International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(8): 147-150
www.biochemjournal.com
Received: 11-05-2024
Accepted: 19-06-2024

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Effect of foliar application of nano urea, boron and zinc sulphate on growth fruit yield and quality of cape gooseberry (*Physalis peruviana* L.)

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DOI: https://doi.org/10.33545/26174693.2024.v8.i8Sc.1742

Abstract
The experiment was carried out at Research Field of Horticulture Research Farm, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) India, during October 2023-2024 to investigate the Effect of foliar application of nano urea, boron and zinc sulphate on growth fruit yield and quality of Cape gooseberry." twelve treatments *combination and* replicated thrice in a Randomized Block Design. In Cape gooseberry use the application of nano urea, Boron and Zinc hasten early flowering along with the expanded duration of blossoming, harvesting by increasing the growth, yield and quality of Gooseberry. The results revealed nutrient management maximized plant height (cm), number of leaves per plant, leaf area (cm^2), number of fruit per plant, fruit weight (g), fruit radial diameter (cm), fruit polardiameter (cm), fruit yield/ha (q), total soluble solids, ascorbic acid (mg/100g). From the above experimental finding it may concluded that, the production of cape gooseberry by the nano urea, boron and Zinc application of T_9 (Nano urea 2.0% + zinc sulphate 0.6% + boron 0.6%) was found to best in terms of growth, yield and quality. In the investigation improves vegetative growth of flowering and improve yield by the help of nano urea and micro nutrients such. The highest net return was also found in the T_9 and highest B:C ratio was found in the same with 2.54.

Keywords: Cape goose berry, nano urea and boron, zinc phosphate

1. Introduction

Cape gooseberry (*Physalis peruviana* L.), belongs to the family Solanaceae, is an important annual fruit crop. It is the rich source of vitamin. A (36 IU/100g), vit. C (11 mg/100 g), Vit. B1, B2, B3, P (40 mg/100 g), Ca and Fe. Besides, antioxidants, it contains phenols, flavonoids, which also exhibit a high degree of antioxidant capacity against free radical. Due to annual nature of the crop, it gives return in shortest possible time and has great demand in fresh market as well as in processing industries to prepare sauces, puddings, pies, jams, chutneys, ice cream etc.

The climatic condition of Prayagraj is suitable growing cape gooseberry. However, the yield of the crop in this condition is still under rated (only 400-500 g plant-1 as compared to 700-900 g plant-1 in leading Cape gooseberry producing countries). Due to shallow root system, production of large number of berries per unit area as well as increasing sensitivity of the crop to nutritional imbalance, cape gooseberry needs extensive use of mineral fertilizers. Due to shallow root system as well as higher productivity of the crop, it is highly responsive to nitrogenous fertilizers.

The application of nitrogenous fertilizer in cape gooseberry was reported to have positive impact on vegetative growth promotion. Although the nutritional status of cape gooseberry plant plays a fundamental role in determining growth, yield and quality, but inorganic form of fertilizers is short in supply and very expensive too which ultimately rises the cost of production of the crop. In addition, even though inorganic forms of fertilizers have direct impact to increase yield of the crop but simultaneously their excessive as well as imbalance application may leads to health hazards, ecological vulnerabilities and diminution of physio-chemical characteristics of soil water too. Further, production of these chemical fertilizers is an energy intensive process requiring energy resources. In addition, importing fertilizers increases burden on foreign exchange reserves in a substantial way.

Therefore, there is an urgent necessity to think about the use of alternative source of nutrients which may boost the crop yields and quality without having any antagonistic effect on soil health and environmental hazards and also to reduce cost of cultivation. Biofertilizers are known to be environment friendly and has the potentiality to reduce the cost of production of different agricultural crops with maximum possible returns. Further, biofertilizers are worked as carriers based on their formulation comprising beneficial microbes in viable condition, intended for soil or seed application. These beneficial micro- organisms present in biofertilizers play a great role for improving the fertility status of the soil and also improve the growth and development of the plant by colonizing in root rhizosphere and stimulating the biological activity of other desired microorganisms (Kumar *et al*. 2019) [7]. Hence, the promising way to reduce the threat of accumulation of chemical source of fertilizers in the soil is to combine chemical fertilizers with biofertilizers.

