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Effect of Biocapsule and Nano Micronutrients on Growth, Quality and Yield of Lettuce (*Lactuca sativa*)

Panchiri Tharun Teja [a*], V. M. Prasad [a], Vijay Bahadur [a], Samir E. Topno [a] and Suchit A. John [a]

[a] Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University Agriculture Technology and Sciences, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present experiment was carried out during 2021-22 in Central Horticulture Research Farm of Department of Horticulture, SHUATS, Prayagraj. The experiment was conducted in Randomized Block Design with 10 treatment replicated thrice with an objective to find out best treatment for growth, yield, quality and B:C ratio. The treatments were T0 (Control), T1 (NPK (RDF) 15:5:20),T2 (Biocapsule 500ppm (Soil drenching)),T3 (NPK (RDF) 15:5:20 + Biocapsule 500ppm (Soil drenching)),T4 (NPK (RDF) + Foliar application of Zno (12%) and Feo (12%) Nano particles (NPs)),T5 (Biocapsule 500ppm (Soil drenching) + Foliar application of Zno (12%) and Feo(12%) Nano particles (NPs)),T6 (NPK (RDF) 15:5:20 + Biocapsule 500ppm (Soil drenching) + Foliar application of Zno (12%) and Feo (12%) Nano particles (NPs)),T7 (NPK (RDF) 15:5:20 + Biocapsule 250ppm (Soil drenching)),T8 (Biocapsule 250ppm (Soil drenching) + Foliar application of Zno (12%) and Feo (12%) Nano particles (NPs)),T9 (NPK (RDF) 15:5:20 + Biocapsule 250ppm (Soil drenching) + Foliar application of Zno (12%) and Feo (12%) Nano particles (NPs)). From our

**Corresponding author: E-mail: tharunteja88860@gmail.com;*

experiment it was concluded that the treatment T5 (Biocapsule 500ppm (Soil drenching) + Foliar application of ZnO (12%) and FeO (12%) Nano particles (NPs)) was found to be best in the terms of germination percentage, vegetative growth, yield parameters, quality parameters and economics with Benefit Cost ratio 2.67.

Keywords: Biocapsule; zinc; iron; growth; development.

1. INTRODUCTION

Lettuce (*Lactuca sativa*) is an annual plant of the daisy family, Asteraceae. It is most often grown as a leaf vegetable, but sometimes for its stem and seeds. Lettuce is most often used for salads, although it is also seen in other kinds of food, such as soups, sandwiches and wraps; it can also be grilled. One variety, the celtuce (*asparagus lettuce*), is grown for its stems, which are eaten either raw or cooked. In addition to its main use as a leafy green, it has also gathered religious and medicinal significance over centuries of human consumption.

"Lettuce was originally farmed by the ancient Egyptians, who transformed it from a plant whose seeds were used to obtain oil into an important food crop raised for its succulent leaves and oil-rich seeds. In world, lettuce and chicory is cultivated over an area of 1.27 million hectare with the production of 27.25 million tonnes. In India, production of lettuce and chicory is around 1.22 million tonnes over an area of 0.19 million hectare" [1].

"Lettuce is a rich source of vitamin K and vitamin A, and a moderate source of folate and iron. In India, it is gaining popularity with the change in food habit and health increasing consciousness among the people. There is an increasing demand by consumers for safe and nutritious foods that improves the physical performance, reduces the risk of diseases and increases the life span" (Ogden *et al.,* 2007). "The nutritional content varies with the degree of leaf colour, green outer leaves having more nutritional value than whitish inner leaves. The regular intake of lettuce helps in lowering cholesterol level, thereby avoiding cardiovascular diseases. Extracts from *Lactuca virosa* are used sleep inducers and cough suppressants in Europe" (Ryder, 1929).

It is a native of Europe and Asia and introduced in India by the Britishers. Lettuce is an annual and belongs to family composite. The leaves and heads are used as salad. There are about 150 varieties of Lettuce.

Role of Biocapsule: Recently, ICAR (Indian Council of Agricultural Research) scientists have developed the technology to pack bio-fertilizers in tiny capsules. This eliminates the need for farmers to carry the sacks of biofertilizers. It consists of a carrier medium rich in live microorganisms. When applied to seed, soil or living plants, it increases soil nutrients or makes them biologically available.

Role of ZnO: Zinc oxide nanoparticles (ZnO-NPs) are considered a 'biosafe material' for stimulation of seed germination and plant growth as well as disease suppression and plant protection by virtue of their antimicrobial activity. Uptake, translocation and accumulation of ZnO-NPs by plants depend upon the distinct features of the NPs as well as on the physiology of the host plant. Zinc plays an important role in the formation of chlorophyll and some carbohydrates, conversion of starch to sugars and it presence in plant tissue helps the plant to withstand cold temperatures.

