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BIO-EFFICACY OF NANO NUTRIENTS (N, ZN AND CU) ON GROWTH 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 Bio-efficacy of Nano nutrients (Nano Nitrogen, Zinc and Copper) on growth and yield of Capsicum. The experiment was carried out in RBD design (Randomized block design) with three replications and ten treatments. Results showed that the treatment with 100% RD-N+100% RD-P + 100 % RD-K + Nano N + Nano Cu + Nano Zn followed by 100% RD-N +100% RD-P + 100 % RD-K + Nano N and 75% RD-N+100% RD-P + 100 % RD-K + Nano N + Nano Cu + Nano Zn recorded maximum growth parameters. In contrast 50% RD-N + 100% RD-P + 100 % RD-K + Nano N showed increase in growth 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.

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 (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).

Bell pepper is rich in Vitamin A (8493 IU), Vitamin C (283 mg) and minerals like Calcium (13.4 mg), Magnesium (14.9 mg), Phosphorus (28.3 mg) and Potassium (263.7 mg) per100 g^{-1} fresh weight. Capsicum is a cool season crop, but it can be grown round the year using protected structures where temperature and relative humidity (RH) can be manipulated. This crop requires a day temperature of 25-30^{0}C and night temperature of 18-20^{0}C with relative humidity of 50-60%. If temperature exceeds 35^{0}C or falls below 12^{0}C, fruit setting is affected. Bell pepper has attained a status of high value crop in India. Its rich content of ascorbic acid and other vitamins and minerals coupled with pleasant flavor and its delicacy in Indian cuisine attained a pride place among other vegetables. They are also frequently used both chopped and raw in salads, or cooked in stir-fries or other mixed dishes. They can be preserved in the form of a jam or by drying, pickling, or freezing. Dried peppers may be reconstituted whole, or processed into flakes or powders. Pickled or marinated peppers are frequently added to sandwiches or salads. Frozen peppers are used in stews, soups, and salsas. Extracts can be made and incorporated into hot sauces.

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 al*., 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 Bio efficacy of Nano nutrients (Nano N, Nano Zn & Nano Cu) on growth and yield of capsicum with the objectiveTo study the effect of Nano N, Zn and Cu on crop growth

MATERIALS AND METHODS

The current studies on Bio Efficacy of Nano Nutrients on growth 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	:	10
Number of Replication	:	3
Plot Size	:	4 X 5 m²
Total number of plants	:	1500 plants
Total number of plants per plot (20 m²)	:	37 plants
Area	:	18 cents
Spacing	:	90X60X60 cm (Paired row system)
Variety	:	Priyanka 55

TREATMENT DETAILS

SYMBOL	TREATMENTS
T_1	100% RDF(-N:-P:-K)(250:150:150kg/ha)(Control)
T_2	0%N+100% RD-P + 100 % RD-K
T_3	100% RD-N +100% RD-P + 100 % RD-K + Nano N
T_4	75% RD-N +100% RD-P + 100 % RD-K + Nano N
T_5	50% RD-N + 100% RD-P + 100 % RD-K + Nano N
T_6	100% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn
T_7	75% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn
T_8	50% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn
T_9	100% RDF(-N:-P:-K) Nano Zn
T_{10}	100% RDF(-N:-P:-K) + Nano Cu

Crop and Variety

Bell pepper var. Priyanka 55 produced by United Genetics India 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. Priyanka 55 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.

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 T_2 (deprived of Nitrogen) and subsequent application of Nitrogen was given at 30th, 60th and 90th day after transplanting to 100% RDN: - treatments. For 75% RDN: - treatments nitrogen was given at 30th and 60th days after transplanting alone and for 50% RDN: - treatments nitrogen was given at 30th days after transplanting alone at 180 grams (urea) per plot per application 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

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.

OBSERVATIONS

In each treatment, five randomly selected plants were tagged for recording the observations on growth, yield, quality and physiological parameters**.**

Growth Parameter

Plant height

The plant height was measured from the base of the plant at ground level to the tip of main stem on 30th, 60th 90th day after transplanting and expressed in centimetres (cm).

Number of Branches

The number of branches arising from the main branch was recorded on the final harvest of randomly tagged five plants on each treatment plot and expressed in numbers.

Days to 50% Flowering

The days taken from planting to 50% flowering was recorded in each plot and then the mean value was expressed in days.

