concentrations of 1, 2, 3, 4 and 5 ml/L water and control was maintained to check the performance. The experiment was laid out in a three replicated randomized block design in a plot size of 3.0m x 3.5m (10.50m²). The results revealed that all the growth and green chillies production traits were significantly ($P<0.01$) influenced under foliar zinc application at different concentrations. The highest Zinc concentration of 5 ml/L water resulted 85.66 cm plant height, took 56.33 days to flower emergence, 77 cm plant spread, 13.00 branches plant⁻¹, 481.33 fruits plant⁻¹, fruit length 5.50 cm, fresh fruit yield of 705 g plant⁻¹ and 16.350 tons fruit yield ha⁻¹. The foliar application Zinc at concentration of 4 ml/L water resulted 81.33 cm plant height, took 55.66 days to flower emergence, 74.33 cm plant spread, 11.93 branches plant⁻¹, 471.66 fruits plant⁻¹, 5.34 cm fruit length, 692.33 g fresh fruit yield plant⁻¹ and 16.093 tons fruit yield ha⁻¹. Foliar zinc application at concentration of 3 ml/L water produced 75 cm plant height, took 54.33 days to flower emergence, 68.66 cm plant spread, 10.80 branches plant⁻¹, 429.00 fruits plant⁻¹, 4.84 cm fruit length, 641.33 g fresh fruit yield plant⁻¹ and 15.294 tons fruit yield ha⁻¹. Similarly, zinc when foliarly applied at concentration of 2 or 1 ml/L water resulted in simultaneously inferior results and the control resulted in the minimum values for all the growth and yield components. It was concluded that with increasing zinc level, the growth and yield contributing traits of chillies variety Talhari were gradually improved. However, the fruit yield ha⁻¹ did not increase significantly under 5 ml/L water Zn concentration when compared with 4 ml/L water; which indicates that Zn @ 4 ml/L water was an optimum level for obtaining economical fruit yield in chillies variety Talhari.

Keywords: Chillies, foliar spray, micronutrient, zinc, growth, fruit yield

Arid Zone Research Institute, (PARC), Umerkot

Corresponding Author: Dr. Attaullah Khan email:attaullahg@gmail.com

INTRODUCTION

Chilli (*Capsicum annum* L.) belongs to Solanaceae family, originates from South America and thought to have been domesticated at least five times by prehistoric peoples in different parts of South, Central and North America, from Peru in the south to Mexico in the

north and parts of Colorado and New Mexico (Wikipedia, 2013). Chilli occupies an important place as one of the commercial high value spice crops. In Pakistan, chilli is grown in an area of 47.3 thousand hectares with production of 70 thousand tons, with an average yield of 1.5 tons per hectare. During the past seven years, the area grown under the chillies and its production fell by 9.2 and 14.2 percent respectively. Resultantly, in this review period, the average yield in tons per hectare dropped by 5.5 percent. The province of Sindh is major producer of chillies as it produces 82 percent of the total production of the country followed by Punjab 10.6 percent and Balochistan 6.1 percent. Red chilli is particularly produced in Kunri taluka of Umerkot District (Arifeen, 2010). This area is famous for high quality and high production of chilli. Particularly, Kunri taluka has the central position and considered as the biggest chilli market in the country. Moreover, chilli is also cultivated extensively in Hyderabad district (Anonymous, 2007). The major chillies exporting countries with their shares are China (24 percent), Spain (17 percent), Mexico (8 percent), Pakistan (7.2 percent), Morocco (7 percent) and Turkey (4.5 percent).

