International Journal of Minor Fruits, Medicinal and Aromatic Plants. Vol. 10 (1) : 84-88, June 2024

Response of boron and zinc on growth, yield and quality of papaya cv. Red Lady

Vivek Kumar[1], Aditi Chakraborty[1*], Nilesh Bhowmick[2], Partha Sarathi Medda[3], Dibyendu Mukhopadhyay[4] and Somnath Mandal[5]

[1*2]*Department of Pomology and Post Harvest Technology, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, India, 736165*

[3]*Department of Plantation Crops and Processing, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, India, 736165*

[4]*Department of Soil Science & Agricultural Chemistry, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, India, 736165*

[5]*Department of Biochemistry, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, India, 736165*

**Email: aditi.chatterjee10@gmail.com*

Receipt : 22.12.2023 ; Revised : 19.03.2024 ; Acceptance : 24.03.2024

DOI : 10.53552/ijmfmap.10.1.2024.84-88

ABSTRACT

The current study was carried out in Uttar Banga Krishi Viswavidyalaya Pundibari, West Bengal, in 2021–2022 to evaluate the response of micronutrients on papaya performance. The treatments were different concentrations of zinc and boron (T_1- distilled water sprayed; T_2- Borax 0.25%; T_3- Borax 0.5%; T_4- Zinc sulphate 0.25%; T_5- Zinc sulphate 0.5%; T_6-Borax 0.25% + Zinc sulphate 0.25%; T_7- Borax 0.25% + Zinc sulphate 0.5% ; T_8- Borax 0.5% + Zinc sulphate 0.25% and T_9 Borax 0.5% + Zinc 0.5%) with three replications. The findings showed that Borax 0.5% + Zinc sulphate 0.25% had the highest plant height at first flowering (93.17 cm) and at first harvesting (184.08 cm); plant girth at first flowering (18.58 cm) and at first harvesting (37.75 cm); plant spread E-W and N-S spread at first flowering (105.00 and 107.50 cm) and at first harvesting (199.92 cm and 202.75 cm) with maximum fruit yield of 25.47 kg. The treatment Borax 0.5% + Zinc sulphate 0.5% resulted inhighest total leaf count per plant at first flowering (32.50) and total soluble solids (12.83 °B) with lowest acidity (0.140%).

***Keywords*:** Fruit yield, growth, micronutrients, papaya, total soluble solids

INTRODUCTION

Papaya (*Carica papaya* L.) is a rapidly growing, short-lived perennial plant in the family Caricaceae (Siriwardana *et al.,* 2019). It is one of the major fruit crops grown in tropical and subtropical areas of the world (Eda, 2023). It is planted largely for its mouthwatering fruits, which are savoured both fresh and in different processed forms. Along with mangoes and pineapples, papaya is one of the most frequently produced fruits in the world. Its popularity is due to its adaptation to tropical temperatures, which accounts for around 15.36% of the world's total production of tropical fruits (Godi *et al.,* 2020). Papaya, the "common man's fruit," is a powerhouse of essential vitamins, fiber, and minerals. Its low fat and protein content make it a low-calorie fruit. The fruit's pharmaceutical properties have led to its use in traditional medicine for treating various disorders. The latex of unripe papaya contains chymopapain and lycopene, used for treating herniated lower lumbar vertebrae and preventing various types of cancer, respectively. Papaya juice helps alleviate colon infections, and the presence of vitamins A and C aids in improving eyesight and strengthening the immune system. Fresh green papaya leaves can be used as antiseptics, whereas brown leaves are a great tonic for blood-purifying activity (Koul *et al.*, 2022).

Lack of micronutrients create major issue that hampers soil and plant vigour all around the world and it reduces production (Imtiaz *et al.,* 2010). Micronutrients are required for betterplant development, blooming, improved fruit set, increased quality of higher fruit production and longer shelf life of horticulture commodities (Raja, 2009; Shekhar *et al.*, 2010).