RESULTS

Field experiment was carried out in farmer field at Chinnapettai, Panruti during 2019-2020, to study the Bio efficacy of Nano nutrients (N, Zn and Cu) on growth of Capsicum. The influence of treatments was studied in terms of morphological and yield components. All the components were recorded in between 30 and 120 days after transplanting and the yield characters were recorded at the time of harvest. The data were statistically analyzed and the details of the experimental results are presented below.

Growth parameters

Plant height

The data featured in table 1 on plant height at 45th, 75th DAT and at final harvest brought in view a significant variation in plant height. Among the treatments, the utmost plant height was recorded in T_6 - 100% RD-N+100% RD-P + 100 % RD-K + Nano N + Nano Cu + Nano Zn (55.95 cm) followed by T_7 -75% RD-N+100% RD-P + 100 % RD-K + Nano N + Nano Cu + Nano Zn (55.71 cm) and T_8 -50% RD-N+100% RD-P + 100 % RD-K + Nano N + Nano Cu + Nano Zn (55.64cm) which recorded on par values at 45th days after transplanting followed by T_3 - 100% RD-N +100% RD-P + 100 % RD-K + Nano N (54.18 cm) , T_4 -75% RD-N +100% RD-P + 100 % RD-K + Nano N (54.04cm) and T_5-50% RD-N +100% RD-P + 100 % RD-K + Nano N (53.99cm) which is also on par . Treatment T_5 - 50% RD-N + 100% RD-P + 100 % RD-K + Nano N and T_8 - 50% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn recorded the plant height of 53.99 cm and 55.64 cm which is greater than T_1 - 100% RDF (-N: -P: -K) 250:150:150kg/ha (46.12cm). The lowest plant height was recorded in T_2 - 0%N+100% RD-P + 100 % RD-K (43cm). The same trend was observed on 75TH DAT and at final harvest.

Number of branches per plant

The data on Number of branches is presented in table 2 revealed that there is a significant variation in Nano nutrients treatment plots compared to the control (RDF). Among the various treatments tested, T_6-100% RD-N+100% RD-P + 100 % RD-K+ Nano N + Nano Cu + Nano Zn (13.59), T_7 -75% RD-N+100% RD-P + 100 % RD-K+ Nano N + Nano Cu + Nano Zn (13.54) and T_8 -50% RD-N+100% RD-P + 100 % RD-K + Nano N + Nano Cu + Nano Zn (13.47) which recorded on par values showed the utmost number of branches followed by T_3 - 100% RD-N +100% RD-P + 100 % RD-K + Nano N (13.28) , T_4 -75% RD-N +100% RD-P +

100 % RD-K + Nano N (13.2) and T_5-50% RD-N +100% RD-P + 100 % RD-K + Nano N(13.14) which is also on par . The lowest number of branches was recorded in T_1 - 100% RDF (-N: -P: -K) 250:150:150kg/ha (11.2) followed by T_2 - 0%N+100% RD-P + 100 % RD-K (10.16)

Table 1: Bio Efficacy of Nano N, Zn and Cu on plant height at 45th day,75th day and at final harvest in Capsicum.

T. No	Treatments	Plant height(cm)		
		45 DAT	65 DAT	At Harvest
T_1	100% RDF(-N:-P:-K)(250:150:150kg/ha)	46.1	60.7	92.0
T_2	0%N+100% RD-P + 100 % RD-K	43.0	56.1	83.0
T_3	100% RD-N +100% RD-P + 100 % RD-K + Nano N	54.1	72.2	109.0
T_4	75% RD-N +100% RD-P + 100 % RD-K + Nano N	54.0	72.0	108.9
T_5	50% RD-N + 100% RD-P + 100 % RD-K + Nano N	53.9	71.7	108.6
T_6	100% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn	55.9	73.1	111.1
T_7	75% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn	55.7	73.0	110.9
T_8	50% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn	55.6	72.9	110.5
T_9	100% RDF(-N:-P:-K) + Nano Zn	50.9	67.5	102.5
T_{10}	100% RDF(-N:-P:-K) + of Nano Cu	51.9	64.1	97.2
	S.ED	**1.3**	**1.3**	**2**
	CD(p=0.05)	**2.7**	**2.8**	**4.1**

Table 2: Bio Efficacy of Nano nutrients (N, Zn and Cu) on Number of branches and Days to 50% Flowering (days) in Capsicum.