Role of FeO: Iron is an essential micronutrient for almost all living organisms because of it plays critical role in metabolic processes such as DNA synthesis, respiration, and photosynthesis. In plants, iron is involved in the synthesis of chlorophyll, and it is essential for the maintenance of chloroplast structure and function.

2. MATERIALS AND METHODS

The present investigation was conducted at the central research farm of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj during 2022.

2.1 Climatic Condition

The area of Prayagraj district comes under subtropical belt in the south east of Utter Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46^{o} C-

48^{o} C and seldom falls as low as 4^{o}C- 5^{o}C. The relative humidity ranges between 20 to 94 %. The average rainfall in this area is around 1013.4 mm annually. However, occasional precipitation is also not uncommon during winter months.

The experiment was conducted in Randomized Block Design with 10 treatment replicated thrice. The treatments were **T_0** (Control), **T_1** (NPK (RDF) 15:5:20),T_2 (Biocapsule 500ppm (Soil drenching)), **T_3** (NPK (RDF) 15:5:20 + Biocapsule 500ppm (Soil drenching)),**T_4** (NPK (RDF) + Foliar application of Zno (12%) and Feo (12%) Nano particles (NPs)), **T_5** (Biocapsule 500ppm (Soil drenching) + Foliar application of Zno (12%) and Feo(12%) Nano particles (NPs)), **T_6** (NPK (RDF) 15:5:20 + Biocapsule 500ppm (Soil drenching) + Foliar application of Zno (12%) and Feo (12%) Nano particles (NPs)), **T_7** (NPK (RDF) 15:5:20 + Biocapsule 250ppm (Soil drenching)), **T_8** (Biocapsule 250ppm (Soil drenching) + Foliar application of Zno (12%) and Feo (12%) Nano particles (NPs)), **T_9** (NPK (RDF) 15:5:20 + Biocapsule 250ppm (Soil drenching) + Foliar application of Zno (12%)and Feo (12%) Nano particles (NPs)).

3. RESULTS AND DISCUSSION

The maximum plant height was observed in the Treatment T_5 with (20.92) cm followed by T_8 with (20.82) cm and the minimum was observed in the T_0 with (18.85) cm. The application of treatment might have improved the soil physical and chemical properties and leading to the adequate supply of nutrients to the plants which might have promoted the maximum vegetative growth. Similar findings were reported by Sivaiah et al. [2]; Meena et al. [3]; Kumar et al. [4] in tomato.

The maximum number of leaves was observed in the Treatment T_5 with 9.79 followed by T_8 with 9.64 and the minimum was observed in the T_0 with 6.59. The application of treatment might have improved the soil physical and chemical properties and leading to the adequate supply of nutrients to the plants which might have promoted the maximum vegetative growth. Similar findings were reported by Singh et al. (2018) and Swetha et al. [5] in tomato.

The maximum length of leaves was observed in the Treatment T_5 with (18.39) cm followed by T_8 with (18.23) cm and the minimum was observed in the T_0 with (15.36) cm. Combination of biocapsule and application of nanozeolite also recorded maximum vegetative growth which helped the plants in better photosynthesis to attain vigor. The findings of the present investigation are in conformity with the reports of Sivaiah et al. [2]; Meena et al. [3]; Kumar et al. [4] as reported in spinach.

The plant spread was observed in the Treatment T_5 with (16.30) cm followed by T_8 with (16.06)cm and the minimum was observed in the T_0 with (13.35) cm. Combination of biocapsule and application of nanozeolite also recorded maximum vegetative growth which helped the plants in better photosynthesis to attain vigor. The findings of the present investigation are in conformity with the reports of Sivaiah et al. [2]; Meena et al. [3]; Kumar et al. [4] as reported in spinach.

The maximum width of leaf was observed in the Treatment T_5 with (7.35) cm followed by T_8 with (6.67) cm and the minimum was observed in the T_0 with (5.02) cm. Combination of biocapsule and application of nanozeolite also recorded maximum vegetative growth which helped the plants in better photosynthesis to attain vigor. The findings of the present investigation are in conformity with the reports of Sivaiah et al. [2]; Meena et al. [3]; Kumar et al. [4] as reported in spinach.