Indian soils have mild zinc and boron deficiencies and availability in the range of 40-55 percent and 25-30 percent, respectively. Micronutrient deficiencies have significant negative impact on crop improvement and sustainable viability of crops across different regions of India (Kumar *et al.*, 2011). Various biological activities, including photosynthesis, the synthesis of nucleic acids, proteins, and carbohydrates as well as the ability to resist biotic and abiotic challenges are all affected by Zn (Cakmak, 2008).

One of these study gaps relates to the efficient utilisation of micronutrients in papaya, such as zinc and boron. Fruit growers are quite concerned about the papaya micronutrient deficit issue. An efficient technique to complete and improve plant nutrition is foliar spray. Foliar spray can fill up nutrient deficiencies caused by stressed plants or poor soil conditions that prevent plants from absorbing nutrients from the soil. Micronutrient foliar sprays are efficient and have a rapid effect on plants. Requirement of micronutrients and their dose vary from crop to crop even variety to variety within the same crop. Besides, agro-climatic factor is another key point that interact with the crop, to be grown in a particular locality. There are little report on effect of zinc and boron on Red Lady variety of Papaya grown in Sub-Himalayan Terai area. With this view, an experiment was conducted to know the effect of boron and zinc and their combination on plant growth, fruit yield and quality.

MATERIALS AND METHODS

The field trial took place between 2021-2022 at the Instructional Farm, Department of Pomology and Postharvest Technology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India. The location is 82 metres above mean sea level, longitude 89^o 23′ 5″ E and latitude 26^o 19′ 86″ N, within West Bengal's Sub-Himalayan Terai area. The experimental field was sandy loam in texture, acidic in nature with a soil pH of 5.52. Physico-chemical properties of soil were as follows – sand (62.31%), silt (20.55 %), clay (11.2 %) Organic carbon (0.75%), available nitrogen (216.5 Kg/ha), available phosphorous (18.24 kg/ha) and available potassium (112.63 kg/ha), available boron in soil (0.68 kg/ha) and DTPA Zinc (0.73 kg/ha).

Healthy papaya cv. Red Lady seeds were dipped in gibberellic acids (200 ppm) for 12 hours and then seeds were sown on polybags containing the rooting media (soil, cocopeat and sand in a ratio of 1:1:1) at the greenhouse which is located at Instructional Farm, Uttar Banga Krishi Vishwavidyalaya, Coochbehar, West Bengal. Papaya saplings were transplanted into the main field at row to row and plant to plant distance of 2 x 2 m. When plants were reached 8 leaves stage, the experiment was started with 9-treatments and each treatment was replicated three times, taking four plants in each replication, using a randomised block design (RBD). In each treatment of each replication, four plants were chosen. Nine different treatment combinations were used, including T_1- distilled water sprayed, T_2- Borax 0.25%, T_3- Borax 0.5%, T_4- Zinc sulphate 0.25%, T_5- Zinc sulphate 0.5%, T_6- Borax 0.25% + Zinc sulphate 0.25%, T_7- Borax 0.25% + Zinc sulphate 0.5%, T_8- Borax 0.5% + Zinc sulphate 0.25%, T_9 Borax 0.5% + Zinc 0.5%.

Before planting in each plot, the required dose of FYM @ 20 tonnes/ha was applied. Starting with the transplanting of seedlings, the recommended dosage of fertilisers (200g N, 200g P, and 250g K/ plant) was applied in four equal splits at two-month intervals in the form of urea, single super phosphate, and muriate of potash. After transplanting in the main field, the micronutrients were treated twice as foliar applications at 60 and 120 days.

The observations were made on different characters, viz., plant height and stem girth at first flowering and first harvesting, plant spread east-west and north-south at first flowering and first harvesting, total leaf count at first flowering, fruit firmness, total soluble solids, titrable acidity and yield per plant was recorded. The parameters were analysed using the statistical application OPSTAT.

