



Effect of Different Levels of Nano Boron and Nano Zinc on Plant Growth and Establishment of Passion Fruit (*Passiflora edulis* Sims) under Prayagraj Agro-climatic Condition

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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 experiment was carried out at Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj during the year 2023-24. The experiment was laid out in Randomized Block Design comprising of 10 treatments viz T0 Control, T1 Nano Boron @ 1ppm (Foliar application), T2 Nano Boron @ 2ppm (Foliar application), T3 Nano Boron @ 3ppm (Foliar application), T4 Nano Zinc @

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1ppm (Foliar application), T5 Nano Zinc @ 2ppm (Foliar application), T6 Nano Zinc @ 3ppm (Foliar application), T7 Nano Boron 1ppm + Nano Zinc @ 2ppm (Foliar application), T8 Nano Boron 2ppm + Nano Zinc @ 2ppm (Foliar application), and T9 Nano Boron 3ppm + Nano Zinc @ 2ppm (Foliar application) with three replications. Every replication's treatments were distributed at random. The Observations were recorded as per the Vegetative growth parameters, survival (%) and chlorophyll content (SPAD value). The results reveal that the treatment T9 Nano Boron 3ppm + Nano Zinc @ 3ppm (Foliar application) was found to be the most suitable over all the other treatments in relation to vegetative growth parameters, survival (%) and chlorophyll content (SPAD value). The lowest cost of Cultivation was found in Treatment T1 which was 54,191.588/-

Keywords: Nano boron; nano zinc; plant growth; establishment; passion fruit; Prayagraj agro-climatic condition.

1. INTRODUCTION

"The passion fruit is a high value and export oriented crop. It belongs to the family Passifloraceae, which is represented by 14 genera. The genus Passiflora is the principal representative of the family and comprises of nearly 580 species, distributed throughout the tropical and subtropical regions of the world" (Silva and San Jose 1994). More than 150 species are native to Brazil, out of which 60 bear edible fruit but only a few are of commercial importance. Martine and Nakesone (1970) suggested "the term passion fruit exclusively to represent the species, *Passiflora edulis* Sims, which contains two forms-purple fruited (*Passiflora edulis* Sims) and yellow fruited (*Passiflora edulis* Sims f. *flavicarpa* Degener)" Sangita and Birendra [1]. "The passion fruit juice is acidic by nature, has a great flavour, is quite delicious, nutritious, and well-liked by most people for its blending ability. The minerals sodium, magnesium, sulphur, chlorides, and ascorbic acid are all present in moderate amounts in passion fruit, which is also an excellent source of vitamin A, riboflavin, and niacin" Chonyaphi et al., [2]. "In India, passion fruit cultivation is confined to Kerala, Tamil Nadu (Nilgiri hills and Kodaikanal), Karnataka (Coorg) and North eastern states (Mizoram, Nagaland, Manipur and Sikkim) with an area and production of 9.11 thousand ha and 45.82 thousand tons. The fruit is a good source of vitamins A and C. Purple (*Passiflora edulis* Sims.) and yellow passion fruit are the two varieties that are known to be edible (*Passiflora edulis* f. *flavicarpa* Deg.)" Chonyaphi et al., [3]. "Boron has a substantial role in plant metabolism physiological like as nucleic acid metabolism, protein, natural hormone biosynthesis, building and transition of carbohydrates, photosynthesis, cell division, cell wall synthesis membrane action and water uptake" [3,4,5]. "Boron is accountable to activate