The maximum leaf area was observed in the Treatment T_5 with (126.34) cm^2 followed by T_8 with (125.36) cm^2 and the minimum was observed in the T_0 with (75.26) cm^2. Combination of biocapsule and application of nanozeolite also recorded maximum vegetative growth which helped the plants in better photosynthesis to attain vigor. The findings of the present investigation are in conformity with the reports of Sivaiah et al. [2]; Meena et al. [3]; Kumar et al. [4] as reported in spinach.

The maximum Average Fresh Weight (g) was observed in the Treatment T_5 with (119.69) g followed by T_8 with (117.49) g and the minimum was observed in the T_0 with (90.26) g. Biocapsule and nanozeolite play an important role in improving productivity and quality of lettuce. Combination of both the manures and other essential nutrients increased the vigor of plants, assimilating area, size of, thereby resulting into higher weight. These results are in close conformity with the findings of Ali et al. [6]; Haleema et al. [7]; Satyamurthy et al. [8]; Pandiyan et al. [9].

The maximum Yield/plot was observed in the Treatment T_5 with (8.65) kg followed by T_8 with (8.02) kg and the minimum was observed in the T_0 with (6.92) kg. Biocapsule and nanozeolite play an important role in improving productivity and quality of lettuce. Combination of both the manures and other essential nutrients increased the vigor of plants, assimilating area, size of, thereby resulting into higher weight. These results are in close conformity with the findings of Ali et al. [6]; Haleema et al. [7]; Satyamurthy et al. [8]; Pandiyan et al. [9].

The maximum yield per hectare was observed in the Treatment T_5 with (23.84) t/ha followed by T_8 with (23.05) t/ha and the minimum was observed in the T_0 with (17.56) t/ha. Biocapsule and nanozeolite play an important role in improving productivity and quality of lettuce. Combination of both the manures and other essential nutrients increased the vigor of plants, assimilating area, size of, thereby resulting into higher weight. These results are in close conformity with the findings of Ali et al. [6]; Haleema et al. [7]; Satyamurthy et al. [8]; Pandiyan et al. [9].

The maximum dry matter was observed in the Treatment T_5 with (10.56) % followed by T_8 with (10.56)% and the minimum was observed in the T_0 with (7.59)%. Biocapsule and nanozeolite play an important role in improving productivity and quality of lettuce. Combination of both the manures and other essential nutrients increased the vigor of plants, assimilating area, size of, thereby resulting into higher weight. These results are in close conformity with the findings of Ali et al. [6]; Haleema et al. [7]; Satyamurthy et al. [8]; Pandiyan et al. [9].

The maximum ascorbic acid was observed in the Treatment T_5 with (14.89) mg/100 g followed by T_8 with (14.12) mg/100 g and the minimum was observed in the T_0 with (10.35) mg/100 g. Maximum Vitamin-c content might be due to increased availability of major as well as minor nutrients specially nitrogen and potassium, because they play vital role in enhancing the quality. Similar findings were also reported by Singh et al. (2018); Swetha et al. [5] and Shnain et al. (2021) in field grown spinach.

The maximum chlorophyll content was observed in the Treatment T_5 with (28.62) followed by T_8 with (28.19) and the minimum was observed in the T_0 with (26.35).

The maximum TSS was observed in the Treatment T_5 with (4.68) ^{0}B followed by T_8 with (4.60) ^{0}B and the minimum was observed in the T_0 with (3.32) ^{0}B. Maximum TSS content might be due to increased availability of major as well as minor nutrients specially nitrogen and potassium, because they play vital role in enhancing the quality. The minimum TSS in T_0 (Control) might be to lack of availability of nutrients. Similar findings were also reported by Singh et al. (2018); Swetha et al. [5] and Shnain et al. (2021) in field grown spinach.

The maximum score for Color and appearance was observed in the Treatment T_5 with (140.65) followed by T_8 with (135.62) and the minimum was observed in the T_0 with (115.62).

The maximum score for flavor was observed in the Treatment T_5 with (8.61)g followed by T_8 with (7.92) and the minimum was observed in the T_0 with (6.13).

The maximum score for taste was observed in the Treatment T_5 with (8.59) followed by T_8 with (8.48) and the minimum was observed in the T_0 with (6.45).

The maximum score for texture was observed in the Treatment T_5 with (8.49) followed by T_8 with (8.37) and the minimum was observed in the T_0 with (6.55).

The maximum score for overall acceptability was observed in the Treatment T_5 with (8.70) followed by T_8 with (8.49) and the minimum was observed in the T_0 with (6.58).

