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INFLUENCE OF FOLIAR APPLICATION OF NANO N, Zn, Cu ON YIELD OF CAPSICUM *(Capsicum annuum L. var. grossum)*

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ABSTRACT

Vegetables are the prime source of vitamins and minerals. As the population increases there is also increase in demand for nutritional vegetables, but in the conventional method of horticulture the production and productivity is considerably less. Thus to increase the productivity and to feed the over burgeoning population there is a need for novel fertilizers such as Nano fertilizers. An experiment was hence conducted in Chinapettai village, Panruti to investigate the Foliar application of Nano nutrients (Nano Nitrogen, Zinc and Copper) on yield of Capsicum. The experiment was carried out in RBD design (Randomized block design) with three replications and thirteen treatments. Results showed that the treatment with 100% RDF (P:K) + 100% Nano N + Nano Zn + Nano Cu followed by 25% RDF -N : RDF (100% P:K) + 75% Nano N + Nano Zn + Nano Cu and 50% RDF -N : RDF (100% P:K) + 50% Nano N + Nano Zn + Nano Cu recorded maximum growth parameters. In contrast 50% RDF -N : 100% RDF (P:K) + 50% Nano N showed increase in yield than the control (100% RDF (-N: -P: -K) (250:150:150kg/ha)) to conclude that Nano nitrogen could have compensated the 50% urea recommendation in conventional fertilizer and also had enhanced effect than control.

Keywords: Nano N, Nano Zn, Nano Cu, foliar spray, capsicum, yield.

INTRODUCTION

Vegetables are economic engines for productive, profitable agriculture economics. Its production provides a promising economic opportunity for reducing rural poverty and unemployment in developing countries and is a key component of farm diversification strategies

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(Schreinemachers *et al*., 2018). India is the second largest producer of vegetables in the world (surpassed only by china). Vegetables are the human race most accessible sources of vitamins and minerals for wholeness. This era trapper the need of vegetable production for economic and nutritional security and to achieve the millennium development goals in a timely fashion.

The genus Capsicum belongs to the family Solanaceae which is grown in several parts of the world and believed to be native of south America (Shoemaker and Teskey,1995). Today, Capsicums are one of the preponderantly used of all natural remedies. Modern Mayan pharmacopoeia divulged that the tissues of capsicum are encompassed in a number of herbal remedies for a variety of malady of probable microbial origin (Cichewicz and Thorpe,1996). Post-operative pain in mastectomy patients and 'phantom limb' pain in amputees are reduced by the use of a cream containing Capsaicin. Itching in dialysis patients and cluster headaches are also reduced by long term use of such creams (Carmichael ,1991).

However, India has many growing concerns. In the Indian economy the horticultural contribution to GDP has steadily declined while achieving enough food production, India still reports for a one fourth of the world's hungry people and home to over million undernourished people. Indian horticulture feels the pain of fatigue of green revolution, the yield in many crops have been stagnated due to over use of fertilizers. Also low nutrient use efficiency due to leaching, declining soil organic matter, multi nutrient deficiencies, shrinking arable land, shortage of labor are results of evacuation of people from farming (Godfray *et al.*,2014)

The nutrient use efficiency of Nitrogen have reminded constant leaving a major amount of fertilizers to pile up in the soil or aquatic system that cause eutrophication, Thus to address these problems, the Nano based nutrients grabs the position which have a characteristic of small size and large surface area to volume ratio ,precisely detect and deliver correct quantity of nutrients required by the crop in suitable proportion that promote productivity and also ensure environmental safety (Carpenter *et a*l.,1998). When minimized to the nanoscale, these nutrients show some characteristics that differ from the presence of the nutrients in the macro scale, allowing unique applications (Naderi and Danesh-Shahraki , 2013). Compared with chemical fertilizers, Nano-fertilizers has larger specific surface area, which makes nutrients more easily absorbed by plants, which significantly improves its fertilizer use efficiency and has significant economic benefits. The application of Nano-fertilizer can improve the physical and chemical properties of soil and improve the ability of water and fertilizer conservation (Yu ZQ ,2014). With the above background, the present study is initiated to know the Foliar application of Nano nutrients (Nano N, Nano Zn & Nano Cu) on yield of capsicum with the following objectives