RESULTS AND DISCUSSION

Growth attributes

The spraying of micronutrients significantly improved all papaya growth parameters (Tables 1 and 2). T_1 recorded considerably lower plant height (74.58 cm and 155.17 cm, respectively) than T_8, which had significantly higher plant height at first flowering (93.17 cm) and first harvesting (184.08 cm). The highest plant girth of the plant was

Table 1: Effect of micronutrient on plant height and plant girth of papaya *cv.* Red Lady

Treatment	Plant height at first flowering (cm)	Plant height at first harvesting (cm)	Plant girth at first flowering (cm)	Plant girth at first harvesting (cm)
T_1 - Control (distilled water sprayed)	74.58	155.17	12.33	28.92
T_2 - Borax @ 0.25%	79.17	161.58	13.42	30.25
T_3 - Borax @ 0.5%	85.83	167.33	14.25	31.50
T_4 - Zinc sulphate @ 0.25%	90.33	179.92	13.83	31.58
T_5 - Zinc sulphate @ 0.5%	92.25	175.08	15.67	33.42
T_6 - Borax @ 0.25% + Zinc sulphate @ 0.25%	81.33	172.83	15.00	34.17
T_7 - Borax @ 0.25% + Zinc sulphate @ 0.5%	87.25	178.00	15.92	35.83
T_8 – Borax @ 0.5% + Zinc sulphate @ 0.25%	93.17	184.08	18.58	37.75
T_9 - Borax @ 0.5% + Zinc sulphate @ 0.5%	90.50	180.75	17.08	36.17
SEm (±)	**0.70**	**4.01**	**0.50**	**0.42**
LSD (0.05)	**2.12**	**12.12**	**1.53**	**1.28**

Table 2: Effect of micronutrient on total leaf count and plant spread of papaya *cv.* Red Lady

Treatment	No. of leaves at first flowering	Plant spread E-W(cm) at first flowering	Plant spread E-W (cm) at first harvesting	Plant spread N-S (cm) at first flowering	Plant spread N-S (cm) at first harvesting	Yield per Plant (Kg/Plant)
T_1 - Control (distilled water sprayed)	19.92	91.58	180.25	93.33	183.17	12.23
T_2 - Borax @ 0.25%	24.08	95.83	187.92	97.17	190.75	15.08
T_3 - Borax @ 0.5%	26.75	98.42	190.33	100.33	192.67	17.19
T_4 - Zinc sulphate @ 0.25%	28.17	97.33	187.58	100.08	191.33	17.90
T_5 - Zinc sulphate @ 0.5%	30.58	96.92	195.42	101.58	197.25	19.98
T_6 - Borax @ 0.25% + Zinc sulphate @ 0.25%	25.25	99.75	192.67	101.08	192.08	18.72
T_7 - Borax @ 0.25% + Zinc sulphate @ 0.5%	26.00	101.75	194.08	103.17	195.50	22.88
T_8 – Borax @ 0.5% + Zinc sulphate @ 0.25%	29.17	105.00	199.92	107.50	202.75	25.47
T_9 - Borax @ 0.5% + Zinc sulphate @ 0.5%	32.50	102.17	195.83	104.67	198.92	22.41
SEm (±)	**0.38**	**1.24**	**1.44**	**0.83**	**1.26**	**0.63**
LSD (0.05)	**1.15**	**3.73**	**4.36**	**2.52**	**3.81**	**1.91**

recorded in T_8 at first flowering (18.58 cm) and at first harvesting (37.75 cm) and lowest at T_1 (12.33 cm and 28.92 cm) respectively. The total leaf count per plant at first flowering was highest in T_9 (32.50) and lowest in T_1 (19.92 cm). The maximum plant spread at first flowering in both directions (east-west, north-south) was recorded in T_8(105.00 and 107.50 cm) similarly highest plant spread at first harvesting in both directions (east-west, north-south) was also recorded in T_8 (199.92 cm and 202.75 cm respectively).