T. No	Treatments	No.of branches plant^{-1}	Days to 50% Flowering (days)
T_1	100% RDF(-N:-P:-K)(250:150:150kg/ha)	11.2	46
T_2	0%N+100% RD-P + 100 % RD-K	10.1	50
T_3	100% RD-N +100% RD-P + 100 % RD-K + Nano N	13.2	41.2
T_4	75% RD-N +100% RD-P + 100 % RD-K + Nano N	13.2	43
T_5	50% RD-N + 100% RD-P + 100 % RD-K + Nano N	13.1	44.2
T_6	100% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn	13.5	39
T_7	75% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn	13.5	42
T_8	50% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn	13.4	43.5
T_9	100% RDF(-N:-P:-K) + Nano Zn	12.1	44.8
T_{10}	100% RDF(-N:-P:-K) + of Nano Cu	11.5	46
	S.E.D	**0.2**	**0.9**
	C.D(p=0.05)	**0.5**	**1.9**

Days to 50 percent flowering

The data presented in Table 3 shows a significant difference in days to 50 percent flowering. The early flowering was recorded in T_6-100% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn (39 days), T_7 - 75% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn (42 days) and T_8 -50% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn (43.5 days) which was on par followed by T_3 - 100% RD-N +100% RD-P + 100 % RD-K + Nano N (41.2 days) , T_4 -75% RD-N +100% RD-P + 100 % RD-K + Nano N(43 days) and T_5-50% RD-N +100% RD-P + 100 % RD-K + Nano N (44.6 days)which also recorded on par values .Delayed 50% flowering was recorded in T_2 -0%N+100% RD-P + 100 % RD-K (50 days).

DISCUSSION

Vegetables plays an important role in Indian economy and there is also a growing demand for high value fresh vegetables to feed the corresponding burgeoning population with dwelling nutrition. The main factors which influence production and productivity are nutrient and environmental condition. The conventional fertilizers are bulk composite and are not available for root and have low efficiency and also when excess release of fertilizer may produce toxicity and destroy the ecological balance of soil and the rest is converted into insoluble form of salts. Also due to large particle size and less solubility it has high loss by leaching or run off.

Nanotechnology is a new branch of science, which deals at the nanoscale(atoms). A particle with higher surface area has a greater number of reaction sites than a particle with low surface area thus, results in enhanced chemical reactivity. Nanotechnology use in nanoscale fertilizer particles has offered new techniques in improving existing crop management (Ghafari and Razmjoo, 2013). The Nano nutrients taken for the study are Nano Nitrogen, Nano Zinc and Nano copper. These nutrients enhance the growth and yield parameters when applied as foliar application. The application of foliar shower is a main crop management strategy, which may help in maximizing the crop yield and quality (Haytova, 2013)

The present study on “Bio efficacy of Nano nutrients (Nano N, Nano Zn and Nano Cu) on growth and yield of Capsicum “was studied to find the best treatment for utmost production of Capsicum. The findings described in the preceding chapter have been critically discussed here in detail.

GROWTH PARAMETERS

Growth is a major indicator of fertilizer uptake and adsorption. Among various treatments tested, plants which are treated with 100% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn (T_6), 75% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn (T_7) and 50% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn (T_8) recorded highest and utmost plant height at 45^{th}, 75^{th} DAT and final harvest which registered on par values (55.95,55.71 and 55.64 cm) and increase in height by 20.8 % than T_1 -100% RDF (-N: -P: -K) 250:150:150kg/ha followed by T_3 - 100% RD-N +100% RD-P + 100 % RD-K + Nano N (54.18 cm), T_4 -75% RD-N +100% RD-P + 100 % RD-K + Nano N(54.04cm) and T_5-50% RD-N +100% RD-P + 100 % RD-K + Nano N(53.99cm) which were also on par and also registered an increase in height by 18.4% than T_1-100% RDF (-N: -P: -K) 250:150:150kg/ha. The results of the experiment were also in agreement with findings of (Abdel *et al*., 2019) on red radish.

As indicated by Bahmaniar and SooaeeMashaee (2010) nitrogen positively affects the plant height. The rise might be due to cell growth under nitrogen. Several studies indicated that foliar application of some nanoparticles can significantly improve plant growth (Mandeh *et al*., 2012; Song *et al.*, 2013). Moreover, plant height was more magnified when Nano fertilizer was mixed with the conventional ones, even at a lower application rate (Benzon *et al.*, 2015).Also the combination of other Nano Nitrogen with Nano Zinc might also be a reason for increase in plant height. The findings are similar to (Ramesh Railaya *et al.*, 2015) in tomato.