In case of organoleptic evaluation score for Color, Flavor, Taste, Texture and overall acceptability was calculated by taking the mean of evaluation members and the score what they have given on Hedonic scale. Hedonic Scale is a scale that indicates the extent of respondents' overall liking or disliking for something [10-12].

Table 1. Effect of Biocapsule and Nano micro nutrients plant height, no. of leaves, length of leaves and width of leaves of lettuce

Treatment	Plant Height (cm)			No. of leaves			Length of leaves (cm)			Width of leaves (cm)		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
T_0	4.65	14.95	18.85	1.59	3.26	6.59	7.89	12.35	15.36	2.09	3.15	5.02
T_1	5.52	15.26	19.36	2.09	3.86	7.32	8.05	13.56	16.57	2.38	3.67	5.24
T_2	5.89	15.76	19.86	2.53	3.98	7.59	8.28	13.79	16.78	2.46	3.75	5.64
T_3	6.25	15.88	19.78	2.49	4.12	8.23	8.89	14.02	17.09	2.76	3.86	5.89
T_4	6.34	15.65	19.66	2.54	4.38	8.65	9.46	14.34	17.36	2.53	3.98	6.88
T_5	6.89	16.87	20.92	2.89	4.68	9.79	10.35	15.36	18.39	2.95	4.35	7.35
T_6	6.56	16.52	20.48	2.12	4.49	9.35	9.32	13.82	16.83	2.65	4.1	6.98
T_7	6.66	16.62	20.63	2.29	4.09	9.34	8.65	14.56	17.58	2.71	4.08	7.09
T_8	6.72	16.72	20.82	2.76	4.56	9.64	9.75	15.19	18.23	2.9	4.12	7.16
T_9	6.68	16.67	20.65	2.38	4.37	8.92	9.05	15.02	17.92	2.88	4.09	6.66
F Test	S	S	S	S	S	S	S	S	S	S	S	S
C.D.$_{@5\%}$	0.86	1.265	1.568	0.562	0.628	0.759	0.86	0.85	1.02	0.39	0.49	0.56
S.E.d	0.412	0.561	0.726	0.247	0.324	0.351	0.412	0.413	0.514	0.153	0.215	0.251

Table 2. Effect of Biocapsule and Nano micro nutrients leaf area, leaf area index, average fresh weight, yield/plot, yield/ha, dry matter content, ascorbic acid and chlorophyll content of lettuce

Treatment	Leaf area cm^2			Leaf area index			Average fresh weight (g)	Yield per plot (kg)	Yield per hectare (kg)	Dry matter content %	Ascorbic acid (mg/100g)	Chlorophyll content (kg)
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS						
T_0	14.72	36.26	75.26	1.02	1.85	3.08	90.26	6.92	6.92	7.59	10.35	26.35
T_1	16.15	39.35	80.32	1.31	1.92	3.45	112.64	7.12	7.12	8.09	11.95	26.56
T_2	16.46	39.56	80.56	1.26	2.03	3.52	111.89	7.35	7.35	8.37	13.64	26.78
T_3	16.58	42.05	84.36	1.38	2.12	3.78	109.56	7.05	7.05	8.19	12.82	26.91
T_4	18.35	42.35	102.35	1.51	2.35	3.64	112.38	7.89	7.89	8.65	12.65	27.62
T_5	20.89	60.35	126.34	1.72	2.86	3.95	119.69	8.65	8.65	10.56	14.89	28.62
T_6	18.65	52.65	96.59	1.46	2.45	3.8	115.68	7.38	7.38	9.46	13.08	27.59
T_7	16.71	56.95	119.26	1.55	2.64	3.71	114.82	7.52	7.52	9.64	13.28	28.05
T_8	19.24	59.32	125.36	1.68	2.78	3.83	117.49	8.02	8.02	10.51	14.12	28.19
T_9	18.32	58.62	103.75	1.6	2.71	3.76	115.37	7.65	7.65	9.85	13.76	28.1
F Test	S	S	S	S	S	S	S	S	S	S	S	S
C.D.$_{@5\%}$	1.851	4.235	8.659	0.59	0.62	0.82	3.68	1.235	1.235	0.65	1.12	2.91
S.E.d	0.921	2.231	4.319	0.312	0.312	0.0415	1.862	0.623	0.623	0.31	0.62	1.43

Table 3. Effect of Biocapsule and Nano micro nutrients Total soluble solid, fresh weight, organoleptic evaluation (Color, Flavor, Taste, Texture, and Acceptance) and B:C ratio of lettuce