Crop yield in Pakistan is not satisfactory due to improper fertilizer management and balanced nutrients are paid little attention. Most of the crop production problems are associated with the deficiency of micronutrients. Zinc is also one of the elements deficient in the soil (Anonymous, 2007). Zinc plays a significant role in plant growth and grain development. Zinc is immobile in soil. Zinc deficiencies may occur on calcareous, high pH, sandy texture, high P, and eroded soils. Zinc deficiencies usually show up under cool wet conditions in early spring when root growth is slow. Poorly drained soils may be also deficient. Badly eroded soils and eroded knolls are likely to be low in Zn, soil test to be sure. Deficiency symptoms will most likely show up first in dry bean. Very high rates of P may induce Zn deficiency in flax. Zinc is involved in enzyme systems, metabolic reactions, and is necessary for production of chlorophyll and carbohydrates. Zinc is not generally translocated within plant and is partly mobile in wheat and barley so the first symptoms appear on the younger leaves. Symptoms differ from one species to another. In wheat and barley, the older leaves may have light blotches between the veins. Younger leaves will have a normal green color and will be smaller. In flax, grayish brown spots appear on the younger leaves with shortened internodes appearing stunted (Ken, 2004).

Foliar feeding is a relatively new, slightly controversial technique of feeding plants by applying liquid fertilizer directly to their leaves (Anonymous, 2004). Foliar fertilizers are being used in vegetables that contain various macro and micro nutrients. Foliar fertilizers immediately deliver nutrients to the tissues and organs of the crop. This is a practice of applying liquid fertilizers to leaves. The study showed that crop yield in chillies enhanced when micronutrients were applied in combination instead of alone. The foliar application of zinc at the rate of 3 ppm gave maximum net return to the growers. Similarly for chili, the treatment of 100 percent NK + three spray of zinc produced the highest number of fruits per plant, dry fruit yield, net income and benefit cost ratio. Increasing frequency of Zn spraying from three to four times did not increase the number of chilli fruits per plant (Jiskani, 2005). Keeping in view the role of zinc for the chilli growth and fruit production, the present study will be carried out to evaluate the effect of foliar spray of Zn on the growth and production of chillies.

MATERIAL AND METHODS

Experiment was conducted during the year 2013 at the farmer's field near Umerkot. Foliar application of different levels of chelated Zinc (Zinc sulphate) was evaluated against chilli variety 'Talhari' in Randomized Complete Block Design with three replications. The net plot size was 3m x 3.5m (10.5 m²). The experimental land was prepared well before the onset of planting season. The land was thoroughly ploughed up by giving 2 dry plowings, the clods were crushed, and leveling was done to eradicate the weeds and to make the soil surface leveled for uniform distribution of irrigation water during soaking dose. Ridges were prepared at the distance of 60 cm and the sub-plots were separated from each other by 45 cm wide bunds. Each block then was sub-divided into three beds. The beds were separated from each other by 30 cm wide bunds. The plots prepared were measured 3.0m x 3.5m (10.5 m²). Irrigation channels were provided to irrigate each bed independently. The sowing of seed for nursery was done on 5th February, 2013 and on attaining the age of one and half month, the nursery/seedlings were transplanted on one side of the ridges on 20th March, 2013. The first irrigation was given after three days of transplanting of seedlings and then at weekly interval. A total of three foliar sprays of zinc were carried out. The first foliar spray of zinc was done

after 45 days of transplanting and remaining two at monthly interval. A uniform dose of 100-90-90 kg ha⁻¹ NPK was also applied in the form of Urea, SSP and MOP, respectively. All P and K along with 1/3rd N were applied at the time of sowing by mixing well in the soil before irrigating the plots for transplanting. The remaining N was applied in two equal splits and first split was applied 21 days after transplanting and remaining N was applied a month later. Each application of fertilizer was immediately followed by irrigation. The crop was kept clean, and a periodical weeds removal practice was carried out to avoid any possible constraint against the experimental process due to uneven irrigation. Thus, all the cultural practices were performed uniformly in all the plots, keeping in view the crop requirement.

Interculturing was followed by earthing and weeding operations were performed when the crop had good stand. Plant protection measures were also kept in operation and three sprayings were done when it was felt that the pest population is crossing economic injury level. Upto the final harvest, the crop was irrigated when felt necessary and three sprayings of insecticides (Dimethoate) were applied against fruit borers. For recording observations on various parameters, five plants in each bed were selected at random and labeled. The data thus recorded were tabulated, and then averages were worked out. Statistical analysis of the data was done to discriminate the superiority of treatment means, using L.S.D (Least Significant Differences) test, as per the statistical methods developed by Gomez and Gomez (1984), using Mstat-C Computer Software all the statistical tests were performed.