It was noted that zinc and boron singly and in combination increased plant height and plant spread

Table 3: Effect of micronutrient on fruit firmness, TSS,titrable acidity of ripe papaya*cv.* Red Lady

Treatment	**Fruit firmness (Kg/cm^2)**	**TSS (°B)**	**Titrable acidity (%)**
T_1 - Control (distilled water sprayed)	5.75	9.36	0.158
T_2 - Borax @ 0.25%	6.04	9.92	0.154
T_3 - Borax @ 0.5%	6.29	10.77	0.152
T_4 - Zinc sulphate @ 0.25%	6.47	10.90	0.151
T_5 - Zinc sulphate @ 0.5%	6.84	11.58	0.148
T_6 - Borax @ 0.25% + Zinc sulphate @ 0.25%	6.66	11.35	0.151
T_7 - Borax @ 0.25% + Zinc sulphate @ 0.5%	6.75	11.48	0.146
T_8 – Borax @ 0.5% + Zinc sulphate @ 0.25%	6.98	12.34	0.144
T_9 - Borax @ 0.5% + Zinc sulphate @ 0.5%	7.12	12.83	0.140
SEm (±)	**0.10**	**0.32**	**0.002**
LSD (0.05)	**0.30**	**0.96**	**0.006**

(east-west and north-south) may be due to enhancing respiration and photosynthesis. Zinc is essential for nitrogen metabolism, auxin synthesis, cell division, and enlargement, promoting overall plant growth. Boron promotes the development of cell walls, maintains the structural integrity of cell membranesand aids in the movement of sugars and energy into the active areas of plants. Singh *et al.* (2010) and Jeyakumar *et al.* (2001) found increased plant height with boron and zinc sprays in papaya. Zinc and boron also contribute to increased plant girth by boosting metabolic activities, leading to cell division and elongation. When zinc and boron were applied as a foliar spray to papaya plants, Singh *et al.* (2010) and Jeyakumar *et al.* (2001) noted similar impacts on plant girth. Furthermore, the application of zinc and boron increases the total leaf count per plant due to enhanced photosynthetic substances and chlorophyll, which in turn encourages the development of leaf buds, cell division and expansion, delays the senescence of leavesand improves leaf persistence (Sajid *et al.*, 2010).

Fruit yield

Reviewing the data in Table 2 showed that foliar sprays of both micronutrients had significant impacts on papaya production per plant under various treatments. T_8 (Borax @ 0.5% + Zinc sulphate @ 0.25%) produced a much higher fruit production (25.47 kg), whereas control plants produced the lowest fruits fruit production (12.23 kg).This results confirmed the beneficial effect of micro-nutrients on papaya yield and the results was supported with the findings of Singh *et al.* (2010), and Modi *et al.* (2012).

The application of zinc and boron enhanced the output per plant, which can be attributed to more fruits. Boron application may have a positive effect on carbohydrate and RNA metabolism, leading to a significant increase in yield. Treatment with zinc increases both the rate of photosynthesis and the carbonic anhydrase activity in leaves.

Fruit quality attributes

When applied as a foliar spray, both the micronutrients had significant effects on papaya's fruit quality attributes (Table 3). Treatment with Borax @ 0.5% + Zinc sulphate @ 0.5% (T_9) recorded the highest fruit firmness (7.12 Kg/cm^2) and TSS (12.83 °B). While, the minimum value of fruit firmness, total soluble solid were recorded in treatment T_1 (control). At T_9 (Borax @ 0.5% + Zinc sulphate @ 0.5%), titrable acidity percent was considerably lowest among the treatments (0.140%) and highest under control (0.158%).

When applied as a foliar spray, both the micronutrients had significant effects on papaya's fruit quality traits, which might be due to the catalytic activity of both the micronutrients, as well as their synergistic impact, particularly at higher concentrations, may be responsible for the increased accumulation of TSS in fruits. According to theory, boron speeds up the transfer of sugars from leaves to developing fruits which hep to increase in TSS. Singh *et al.* (2010) and Rawat *et* *al.* (2010) also observed beneficial effects of both the micronutrient on TSS concentration in papaya and guava, respectively. Additionally, the decrease in titrable acidity of papaya fruits with the application of both micronutrient and their combinations may be due to these micronutrients' beneficial effects on the speedy conversion of acids into sugars and their derivatives, possibly through the reversal of the glycolic pathway or their use as substrates in respiration. These results support the papaya research conducted by Singh *et al.* (2010).