To study the effect of Nano N, Cu and Zn on crop yield

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MATERIALS AND METHODS

The current studies on **Foliar application of Nano Nutrients on yield of Capsicum** were carried out in a farmer's field at Chinnapettai village in Panruti, Cuddalore district of Tamilnadu during 2019-2020. The details of materials used and the methods adopted during the course of investigation are presented below

Geographical location of the experimental field

The experimental site is geographically situated at 11°.49' North latitude and 76.97° East longitude at an average elevation of 23 meters above mean sea level in the Cuddalore district of Tamilnadu.

Weather and climate

The weather of Panruti is moderately warm with hot Summer. The maximum mean temperature of the location ranges from 20.6°C to 34. 4°C.while the minimum mean temperature ranges from 20°C to 27°C. The average Precipitation is about 1030.35 mm annually, of which 547.14 mm is received during North East monsoon (Oct-Dec), 340.04 mm is received during South West monsoon (June-Sept) and 143 mm is received as summer shower.

EXPERIMENTAL DETAILS

Location	:	Chinnapettai, Panruti.
Number of Treatments	:	13
Number of Replication	:	3
Plot Size	:	4 X 5 m^2
Total number of plants	:	2400 plants
Total number of plants per plot (20 m^2)	:	60 plants
Area	:	19.5 cents
Spacing	:	90X60X60 cm (Paired row system)
Variety	:	Indra

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TREATMENT DETAILS

SYMBOL	TREATMENTS
T_1	100% RDF (N:P:K) (250:150:150kg/ha)
T_2	25% RDF -N : 100% RDF (P:K) + 75% Nano N
T_3	50% RDF -N : 100% RDF (P:K) + 50% Nano N
T_4	75% RDF -N : 100% RDF (P:K) + 25% Nano N
T_5	100% RDF (P:K) + 100% Nano N
T_6	100% RDF (N:P:K) + Nano Zn
T_7	100% RDF (N:P:K) + Nano Cu
T_8	100% RDF (N:P:K) + Nano Zn + Nano Cu
T_9	100% RDF (P:K) + 100% Nano N + Nano Zn
T_{10}	100% RDF (P:K) + 100% Nano N + Nano Cu
T_{11}	100% RDF (P:K) + 100% Nano N + Nano Zn + Nano Cu
T_{12}	25% RDF -N : RDF (100% P:K) + 75% Nano N + Nano Zn + Nano Cu
T_{13}	50% RDF -N : RDF (100% P:K) + 50% Nano N + Nano Zn + Nano Cu

Crop and Variety

Bell pepper var. Indra produced by Sygenta Pvt. Ltd. was used in the study.

Source of Nano Nutrients

The Nano Nutrients such as Nano Nitrogen, Nano Zinc and Nano Copper used in this Study Were Obtained from IFFCO (Indian Farmers Fertiliser Cooperative Limited).

METHODS

Crop management

Preparation of nursery and sowing of seeds

Seeds of Capsicum var. Indra were sown in the protrays (98 cells) at one seed per cell filled with coir pith. The seeded protrays were maintained in a HDPE green 50% shade net. Provision was also made to pull polythene sheet over the pro-trays in the event of rainfall by way of making low tunnel structure made of 3/4" LDPE pipes and 400 gauge UV stabilized polyethylene sheet.

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Preparation of main field and planting

The main field was ploughed three to four times until fine tilth, after the first tilth Farm yard manure (1.5t) were applied. Paired rows were formed and drips was laid out and the spacing adopted was 90 x 60 x 60 cm in paired row system. 100-micron polythene sheets were used for mulching.

Transplanting

Transplanting was done in evening and watered immediately after transplanting. About 35 days old seedlings were used for transplanting. Gap filling was done 10 days after transplanting with existing seedling to maintain the ideal plant population.

Irrigation

Drip irrigation was used for irrigation with a capacity of two litres per hour. Thus each plant received about 310ml per irrigation for 10 minutes. Life irrigation was given three days after transplanting and subsequent irrigation was done for every three days.