of dehydrogenase enzymes, sugar translocation, nucleic acids and plant hormones" [6]. "Boron deficiency can cause serious problems such as defective fruit development, less yield and poor fruit quality" [7]. "Boron foliar spraying have effective within a limited number of studies to decrease the avalanche of fruit, fruit cracking, controlling boron levels and plant bio regulators (PBR) applications" [8]. "Application of boron increases fruit set and yields by its role in pollen tube germination and elongation" (Abd-Allah, 2006). "Zn is a divalent cation (Zn^{++}) with completely filled d-shell orbitals, making the element redox-stable thus forming more stable complexes (meaning no redox activity in plants) unlike other metal ions such as Mn, Fe, and Cu" [9]. "Zinc role in plant metabolism is essential to activates like carbonic anhydrase which is critical in the photosynthesis of C4 and C3 plants. Without zinc, RNA polymerase cannot occur, and the enzyme inactivated. Zinc is also involved in ribosomal fraction stabilization, cytochrome synthesis, and carbohydrate metabolism" [10]. "Zinc activates enzymes involved in protein synthesis, pollen formation, and regulation of auxin. It is also involved in gene expression which is necessary for the tolerance of environmental stresses in plants. Zinc plays a critical role in plant reproduction, water stress prevention, and protects against toxic effects of reactive oxygen species" [11]. Presence of Zn as a cofactor, protects plants from oxidative stress. Zinc also provides defense mechanisms against harmful pathogens. Thus, this study was taken upto to study the objectives which are framed; To study the effect of Nano Boron and Nano Zinc on vegetative growth and establishment of Passion Fruit crop and to estimate the cost of cultivation.

2. MATERIALS AND METHODS

The experiment was carried out the Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture,

Technology and Sciences, Prayagraj 2023-2024. The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46 (°C) – 48 °C and seldom falls as low as 4 °C – 5 °C. The relative humidity ranged between 20 to 94 per cent. The average rainfall in this area is around 1013.4 mm annually. The meteorological data (November to March) with respect to total rainfall, maximum and minimum temperature, relative humidity. Randomized Block Design (RBD) was used to set up the experiment. with three replications. The treatment consisted of different levels of Nano Zinc (1, 2 and 3ppm) and Nano Boron (1, 2 and 3ppm) foliar application. Thus, there were ten treatments combinations. Seedling were raised in polybags and 40 days old seedling were transplanted to the main field. The seedlings of papaya were transplanted in the field adopting a spacing of 5 x 5 m. The data recorded on vegetative growth viz., plant height (cm), number of leaves per plant, number of branches per plant, stem girth (mm), leaf area (cm²), Leaf area index LAI, chlorophyll content (SPAD) and survival (%) were analyzed statistically (Panse and Sukhatme, 1967).

3. RESULTS AND DISCUSSION

Plant height (cm): It was observed from the Table 1 that the effect of different levels of Nano boron and nano zinc showed significant effect on plant height (cm), number of leaves per plant, number of branches per plant, stem girth (mm), leaf area (cm²), Leaf area index LAI, chlorophyll content (SPAD) and survival (%) of **Passion Fruit**. The progressive increase in plant height (63.11cm) was recorded in T₉ Nano Boron 3ppm + Nano Zinc @ 2ppm (Foliar application) followed by T₈ Nano Boron 2ppm + Nano Zinc @ 2ppm (Foliar application) and T₇ Nano Boron 1ppm + Nano Zinc @ 2ppm (Foliar application) and the minimum plant height (42.69cm) was recorded in T₀ Control.

Number of leaves per plant: The progressive increase in number of leaves per plant (43.02) was recorded in T₉ Nano Boron 3ppm + Nano Zinc @ 2ppm (Foliar application) followed by T₈ Nano Boron 2ppm + Nano Zinc @ 2ppm (Foliar application) and T₇ Nano Boron 1ppm + Nano Zinc @ 2ppm (Foliar application) and the minimum number of leaves per plant (25.83) was recorded in T₀ Control.

Number of branches per plant: The progressive increase in number of branches per plant (4.63) was recorded in T₉ Nano Boron 3ppm + Nano Zinc @ 2ppm (Foliar application) followed by T₈ Nano Boron 2ppm + Nano Zinc @ 2ppm (Foliar application) and T₇ Nano Boron 1ppm + Nano Zinc @ 2ppm (Foliar application) and the minimum number of branches per plant (3.07) was recorded in T₀ Control.