RESULTS

Plant height

The chillies plantation receiving foliar application of Zn at the concentration of 5 ml/L water resulted plants of maximum height (85.66cm), closely followed by 81.33 cm and 75.00 cm plant height observed when Zn was foliarly applied at the concentrations of 4 ml/L water and 3 ml/L water, respectively. The results further indicated that reduced Zn concentration of 2 ml/L water or 1ml/L water produced plants of lesser height i.e. 69.00 cm and 66.33 cm, respectively. However, the least plant height of 61.66 cm was recorded in control, where only soil applied NPK fertilizers were applied and foliar application of Zn was

controlled. The above results clearly show that not only there was a significant ($P<0.01$) improvement in plant height with foliar application of Zn, but its increasing concentration resulted in a successive increase in the plant height. However, this increase in plant height was not so pronounced when Zn concentration was used beyond 4 ml/L water, because the differences in plant height under Zn concentrations of 5 and 4 ml/L water were statistically non-significant ($P>0.05$). This showed that 4 ml/L water Zn concentration was sufficient to result optimum plant height in Talhari chillies.

Days to flower emergence

The chillies supplied with foliar application of Zn at the concentration of 5 ml/L water delayed flowering and flower emergence was observed in 56.39 days, followed by flowering emergence in 55.66 and 54.33 days observed in plots supplied with foliar application of Zn at the concentrations of 4 ml/L water and 3 ml/L water, respectively. The lower Zn concentration of 2 ml/L water or 1 ml/L water exposed early flowering i.e. 52.00 and 51.33 days, respectively. However, the flower emergence in minimum number of days (49.66) was noted in control plots, where no foliar application of Zn was applied. This delayed flowering under higher Zn concentrations was mainly associated with better plant growth and due to increasing growth period of the plants the flower emergence was delayed for few days. In case of control plots, the early flower emergence was associated with relatively weaker crop growth and due to reduced growth period, the flowering occurred earlier than those received higher Zn levels.

Plant canopy

The spreading habit in plants is variety dependent, some varieties of the same species having habit to grow tall, while some keep the behaviour to spread. The results concerning to plant spread of chillies variety “Talhari” as influenced by foliar application of Zn are presented in Table-1. The analysis of variance described that the effect of foliar Zn application at different concentrations on plant spread was highly significant ($P<0.01$). The Talhari chillies plant spread was maximum (77 cm) under foliar Zn application concentration of 5 ml/L water, followed by plant spread of 74.33 cm and 68.66 cm recorded in plots given

Zn foliar application at the concentrations of 4 ml/L water and 3 ml/L water, respectively. The minimizing Zn concentration to 2 ml/L water and 1 ml/L water further decreased plant spread to 64.33 cm and 62.33 cm, respectively. However, the minimum plant spread of 60 cm was obtained in control plots, where foliar application of Zn was controlled. The results further indicated that plant spread was increased successively with each increased concentration of Zn, which suggested that the plants foliage essentially needed Zn for its proper growth and with its foliar application at higher concentration, the plants spread increased accordingly.

Number of branches

The chillies crop that supplied with foliar application of Zn at the concentration of 5 ml/L water produced maximum number of branches (13 plant⁻¹), followed by 11.93 and 10.80 branches plant⁻¹ recorded in plots supplied with foliar Zn application at the concentrations of 4 ml/L water and 3 ml/L water, respectively. The lower Zn concentration of 2 ml/L water or 1 ml/L water produced relatively lesser number of branches i.e. 10.06 and 8.60 plant⁻¹, respectively. However, the minimum number of branches (7.93 plant⁻¹) was recorded in control plots, where no foliar application of Zn was applied. It was noted that there was a gradual increase in the number of branches plant⁻¹ with each increased concentration of Zn, which reflected that the plants absorb the readily available Zn and higher concentration obviously had positive impact on sprouting the branches.