2. Materials and Methods

2.1 Geographical location of the experimental site

The experimental site is located at a latitude of 25^{0}41' North and longitude of 81^{0}84 'East, with an altitudeof98meters above the mean sea level (MSL).

2.2 Climatic conditions of the experimental area

The area of Prayagraj comes under humid sub-tropical climate, which experiences warm humid monsoon, hot dry summer and cold dry winter. The annual mean temperature is 26.1 ºC while monthly mean temperatures are 18-29 ºC. The daily average maximum temperature is about 22 ºC and the minimum temperature is 9 ºC. The average annual rainfall received is 1042.2 mm. At this location, the temperature reaches upto 46 ºC-48 ºC and the minimum temperature recorded is 4 ºC-5 ºC. The relative humidity ranges in this location ranges between 20-94%.

2.3 Experimental details

Table 1: Treatment Combinations

Treatment	Description
T_0	Control (N:P:K 0.8%: 0.2%: 0.2%
T_1	Nano urea 1.0% + zinc sulphate 0.2% + boron 0.2%
T_2	Nano urea 1.0% + zinc sulphate 0.4% + boron 0.4%
T_3	Nano urea 1.0% + zinc sulphate 0.6% + boron 0.6%
T_4	Nano urea 1.5% + zinc sulphate 0.2% + boron 0.2%
T_5	Nano urea 1.5% + zinc sulphate 0.4% + boron 0.4%
T_6	Nano urea 1.5% + zinc sulphate 0.6% + boron 0.6%
T_7	Nano urea 2.0% + zinc sulphate 0.2% + boron 0.2%
T_8	Nano urea 2.0% + zinc sulphate 0.4% + boron 0.4%
T_9	Nano urea 2.0% + zinc sulphate 0.6% + boron 0.6%

3. Results and Discussion

3.1 Vegetative Growth, Flowering parameter and Fruit Parameter

The data revealed that different treatments of application of nano urea, Boron and Zinc the on different parameter such maximum plant height (111.40 cm), leaf area (163.70 cm^2), Number of leaves per branch (15.51), minimum days to first flowering (66.42), minimum days to 50% flowering (74.75), fruit weight(g) 7.23 (g) and number of fruit found in treatment T_9 i.e. 57.05 respectively, while the minimum plant height (81.74 cm), leaf area (123.37 cm^2), Number of leaves (10.05), maximum days to first flowering (83.42), maximum days to 50% flowering (95.42), fruit weight(g) 5.33 (g) and number of fruit found in treatment 40.92 Control (T_0) respectively.

The increased plant height of cape gooseberry may be due to the increased nitrogen fixation, organic nitrogen utilization, development of root system (Sharma *et al.*, 2019) [16]. Due to application of inorganic fertilizers increased the available NPK status & microbial biomass & dehydrogenase activity &hence they help in increasing plant height (Sandhu and Gill 2011) [12]. Similar results were also reported in cape gooseberry. Prakash *et al.* (2018) [11] also noticed that increment in plant height may be due to role of bio-fertilizers in increasing nutrients uptake especially nitrogen which has role in the assimilation of amino acids.

Higher number of leaves & leaf area might be due to higher cell division caused by cytokinins & also due to higher supply of assimilate mediated by biofertilizers application. Increased number of leaves might have increased the photosynthetic activity resulting in higher accumulation of carbohydrates. Relatively higher amount of carbohydrate could have promoted the growth rate & in turn increased the berry weight. The findings are in close agreement with the findings of Prakash *et al.* (2018) [11] in cape gooseberry.

The maximum leaf area was found at Nano urea 2.0% + zinc sulphate 0.6% + boron 0.6%, whereas the minimum leaf area was recorded under at control. These findings are in agreement with result of Sandhu and Gill (2011) [12]. The increase in leaf area is due to absorption of growth promoting substances produced by treatment combination in the root zone of the crop.