Stem diameter (mm): The progressive increase in stem girth (mm) (6.21) was recorded in T₉ Nano Boron 3ppm + Nano Zinc @ 2ppm (Foliar application) followed by T₈ Nano Boron 2ppm + Nano Zinc @ 2ppm (Foliar application) and T₇ Nano Boron 1ppm + Nano Zinc @ 2ppm (Foliar application) and the minimum stem girth (mm) (4.04) was recorded in T₀ Control.

Leaf area (cm²): The maximum leaf area (132.35cm²) was found in treatment with T₉ Nano Boron 3ppm + Nano Zinc @ 2ppm (Foliar application) followed by T₈ Nano Boron 2ppm + Nano Zinc @ 2ppm (Foliar application) and T₇ Nano Boron 1ppm + Nano Zinc @ 2ppm (Foliar application). Whereas, the minimum leaf area (105.44cm²) was recorded in T₀ Control.

Leaf area index (LAI): The maximum Leaf area index LAI (5.29) was found in treatment with T₉ Nano Boron 3ppm + Nano Zinc @ 2ppm (Foliar application) followed by T₈ Nano Boron 2ppm + Nano Zinc @ 2ppm (Foliar application) and T₇ Nano Boron 1ppm + Nano Zinc @ 2ppm (Foliar application). Whereas, the minimum Leaf area index LAI (4.22) was recorded in T₀ control.

Chlorophyll content (SPAD Value): The maximum chlorophyll content (SPAD) (70.05) was found in treatment with T₉ Nano Boron 3ppm + Nano Zinc @ 2ppm (Foliar application) followed by T₈ Nano Boron 2ppm + Nano Zinc @ 2ppm (Foliar application) and T₇ Nano Boron 1ppm + Nano Zinc @ 2ppm (Foliar application). Whereas, the minimum chlorophyll content (SPAD) (48.81) was recorded in T₀ Control. These are similar findings reported by Singh et al., [8]. “Boron disorder is widespread micronutrient problem in agriculture, which leads to reduce yield and lack crop quality” [12]. “Boron roles in plants involve effects on fruit set and yield, and is indirectly responsible for the energized dehydrogenase enzymes, sugar translocation, nucleic acids and plant hormones” (Brady and Weil, 1996), [5,13,14].

Table 1. Effect of different levels of nano boron and nano zinc on plant growth and establishment of passion fruit under prayagraj agro-climatic condition

S. No.	Treatments No.	Treatments details	Parameters							
			Plant height (cm)	Number of leaves per plant	Number of branches per plant	Stem girth (mm)	Leaf area (cm ²)	Leaf area index LAI	Chlorophyll content (SPAD value)	Survival (%)
1	T ₀	Control	42.69	25.83	3.07	4.04	105.44	4.22	48.81	67.66
2	T ₁	Nano Boron @ 1ppm (Foliar application)	51.68	31.69	3.49	4.23	113.30	4.53	49.16	100.00
3	T ₂	Nano Boron @ 2ppm (Foliar application)	54.41	34.93	3.76	5.25	116.39	4.66	50.54	100.00
4	T ₃	Nano Boron @ 3ppm (Foliar application)	52.05	31.57	4.14	5.51	115.89	4.64	62.02	100.00
5	T ₄	Nano Zinc @ 1ppm (Foliar application)	53.88	30.35	4.18	5.34	109.13	4.37	64.48	100.00
6	T ₅	Nano Zinc @ 2ppm (Foliar application)	54.33	29.29	4.36	5.44	112.80	4.51	66.69	99.98
7	T ₆	Nano Zinc @ 3ppm (Foliar application)	53.72	37.50	4.46	5.63	117.32	4.69	64.92	100.00
8	T ₇	Nano Boron 1ppm + Nano Zinc @ 2ppm (Foliar application)	55.01	38.30	4.50	5.89	119.93	4.80	67.64	100.00
9	T ₈	Nano Boron 2ppm + Nano Zinc @ 2ppm (Foliar application)	57.51	40.44	4.58	6.07	125.98	5.04	66.11	100.00
10	T ₉	Nano Boron 3ppm + Nano Zinc @ 2ppm (Foliar application)	63.11	43.02	4.63	6.21	132.35	5.29	70.05	100.00
F-Test			S	S	S	S	S	S	S	S
C.D.at 0.5 %			2.25	1.53	0.113	0.15	4.98	0.199	1.72	0.024
S.Ed. (+)			1.07	0.72	0.054	0.07	2.37	0.094	0.82	0.011
CV			2.44	2.60	1.61	1.72	2.48	2.48	1.64	0.014