The physiological mechanisms through which Nano nitrogen in combination with conventional fertilizers and Nano zinc and Nano copper exerts their effects may depend on enzymes for hormone synthesis. Zinc plays an important role in many biochemical functions within plants. Zinc is an essential component of over 300 enzymes (Fox and Guerimot, 1998). Also zinc is involved in synthesis of tryptophan which is a precursor of IAA (indole acetic acid) (Spiegel-Roy and Goldschmidt, 2008). Nitrogen in Nano form results in better absorption and less nutrient loss and more nutrient use efficiency due to small size to large surface area volume also Nitrogen plays chief role in protein and chlorophyll synthesis which result in dark green leaves and promotes leaves stem and vegetative parts of plant (Bloom, 2015). Nano fertilizers are aimed to make nutrients more available to leaves, consequently increasing nutrient use efficiency (Suppan, 2013). Some characteristics of nanoparticles, including the large specific surface area, unique magnetic/optical properties, electronic states, and catalytic reactivity confer nanoparticles a better reactivity than the equivalent bulk materials (Agrawal and Rathore, 2014)

Number of branches plant^{-1} was also influenced by the Nano nutrients. T6 -100% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn, (13.59), T_7 -75% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn (13.54) and T_8-50% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn (13.47) which is also on par showed the utmost number of branches and an increase in number of branches by 21.3 % than T_1- 100% RDF (-N: -P: -K) 250:150:150kg/ha followed by T_3 - 100% RD-N +100% RD-P + 100 % RD-K + Nano N (13.28), T_4 -75% RD-N +100% RD-P + 100 % RD-K + Nano N (13.2) and T_5-50% RD-N +100% RD-P + 100 % RD-K + Nano N(13.14) which is also on par and increase in number of branches by 18.57 % than T_1

The results are in close agreement with the finding of Khospeyak *et al.* (2016) who reported that the plant height, number of lateral branches, number of umbels per plants, number of grains per plant, 1000-grain weight were significantly higher with Nano fertilizer treatment over conventional fertilizers.

As the growth is influenced by Nano nitrogen and zinc there is increase in number of branches per plant. The increase in number of branches per plant with increase in N rate may be due to the fact that nitrogen promoted vegetative growth and branching on the inflorescence. These results agree with those documented by Uddin *et al*. (1992).

Number of days to 50% flowering is an important criterion that governs the earliness of a crop. It is influenced by diverse factors like genetic, environmental, physiological, nutritional, hormonal and cultural. The present study revealed that plant nutrient at timely condition is a pre-requisite for onset of early flowering (Balakrishnan, 1986).

Among the ten treatments, T6 -100% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn (39 days), T_7 -75% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn (42 days) and T_8 -50% RD-N+100% RD-P + 100 % RD-K Nano N + Nano Cu + Nano Zn (43.5 days)which is also on par and increased by 17.94 % than T_1-100% RDF (-N: -P: -K) 250:150:150kg/ha followed by T_3 - 100% RD-N +100% RD-P + 100 % RD-K + Nano N (41.2 days) , T_4 -75% RD-N +100% RD-P + 100 % RD-K + Nano N(43 days) and T_5-50% RD-N +100% RD-P + 100 % RD-K + Nano N (44.6 days)which is also on par has 11.65 % increase than T_1-100% RDF (-N: -P: -K) 250:150:150kgha^{-1}. Delayed 50% flowering was recorded in T_2 -0%N+100% RD-P + 100 % RD-K (50 days). The results are similar with (Laware and Shilpa Raskar, 2014).

Flowering is controlled by four main pathways promoting flowering phase: photoperiodic, vernalization, autonomous, and hormonal (Zeevaart, 2006). Autonomous and hormonal pathways are thought to be independent from environmental factors, but connected with plant development and age (Mouradov *et al.,* 2002; Wang *et al*., 2012). Nano Zinc enhances cation-exchange capacity of the roots, which in turn enhances absorption of essential nutrients, especially nitrogen which is responsible for higher protein content. Nitrogen is the main component of protein, and all types of enzymes are mainly composed of proteins. Nucleic acid, nucleotides, coenzymes, phospholipids, and cytokinins contain nitrogen. Previous studies have also confirmed that many hormones such as gibberellin and cytokinin are closely related to the regulation of flowering (Bernier and Perilleux, 2005).

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