Table 1: Effect of different levels of foliar applications of zinc on fruiting bodies

Zn concentrations	Plant height (cm)	Days to flowering	Plant spread (cm)	Number of branches plant ⁻¹
Control	61.66 b	49.66 c	60.00 f	7.93 cd
Zn @ 1 ml/L water	66.33 b	51.33 b	62.33 e	8.60 c
Zn @ 2 ml/L water	69.00 b	52.00 b	64.33 d	10.06 b
Zn @ 3 ml/L water	75.00 ab	54.33 ab	68.66 c	10.80 b
Zn @ 4 ml/L water	81.33 a	55.66 a	74.33 b	11.93 a
Zn @ 5 ml/L water	85.66 a	56.33 a	77.00 a	13.00 a
SE±	0.4165	0.370	0.354	0.276
LSD 0.05	1.750	1.555	1.492	1.162

Values followed by same letters do not differ significantly at 0.05 probability level.

Number of fruits

The foliar application of Zn at the concentration of 5 ml/L water produced maximum number of fruits (481.33 plant⁻¹), followed by 471.66 and 429.00 fruits plant⁻¹ on average recorded in plots given foliar Zn application at the concentrations of 4 ml/L water and 3 ml/L water, respectively. The reduced Zn concentration of 2 ml/L water and 1 ml/L water resulted substantial decrease in the number of fruits i.e. 393.33 and 343 plant⁻¹ respectively. However, the lowest number of fruits (315.33 plant⁻¹) was recorded in control plots, where no foliar Zn application was carried out. The number of fruits plant⁻¹ under increased Zn concentration resulted in improved number of fruits plant⁻¹, which indicated that the plants utilized the foliarly supplied Zn optimally. However, Zn concentration beyond 4 ml/L water did show economical impact on this trait, because the differences in the number of fruits under 5 and 4 ml/L concentration were statistically non-significant.

Fruit size

The results indicated that foliar application of Zn at the concentration of 5 ml/L water resulted significantly longer fruits (5.50 cm) on average, followed by average fruit length of 5.34 cm and 4.84 cm recorded in plots given Zn foliar application at the concentrations of 4 ml/L water and 3 ml/L water, respectively. The minimizing Zn concentration to 2 ml/L water and 1 ml/L water further decreased fruit length to the level of 4.61 cm and 4.35 cm, respectively. However, the minimum fruit length of 4.12 cm was obtained in control plots, where the foliar application of Zn was absent. The results further indicated that fruit length was increased successively with each increased concentration of Zn, which suggested that the plants were essentially in need of these readily available Zn applied as foliar.

Fresh fruit weight

The fresh fruit weight was significantly highest i.e. 705 g plant⁻¹ in plots receiving foliar Zn application at the highest concentration of 5 ml/L water, followed by average fresh fruit weight of 692.33 g plant⁻¹ and 641.33 g plant⁻¹ achieved from the treatments under foliar Zn application at the concentrations of 4 ml/L water and 3 ml/L water, respectively. The reduction in Zn concentration to 2 ml/L or 1 ml/L water further diminished fresh fruit weight to 602 g and 583.33 g plant⁻¹, respectively. However, the minimum fresh fruit weight of

521.66 g plant⁻¹ was obtained in control plots, where the crop was left untreated for Zn. There was a gradual increase in fresh fruit weight plant⁻¹ with increase in Zn concentration, which indicates that the soil under experiment was not adequate in Zn and with its foliar application, the plants readily utilized the Zn and received positive impact on fresh fruit weight plant⁻¹.

Fresh fruit yield

The fresh fruit yield was remarkably maximum (16.350 kg tons ha⁻¹) in plots fertilized with foliar application of Zn at the highest concentration of 5 ml/L water, closely followed by average fresh fruit yield of 16.093 tons ha⁻¹ recorded from the plots received foliar application of Zn at the concentrations of 4 ml/L water. The reduced concentrations of Zn i.e. 3 ml/L or 2 ml/L water further deteriorated the fresh fruit yield to 15.294 and 14.542 tons ha⁻¹, respectively; while the lowest Zn concentration for foliar feeding of 1 ml/L water resulted the average fresh fruit chillies yield of 14.188 tons ha⁻¹. However, the minimum fresh fruit yield of 13.386 tons ha⁻¹ was recorded in control plots, where the crop was not supplied with foliar application of Zn. There was a consecutive increase in fresh fruit yield ha⁻¹ with increase in Zn concentration but such increase in yield was uneconomical when Zn concentration was applied beyond 4 ml/L water, because the differences in yield were non-significant when 4 ml and 5 ml/L water Zn concentrations were compared.