The minimum number of days to first flowering and days to 50% flowering were recorded in the plants which were treated with Nano urea 2.0% + zinc sulphate 0.6% + boron 0.6%. This phenomenon may be on account of prolonged growth of plant in the presence of nano urea and micro nutrients. These results corroborate the findings of Shankar *et al.*, (2018) and Singh *et al.* (2012) [18, 19].

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Further, it was also observed that the maximum number of fruits per plant was recorded with Nano urea 2.0% + zinc sulphate 0.6% + boron 0.6%, whereas the minimum number of fruits per plant was observed with 50% NPK. It may possibly be due to fact that INM application accelerated the development of fruits which are positively correlated with the number of fruits in the following spring. Increased number of fruits might have also resulted because of increase in number of flowers per plant. Similar observations were also reported by Shankar *et al.* (2018) [18] in cape gooseberry.

Table 2: Effect of foliar application of nano urea, boron and zinc sulphate on Plant height(cm), Number of leaves per branch, Days to first flowering and Days to 50% flowering, leaf area (cm^2) and fruit parameter of Cape gooseberry.

Treatment	Plant height (cm)	No. of leaves/plant	Leaf area (cm^2)	Days to first flowering (days)	Days to 50% flowering (days)	No. of fruit/plant	Avg. wt of fruit (gm)
T_0	81.74	10.05	123.37	83.42	95.42	40.92	5.33
T_1	83.9	11.3	131.7	80.75	89.08	44.05	5.96
T_2	90.57	12.28	136.7	71.75	83.75	44.14	6.06
T_3	98.9	13.27	142.37	68.08	89.08	45.07	6.39
T_4	101.24	13.6	143.7	79.75	87.75	47.14	6.69
T_5	102.07	13.99	150.37	68.08	77.75	49.01	6.96
T_6	102.74	14.9	153.04	66.75	75.42	53.88	7.06
T_7	103.74	15.05	158.37	64.75	70.42	54.6	7.23
T_8	108.07	15.14	160.52	62.75	70.08	55.88	7.46
T_9	111.4	15.51	163.7	60.42	69.75	57.05	7.56
F Test	S	S	S	S	S	S	S
S.ED	3.13	0.57	4.17	2.52	2.98	1.82	0.23
C.D. 5%	1.56	0.29	2.09	1.26	1.49	0.91	0.11
CV	10.35	13.43	9.01	11.27	11.63	12.18	10.8

3.2 Fruit parameter, yield parameter and Quality Parameter

The data revealed that different treatments of application of nano urea and micro nutrients the on different parameter such, Maximum and minimum polar diameter of the treatments (2.70 cm) and minimum (1.84 cm), radial diameter 2.67 cm and 2.08 cm, fruit yield per hectare 190.58 q/ha, 133.46 q /ha, Total Soluble Salts found in treatment T_8 11.21 ^{0}B and 8.88 ^{0}B, ascorbic acid. 41.54 mg/100 g and 30.21 mg/100 g, Acidity (%), 0.295 and 0.103 respectively.

Wange *et al.* (1998) [20] in cape gooseberry, Kadlag *et al.* (2007) in tomato and Tripathi *et al.* (2010) [21] in cape gooseberry, who recorded higher yield with *Azotobacter* application. The increase in yield might be due to increased fruit set per plant, fruit length and fruit width as well as fruit weight influenced by nitrogen fixers.

The increase in TSS content with combined use with nano urea, Zinc and Boron might be due to accumulation of sugars and other soluble components from hydrolysis of protein and oxidation of ascorbic acid. This finding corroborates with the findings of Kaur and Kaur (2009) [22].

The reduction in titratable acidity may be attributed to conversion of organic acids and photosynthesis into sugar during fruit ripening by applying nano urea and Boron. The reduction in titratable acidity may also be due to utilization of acids as a substrate for respiration during the ripening and neutralization of organic acids due to potassium in tissues. These findings are in close conformity with the results of Prakash *et al.*, (2018) [11], Patidar *et al.* (2018) [10] in cape gooseberry.