Fertilizer Application

The recommended dose of phosphorus and potassium were applied at basal (150:150 kg /ha) as SSP (Single super phosphate) and MOP (Murate of potash) at 1.875 kg and 500 g per plot. Nitrogen was applied in the form of urea as per the treatments as 100 % ,75% and 50 % .500 g of urea was applied as basal dose to all the treatment except treatments (deprived of Nitrogen) and subsequent application of Nitrogen was given at 30^{th}, 60^{th} and 90^{th} day after transplanting to 100% RDN: - treatments. For 75% RDN: - treatments nitrogen was given at 30^{th} and 60^{th} days after transplanting alone and for 50% RDN: - treatments nitrogen was given at 30^{th} days after transplanting alone as top dressing.

Application of Nano Fertilizers

Application of Nano Nutrients such as Nano Nitrogen, Nano Zinc and Nano Copper was done by Foliar application at three stages (Vegetative stage, flowering stage and fruiting stage). The Foliar application of Nano nutrients was given as per the treatments at the rate of 4ml per litre with power sprayer.

Training

The plants were trained by jute ropes tied to the horizontal gauge wire in the top. Training was done at 4 weeks after transplanting.

Harvesting

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Harvesting was done 60 days after transplanting and when fruits show waxy coating and ideal size. Harvesting was done at 10 days' interval. The fruits harvested from tagged plants were used for taking yield parameters.

Yield Parameters

Number of Fruits per plant

The Number of Fruits harvested from randomly tagged five plants till final harvest was summed up and the mean was worked out and expressed in numbers.

Fruit set Percentage

The fruit set was worked out using the following formula and expressed in per cent.

$$\text{Fruit set (\%)} = \frac{\text{Mean number of fruits plant}^{-1}}{\text{Mean number of flowers plant}^{-1}} \times 100$$

Fruit length and Fruit girth

The length of fruit from the stalk end to the tip was measured using a metre scale and the mean expressed in centimetres.

The girth of fruit was measured using a thread and metre scale and the mean expressed in centimetres.

Single Fruit weight

The weight of individual fruit was recorded and the mean expressed in grams.

Estimated yield hectare^{-1}

From the values of cumulative yield per plot, the yield per hectare was estimated and expressed in tonnes hectare^{-1} (t/ha^{-1}).

Ascorbic acid

The ascorbic acid content was estimated by Harris *et al*., (1933) and expressed as Milligram 100 gram $^{-1}$ of fruit.

STATISTICAL ANALYSIS

The data recorded were subjected to statistical analysis as per the method suggested by Panse and Sukhatme (1967). For significant results, the critical difference was worked out at 5 percent probability level by using DOSbox AGDATA software.

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EXPERIMENTAL RESULTS

The data related to percentage fruit set ,dry matter ,number of fruits per plant ,fruit length ,fruit girth and single fruit weight is presented in the Table 1.The highest data was found in T_{11}-100% RDF (P:K) + 100% Nano N + Nano Zn + Nano Cu followed by T_9-100% RDF (P:K) + 100% Nano N + Nano Zn, T_{10}-100% RDF (P:K) + 100% Nano N + Nano Cu, T_{12}-25% RDF -N : RDF (100% P:K) + 75% Nano N + Nano Zn + Nano Cu and T_{13}-50% RDF -N : RDF (100% P:K) + 50% Nano N + Nano Zn + Nano Cu which records on par values. The lowest data was found in T_1-100% RDF(N:P:K)(250:150:150kg/ha).

Table 1: Foliar application Of Nano Nutrients On Dry Matter, Percentage Fruit Set, Number Of Fruits Per Plant , Fruit Physical parameters And Single Fruit Weight Of Capsicum