Table-2 Effect of different levels of foliar applications of zinc on fruiting bodies

Zn concentrations	Fruits plant ⁻¹	Fruit length (cm)	Fresh fruit weight (g)	Fresh fruit yield (tons ha ⁻¹)
Control	315.33 de	4.12 e	521.66 e	13.386 d
Zn @ 1 ml/L water	343.00 d	4.35 d	583.33 d	14.188 cd
Zn @ 2 ml/L water	393.33 c	4.61 c	602.00 c	14.542 c
Zn @ 3 ml/L water	429.00 b	4.84 b	641.33 b	15.294 b
Zn @ 4 ml/L water	471.66 a	5.34 ab	692.33 ab	16.093 a
Zn @ 5 ml/L water	486.33 a	5.50 a	705.00 a	16.350 a
SE±	6.193	0.0354	2.655	0.2301
LSD 0.05	26.02	0.1534	11.16	0.5479

Values followed by same letters do not differ significantly at 0.05 probability level.

DISCUSSION

The agricultural soils in the country are inadequate in most of the elements essentially required for plant growth including Zn and due to this deficiency most of the crops are not giving the potential yields. Poorly drained soils may be more deficient in Zn and symptoms of its deficiency differ from one crop species to another being cultivated. Foliar feeding of Zn is although a new technique but it has been in practice commonly in advanced countries of the world in the gardens and vegetables (Anonymous, 2004).

The present study showed that highest Zn concentration of 5 ml/L water resulted 85.66 cm plant height, took 56.33 days to flower emergence, 77 cm plant spread, 13.00 branches plant⁻¹, 481.33 fruits plant⁻¹, fruit length 5.50 cm, fresh fruit yield of 705 g plant⁻¹ and 16.350 tons fruit yield ha⁻¹. Similarly, Zn concentration of 4 ml/L water resulted 81.33 cm plant height, took 55.66 days to flower emergence, 74.33 cm plant spread, 11.93 branches plant⁻¹, 471.66 fruits plant⁻¹, 5.34 cm fruit length, 692.33 g fresh fruit yield plant⁻¹ and 16.093 tons fruit yield ha⁻¹. Similarly, Foliar application of Zn applied at concentration of 3, 2 or 1 ml/L water, resulted in reduced values for all the growth and yield components. These results are further supported as Sharma *et al.* (2000), who applied a combination of macro and micronutrient solution as foliar spray on chillies and found improved growth and fruit yield over straight NPK fertilizers. Moreover, the studies carried out by Radulovic (1996) indicated positive impact of foliar Zn application on chillies, while the studies conducted by Cengiz *et al.* (1999) concluded a significant improvement on the growth of plant and reported improved fruit quality.

The present study further concluded that the fruit yield ha⁻¹ did not increase significantly under 5 ml/L water Zn concentration when compared with 4 ml/L water; which indicates that Zn @ 4 ml/L water was an optimum level for obtaining economical fruit yield in chillies variety Talhari. Similar results have also been reported by Jiudith *et al.* (2005) from England, while from India Maheswari *et al.* (2003), Yadav *et al.* (2003), Bhatt and Srivastava (2006) and Hatwar *et al.* (2006) found good results when Zn was applied as foliar spray on chillies. The studies carried out by Baloch *et al.* (2008), Abu-Sarra *et al.* (2009) indicated that Zn deficiency can be improved by foliar application of Zn sulphate on chillies.

While comparing the results from the present study and findings reported by other workers in different parts of the world, it was found that mostly the soils showed deficiency of Zn, and particularly the soils of Pakistan are severely deficient of this nutrient. So, for obtaining better yield performance in chillies, the farmers must be advised to conduct foliar spray of Zn either in the form of Zn sulphate or any other commercial Zn based product on chillies to keep the chillies plants healthy for high quality chillies production.