The respective increase in ascorbic acid content might be due to the increased efficiency of microbial inoculants to fix atmospheric nitrogen, increase in availability of phosphorous and secretion of growth promoting substances, which accelerates the physiological process like carbohydrates synthesis. Singh *et al*., 2012 [19] reported that bio-fertilizers application maximize the amount of ascorbic acid content. Similar results were also reported by Prakash *et al.* (2018) [11] in cape gooseberry.

Table 3: Effect of foliar application of nano urea, boron and zinc sulphate on fruit parameter, Yield parameter and quality parameter of Cape gooseberry.

Treatment	Polar Diameter (cm)	Radial Diameter (cm)	Fruit Yield (q/ha)	Ascorbic acid (mg/100g)	Total soluble solids (°Brix)	Acidity (%)
T_0	1.84	2.08	133.46	48.21	8.88	0.16
T_1	1.9	2.24	144.89	49.65	9.21	0.23
T_2	2.07	2.24	149.98	50.54	8.54	0.12
T_3	2.14	2.33	157.73	51.39	9.21	0.26
T_4	2.14	2.39	162.15	53.54	9.21	0.16
T_5	2.14	2.4	177.46	55.99	9.54	0.23
T_6	2.3	2.47	179.95	56.38	9.88	0.1
T_7	2.47	2.53	185.25	58.88	10.88	0.23
T_8	2.59	2.54	187.56	60.54	11.21	0.26
T_9	2.7	2.67	190.58	61.33	11.88	0.29
F Test	S	S	S	S	S	S
S.ED	0.09	0.05	6.33	1.45	0.27	0.02
C.D. 5%	0.04	0.03	3.16	0.72	0.13	0.01
CV	12.72	7.27	12.4	12.58	8.79	1.2

3.3 Economics of Strawberry

The maximum (2.54:1) benefit:cost ratio was recorded under T9 (Nano urea 2.0% + zinc sulphate 0.6% + boron 0.6%) which was followed by T8 (2.44:1). Highest net income was also obtained under T9 (Rs. 261900.00) and it was followed by T8 (Rs. 250906.00). Minimum (6.44:1) benefit: cost ratio was recorded under T1 while least net income was found by application of T0 (Rs. 101860.00).

Table 4: Economics of treatment of cape gooseberry

Treatment Symbol	Treatment Combination	Cost of cultivation/ha	Gross Return/ha	Net Return/ha	B:C Ratio
T_0	CONTROL (N:P:K 0.8%: 0.2%: 0.2%)	90000	191860	101860	1.13
T_1	Nano urea 1.0% + zinc sulphate 0.2% + boron 0.2%	101000	230346	129346	1.28
T_2	Nano urea 1.0% + zinc sulphate 0.4% + boron 0.4%	101300	207696	106396	1.05
T_3	Nano urea 1.0% + zinc sulphate 0.6% + boron 0.6%	101500	267582	166082	1.63
T_4	Nano urea 1.5% + zinc sulphate 0.2% + boron 0.2%	101600	252134	150534	1.48
T_5	Nano urea 1.5% + zinc sulphate 0.4% + boron 0.4%	101650	274361	172711	1.69
T_6	Nano urea 1.5% + zinc sulphate 0.6% + boron 0.6%	103000	280476	177476	1.73
T_7	Nano urea 2.0% + zinc sulphate 0.2% + boron 0.2%	103200	269715	166515	1.61
T_8	Nano urea 2.0% + zinc sulphate 0.4% + boron 0.4%	103250	354156	250906	2.44
T_9	Nano urea 2.0% + zinc sulphate 0.6% + boron 0.6%	103300	365200	261900	2.54

4. Conclusion

From the above experimental finding it may concluded that, the application of T_9 (Nano urea 2.0% + zinc sulphate 0.6% + boron 0.6%) was found to best in terms of growth, yield and quality. The flowering, growth, yield and quality parameters of cape goose berry improved with application of zinc, and boron.

All these quality parameters of head registered significant increase due to application of T_9 (Nano urea 2.0% + zinc sulphate 0.6% + boron 0.6%)) along with the recommended dosage and organic manure application over control. Since these results are based on one-year experiment, further trials may be needed to substantiate the results.

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