T.No	Treatments	Dry matter (t/ha)	Percentage fruit set (%)	No.of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Single fruit weight (g)
T_1	100% RDF(N:P:K)(250:150:150kg/ha)	8.8	58.3	4.4	7.6	15.7	121.5
T_2	25% RDF -N : 100% RDF (P:K) + 75% Nano N	11.1	77.5	4.5	9.8	21.0	155.7
T_3	50% RDF -N : 100% RDF (P:K) + 50% Nano N	11.0	77.5	4.3	9.8	20.0	152.4
T_4	75% RDF -N : 100% RDF (P:K) + 25% Nano N	10.7	76.6	4.4	9.7	19.5	144.7
T_5	100% RDF (P:K) + 100% Nano N	11.3	77.9	4.3	9.9	20.5	156.6
T_6	100% RDF (N:P:K) + Nano Zn	9.4	65.5	4.3	9.0	18.0	130.1
T_7	100% RDF (N:P:K) + Nano Cu	9.3	65.3	4.4	9.4	18.8	134.2
T_8	100% RDF (N:P:K) + Nano Zn + Nano Cu	9.8	66.7	4.4	9.1	19.4	139.2
T_9	100% RDF (P:K) + 100% Nano N + Nano Zn	11.4	78.4	4.4	10.1	20.6	157.5
T_{10}	100% RDF (P:K) + 100% Nano N + Nano Cu	11.3	78.6	4.6	9.9	20.8	157.7
T_{11}	100% RDF (P:K) + 100% Nano N + Nano Zn + Nano Cu	11.7	80.4	4.7	10.7	21.6	159.8
T_{12}	25% RDF -N : RDF (100% P:K) + 75% Nano N + Nano Zn + Nano Cu	11.7	79.5	4.6	10.5	21.5	158.7
T_{13}	50% RDF -N : RDF (100% P:K) + 50% Nano N + Nano Zn + Nano Cu	11.5	78.9	4.6	10.4	21.5	158.1
	S.E.M	**1.12E-07**	**0.4**	**0.1**	**0.5**	**0.7**	**0.7**

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	C.D(p=0.05)	**3.37E-07**	**1.3**	**0.3**	**1.4**	**2.0**	**2.2**

Table 2: Effect of yeild and ascorbic acid on capsicum

T.No.	Treatments	Yield ha^{-1}(t)	Ascorbic acid content(mg/100g)
T_1	100% RDF(N:P:K)(250:150:150kg/ha)	16.0	126.8
T_2	25% RDF -N : 100% RDF (P:K) + 75% Nano N	19.0	150.5
T_3	50% RDF -N : 100% RDF (P:K) + 50% Nano N	19.8	148.4
T_4	75% RDF -N : 100% RDF (P:K) + 25% Nano N	19.3	138.8
T_5	100% RDF (P:K) + 100% Nano N	20.4	153.2
T_6	100% RDF (N:P:K) + Nano Zn	17.3	136.1
T_7	100% RDF (N:P:K) + Nano Cu	16.8	138.8
T_8	100% RDF (N:P:K) + Nano Zn + Nano Cu	17.7	142.1
T_9	100% RDF (P:K) + 100% Nano N + Nano Zn	20.6	153.8
T_{10}	100% RDF (P:K) + 100% Nano N + Nano Cu	20.5	154.3
T_{11}	100% RDF (P:K) + 100% Nano N + Nano Zn + Nano Cu	21.2	159.8
T_{12}	25% RDF -N : RDF (100% P:K) + 75% Nano N + Nano Zn + Nano Cu	21.1	159.6
T_{13}	50% RDF -N : RDF (100% P:K) + 50% Nano N + Nano Zn + Nano Cu	20.8	159.5
	S.E.M	**0.4**	**0.6**
	C.D	**1.2**	**1.8**

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OVERALL VIEW OF THE FIELD

PEAK FRUITING STAGE

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Best treatment fruits T_{11}-100% RDF (P:K) + 100% Nano N + Nano Zn + Nano Cu

Estimated yield ha^{-1}

The data pertaining to estimated yield ha $^{-1}$ is presented in the Table 2. The maximum yield ha $^{-1}$ was recorded in T_{11}-100% RDF (P:K) + 100% Nano N + Nano Zn + Nano Cu (21.2t) followed by T_9-100% RDF (P:K) + 100% Nano N + Nano Zn (20.6t), T_{10}-100% RDF (P:K) + 100% Nano N + Nano Cu (20.5t), T_{12}-25% RDF -N : RDF (100% P:K) + 75% Nano N + Nano Zn + Nano Cu (21.1t) and T_{13}-50% RDF -N : RDF (100% P:K) + 50% Nano N + Nano Zn + Nano Cu (20.8t) which records on par values. The minimum yield ha $^{-1}$ was recorded in T_1-100% RDF(N:P:K)(250:150:150kg/ha) (16.0 t).