Table 2. Cost of cultivation of passion fruit for 1ha of land

Sl. No.	Particulars	Unit	Qty.	Rate/Unit (Rs.)	Cost (Rs. / ha)
A.	Land Preparation				
1	Ploughing	Hours	4	800	3200
2	Harrowing	Hours	4	800	3200
3	Layout for pit/ Ring basin	Labour	25	350	8750
B.	Transplanting				
1	Cost of the plant	No.	400	30	12000
2	Transplanting of plant	Labour	20	350	7000
C.	Foliar application				
1	Labour for application of fertilizer	Labour	6	350	2100
D.	Irrigation				
	2 Labours per irrigation (6 days interval for 2 Hrs)	Water	12	350	4200
E.	Inter-culture				
	Weeding (6 labours per weeding)	Labour	12	350	4200
I.	Rental value of land	Months	3	1000	3000
J.	Supervision charges	Months	3	500	1500
k.	Transportation				5000
Total fixed cost (Rs./ha)					54,150/-

Table 3. Cost of treatments for cultivation for passion fruit

Treatments No.	Treatments combinations	Nano Boron @ (100g) Rs.8400		Nano Zinc @5g (Rs. 5500/kg)		Cost Treatment
		g ha ⁻¹	Amount	g ha ⁻¹	Amount	
T ₀	Control	-	-	-	-	-
T ₁	Nano Boron @ 1ppm (Foliar application)	0.495g	41.58			41.58
T ₂	Nano Boron @ 2ppm (Foliar application)	0.990g	83.16			83.16
T ₃	Nano Boron @ 3ppm (Foliar application)	1.485g	124.74			124.74
T ₄	Nano Zinc @ 1ppm (Foliar application)			0.495g	544.5	544.5
T ₅	Nano Zinc @ 2ppm (Foliar application)			0.990g	1089	1089
T ₆	Nano Zinc @ 3ppm (Foliar application)			1.485g	1633.5	1633.5
T ₇	Nano Boron 1ppm + Nano Zinc @ 1ppm (Foliar application)	0.495g	41.58	0.495g	544.5	586.08
T ₈	Nano Boron 2ppm + Nano Zinc @ 2ppm (Foliar application)	0.990g	83.16	0.990g	1089	1172.16
T ₉	Nano Boron 3ppm + Nano Zinc @ 3ppm (Foliar application)	1.485g	124.74	1.485g	1633.5	1758.24

Survival percentage (%): The maximum survival (%) (100) was found in treatment with T₉ Nano Boron 3ppm + Nano Zinc @ 2ppm (Foliar application) followed by T₈ Nano Boron 2ppm + Nano Zinc @ 2ppm (Foliar application) and T₇ Nano Boron 1ppm + Nano Zinc @ 2ppm (Foliar application) and the minimum survival (%) (67.66) was recorded in T₀ Control. These are similar findings reported by Singh et al., [8].

4. CONCLUSION

In terms of plant height (63.11cm), number of leaves per plant (43.02), stem girth (mm) (6.21), leaf area (132.35cm²), leaf area index LAI (5.29), chlorophyll content (SPAD) (70.05), and survival (%) (100), it is determined that T₉ Nano Boron 3ppm + Nano Zinc @ 2ppm (Foliar application) performed best.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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