Treatment	Total soluble solid ^{0}B	Organoleptic evaluation					B:C Ratio
		Color	Flavor	Taste	Texture	Acceptance	
T_0	3.32	6.57	6.13	6.45	6.55	6.58	1.97
T_1	3.98	7.95	7.18	8.17	7.9	8.33	2.20
T_2	4.25	6.89	6.59	7.09	7.35	7.59	2.33
T_3	4.35	7.26	6.79	7.19	7.26	7.43	2.28
T_4	4.42	7.62	7.09	7.4	7.64	7.7	2.42
T_5	4.68	8.95	8.61	8.59	8.49	8.7	2.67
T_6	4.51	7.64	7.38	7.19	7.91	7.82	2.48
T_7	4.59	7.08	6.6	6.85	7.09	6.83	2.55
T_8	4.6	8.43	7.92	8.48	8.37	8.49	2.58
T_9	4.55	7.6	7.17	7.57	7.44	7.63	2.39
F Test	S	S	S	S	S	S	
C.D.$_{@5\%}$	0.94	1.01	0.989	0.89	0.866	0.177	
S.E.d	0.437	2.188	2.141	1.927	1.875	0.383	

4. CONCLUSION

From our experiment it was concluded that the treatment T_5 (Biocapsule 500ppm (Soil drenching) + Foliar application of ZnO (12%) and FeO (12%) Nano particles (NPs)) was found to be best in the terms of germination percentage, vegetative growth, yield parameters, quality parameters and economics with B:C ratio 2.67.

So, we can say that the Bicapsules and nano-fertilizers are the future of the agriculture and they can bring tremendous change and revolution in agriculture by increasing the production without deterioration the fertility of the soil and ultimately increasing the income of the farmers. These organic fertilizers are key to sustainable development for an economy.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAOSTAT. www.fao.org/faostat/en/data/CC. Food Supply- Crops Primary Equivalent.Visited on 15/12/2021; 2018.
2. Sivaiah NK, Swain SK, Sandeep VV, Raju B. Effect of foliar application of micronutrients on growth parameters in tomato (*Lycopersicon esculentum* Mill.). Discourse Journal of Agriculture and Food Sciences. 2013;1(10):146-151.
3. Meena EC, Maji SJ, Meena K, Govind R, Kumawat KR, Meena SK, Sodh K. Improvement of growth, yield and quality of tomato (*Solanum lycopersicum* L.) cv. azad T-6 with foliar application of zinc and boron. International Journal of Bio-resource and Stress Management. 2015;6(5):598-601.
4. Kumar NS, Ahirwar K, Khare AK, Mishra US, Singh D, Jatav R. Effect of micronutrients and bio-fertilizers on yield and yield attributes of tomato. International Journal of Agriculture Sciences. 2016;8(38):1780-1782.
5. Swetha K, Saravanan S, Lalu NB. Effect of micronutrients on fruit quality, shelf life and economics of tomato (*Solanum lycopersicum* L.) cv. pkm-1. Journal of Pharmacognosy and Phytochemistry. 2018;7(5):3018-3020.
6. Ali MR, Mehraj H, Jamal Uddin AFM. Effects of foliar application of zinc and boron on growth and yield of summer tomato. Journal of Biological and Agricultural Research. 2015;06(01): 512-517.
7. Haleema B, Abdur R, Hussain AS. Effect of calcium, boron and zinc foliar application on growth and fruit production of tomato. Sarhad Journal of Agriculture. 2017;30(1):19-30.
8. Sathyamurthy VA, Shanmugasundaram T., Rajasree V, Arumugam T. Effect of foliar application of micronutrients on growth, yield and economics of tomato (*Lycopersicon esculentum* Mill.). Madras Agricultural Journal. 2017;104(4-6): 188-193.
9. Pandiyan R, Sathyamurthy VA. Pugalenthi L. Effect of foliar application of Micronutrients on Growth, and Quality of Tomato.International Journal of Trend in Scientific Research and Development. 2018;2(4):1988-1992.
10. Anonymous. Horticultural statistics at a glance, horticulture statistics division department of agriculture, cooperation & farmers welfare ministry of agriculture & farmers welfare government of India; 2015.
11. Kumar NM, Ajay KP, Amin MB. Growth and yield of solanaceous vegetables in response to application of micronutrients – A review. International Journal of Innovative Science, Engineering & Technology. 2017;3(2):611-626.
12. Reddy GPD, Reddy PSR, Chandramohan GR, Thanuja SG. Effect of foliar application of micronutrients on growth and yield parameters in tomato (*Solanum lycopersicon* L.). International Journal Pure Applied Bio-sciences. 2018;6(2):929-934.

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