Ascorbic acid

In reference to the data presented in Table 2 on ascorbic acid, T_{11}-100% RDF (P:K) + 100% Nano N + Nano Zn + Nano Cu (159.8mg/100 g), T_{12}-25% RDF -N : RDF (100% P:K) + 75% Nano N + Nano Zn + Nano Cu (159.6 mg /100g) and T_{13}-50% RDF -N : RDF (100% P:K) + 50% Nano N + Nano Zn + Nano Cu (159.5 mg/100g) recorded highest amount of ascorbic acid followed by T_5 -100% RDF (P:K) + 100% Nano N (153.2 mg/100g), T_9-100% RDF (P:K) + 100% Nano N + Nano Zn (153.8 mg/100g), T_{10}-100% RDF (P:K) + 100% Nano N + Nano Cu (154.3 mg/100g) which recorded on par values .The least recorded ascorbic acid content was found in T_1-100% RDF(N:P:K)(250:150:150kg/ha).

DISCUSIION

The results showed 37.6 % increase in fruit length than control. The result is similar to the finding of *(Davarpanah et al.*,2017) in pomegranate using Nano Nitrogen.

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Among the thirteen treatments maximum fruit Physical parameter is recorded in treatment T_{11}-100% RDF (P:K) + 100% Nano N + Nano Zn + Nano Cu, T_{12}-25% RDF -N : RDF (100% P:K) + 75% Nano N + Nano Zn + Nano Cu and T_{13}-50% RDF -N : RDF (100% P:K) + 50% Nano N + Nano Zn + Nano Cu showed coequality regarding fruit girth followed by T_5 - 100% RDF (P:K) + 100% Nano N, T_9-100% RDF (P:K) + 100% Nano N + Nano Zn, T_{10}-100% RDF (P:K) + 100% Nano N + Nano Cu which also recorded on par values .The minimum fruit girth was recorded in treatment T_1-100% RDF(N:P:K)(250:150:150kg/ha) (15.7cm). Also it is evident that Nitrogen deficiency in leads to growth limitation in all plant organs, including roots, stems, leaves, flowers, and fruits (Barker and Pilbeam, 2007). The result is in close agreement with (Osama *et al.*,2015) in Mango. Improvements in fruit physical parameters after N application may be due to increases in the efficiency of metabolic processes, since N is a constituent of proteins, enzymes, and chlorophyll related to photosynthesis and growth. The developing fruit acts as a strong sink and it is well known that during fruit cell division, high amounts of C and N in the fruitlet tissues are needed for rapid cell division (Cheng *et al.*, 2007; Xia *et al.*, 2009).

The reason for increased fruit weight is increase nitrogen uptake and abortion by the plant which indirectly increase the fruit weight as the Nitrogen plays a chief role in source and sink development and protein synthesis (Sharma *et al.*, 2014).

The yield increase is due to combined effect of Nano Nitrogen, Nano zinc and Nano copper. foliar application of Nano nitrogen increased the absorption capacity and absorbed nitrogen in leaf (source) directly influenced the sink (fruit). Also at certain point the excess Nitrogen cannot ensure a significant increase in crop productivity, yet its abundant application can induce a decrease in crop yield and cause environmental damage thus in T_{11}-100% RDF (P:K) + 100% Nano N + Nano Zn + Nano Cu, T_{12}-25% RDF -N : RDF (100% P:K) + 75% Nano N + Nano Zn + Nano Cu and T_{13}-50% RDF -N : RDF (100% P:K) + 50% Nano N + Nano Zn + Nano Cu treatments recorded on par values

The increase in ascorbic acid might be due to enhanced enzymatic activity of ascorbic acid oxidase, as Cu is also involved in carbohydrate metabolism wherein positive and close relationship with formation of ascorbic acid exists. The pronounced effect of Cu in increasing the ascorbic acid and other quality traits could be attributed to the effect of Cu in promoting the absorption of other nutrients, and Zn to a considerable degree as evidenced by the positive correlation between Cu and these elements.

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