CONCLUSION

According to the findings of the current experiment, T_8 (Borax @ 0.5% + Zinc sulphate @ 0.25%) had maximum positive impact on plant growth and higher production of quality papaya over control (with no micro-nutrient). Whereas, T_9 (Borax @ 0.5% + Zinc sulphate @ 0.5%) had maximum positive impact over control when it comes to production of papaya cv. Red Lady grown in Terai region of West Bengal.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES :

Cakmak, I. 2008. Enrichment of cereal grains with zinc: agronomic or genetic biofortification. *Plant and soil.*, **302**: 1-17.

Eda, R. 2023. Influence of organic manures and fruit coatings on biochemical parameters of papaya cv. Arka Prabhat. *International Journal of Minor Fruits, Medicinal and Aromatic Plants,* **9**(1): 88- 96.

Godi, V., Hegde, M., Vidya, A., Thimmegouda, M. N., Subbarayappa, C. T., Shivanna, B. and Hanamantharaya, B. G. 2020. Effect of different irrigation and fertilizer levels on growth, yield and cost economics of papaya (*Carica papaya* L.) *cv*. Red Lady under open field conditions. *International Journal of Chemical Studies,* **8**: 2184-2191.

Imtiaz, M., Rashid, A., Khan, P., Memon, M. Y. and Aslam, M. 2010. The role of micronutrients in crop production and human health. *Pak. J. Bot.*, **42**(4): 2565-2578.

Jeyakumar, P., Durgadevi, D. and Kumar, N. 2001. Effects of zinc and boron fertilisation on improving fruit yields in papaya (*Carica papaya* L.) cv. CO5. *Plant Nutrition: Food security and sustainability of agro-ecosystems through basic and applied research*, 356-357.

Koul, B., Pudhuvai, B., Sharma, C., Kumar, A., Sharma, V., Yadav, D. and Jin, J. O. 2022. *Carica papaya* L.: a tropical fruit with benefits beyond the tropics. *Diversity, MDPI* **14**(8): 683.

Kumar, M., Swarup, A., Patra, A. K. and Chandrakala, J. U. 2011. Micronutrient fertilization under rising atmospheric CO_2 for micronutrient security in India. *Ind. J. Ferti.*, **7**(7): 52-60.

Modi, P. K., Varma, L. R., Bhalerao, P. P., Verma, P. and Khade, A. 2012. Micronutrient spray effects on growth, yield and quality of papaya (*Carica papaya* L.) cv. Madhu Bindu. *Madras Agric. J.*, **99**: 500- 502.

Raja, M. E. 2009. Importance of micronutrients in the changing horticultural scenario in India. *J. Hort. Sci.*, **4**(1): 1-27.

Rawat, V. R. Y. T. J., Tomar, Y. K. and Rawat, J. M. S. 2010. Influence of foliar application of micronutrients on the fruit quality of guava cv. Lucknow-49. *J. of Hill Agri.*, **1**(1): 75-78.

Sajid, M., Rab, A., Ali, N., Arif, M., Ferguson, L. and Ahmed, M. 2010. Effect of foliar application of Zn and B on fruit production and physiological disorders in sweet orange cv. Blood orange. *Sarhad J. Agric.*, **26**(3): 355-360.

Shekhar, C., Yadav, A. L., Singh, H. K. and Singh, M. K. 2010. Influence of micronutrients on plant growth, yield and quality of papaya fruit (*Carica papaya* L.) *cv.* Washington. *Asian J. Hort.*, **5**(2): 326-329.

Singh, D. K., Ghosh, S. K., Paul, P. K. and Suresh, C. P. 2010. Effect of different micronutrients on growth, yield and quality of papaya (*Carica papaya* L.) *cv.* Ranchi. *Acta Hort.*, **851**: 351-356.

Siriwardana, A. J. M. C. M., Wathugala, D. L. and Kumarasinghe, H. K. M. S. 2019. Growth and yield responses of papaya (*Carica papaya* L.) intercropped with herbaceous weeds. *International Journal of Minor Fruits, Medicinal and Aromatic Plants*, **5**(2): 33- 38.