Conclusions

It was concluded that with increasing zinc level, the growth and yield contributing traits of chillies variety Talhari were gradually improved. However, the fruit yield ha⁻¹ did not increase significantly under 5 ml/L water Zn concentration when compared with 4 ml/L water; which indicates that Zn @ 4 ml/L water was an optimum level for obtaining economical fruit yield in chillies variety Talhari.

LITERATURE CITED

- Abu-Sarra, A. F, H.S. El Hassan, N.A. Ali, and O.A. Dahab. 2009. Response of tomato to “Elnada Elakhader” foliar fertilizer under Gezira Conditions, Sudan. Sudan Journal of Agricultural Research, 14 (3/4) : 206-210.
- Anonymous. 2004. Chillies Home Page. Global Commercial Services for the Spice Industry. Spizes.Com. Quest International. <http://www.Spizes.com>.
- Anonymous. 2007. Micronutrient fertilizers: Fetrilon Combi, a foliar application for vegetables. <http://www.agnova.com.au/resources/Fetrilon-Combi-guide>.
- Arifeen, M. 2010. Chilli: The most valuable cash crop. The Financial Daily, Saturday 17th April, 2010.
- Baloch, Q.B., Q. D. Chachar and M. N. Tareen. 2008. Effect of foliar application of macro and micro nutrients on production of green chilies *Capsicum annuum* L. Journal of Agricultural Technology 2008, V.4(2):177-184.
- Bhatt, L. and B.K. Srivastava. 2006. Effect of foliar application of micronutrients on the nutritional composition of tomato. Indian Journal of Horticulture, 63 (3) : 312-317.
- Cengiz, K., D. Higgs and A. Burton. 1999. Foliar application of iron as a remedy for zinc toxic tomato plants. Journal of Plant Nutrition, 22 (12) : 1829 – 1837.

- Gomez, K.A. and A. A. Gomez. 1984. Statistics for Agricultural Research (Second Edition). John Willey and Sons, New York.
- Hatwar, G. P., S.U. Gondane, S.M. Urkude and O.V. Gahukar. 2006. Effect of micronutrients on growth and yield of chilli. Journal of Soils and Crops, 11 (5) : 69-73.
- Jiskani, M.M. 2005. Foliar fertilizers fast acting agents. Daily DAWN, the Internet Edition, Monday December 5, 2005.
- Jiudith, C., G. Miguel, M. Ever and L. Cesar. 2005. Effect of heavy metals on the growth of the tropical chilli. Revista de biología tropical, 53 (3/4): 325-330.
- Ken, P. 2004. Forms of micronutrient fertilizer. Sask. Agriculture & Food, Rigas Karamanos (Westco), Agriculture and Agri-Food Canada, Pp. 1-10.
- Maheswari, T. U., K. Haripriya and S. Kamalakannan. 2003. Impact of foliar organic nutrients on nutrient uptake pattern of chilli *Capsicum annuum* L. cv. K2. South Indian Horticulture, 51 (1/6) : 168-172.
- Radulovic, M., 1996. Soil and vegetable nutrients supply in the region of the Zeta Montenegro. Review-of-Research-Work-at-the-Faculty-of-Agriculture,-Belgrade. 41(1): 31-40.
- Sharma, B.R., A.P.S. Chadha and H.K. Bajpai. 2000. Response of chilli *Capsicum annuum* Linn. to nitrogen and phosphorus levels under irrigated condition. Advances in Plant Sciences. 9 (2): 213-214.
- Wikipedia. 2013. Chillies: history, cultivation and processing. Wikipedia, the biggest online students' website, pp. 1-6.
- Yadav, P.V.S., A. Tikkoo and N.K. Sharma. 2003. Effect of zinc and boron application on growth, flowering and fruiting of tomato, *Lycopersicon esculentum* Mill. Haryana Journal of Horticultural Sciences, 13 (6): 107-112.