Int.J.Curr.Microbiol.App.Sci (2017) *6*(9): 2081-2086

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 9 (2017) pp. 2081-2086**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.609.255

Effect of Quantity of Soil Application of Zinc, Boron and Iron on Growth and Yield in Papaya cv. Red Lady

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Keywords

Papaya, Red Lady, Micronutrients, Growth and Yield.

Article Info

Accepted:
21 August 2017
Available Online:
10 September 2017

A B S T R A C T

The experiment was carried out at Haveli, College of Horticulture, Bagalkot, during the year 2016-2017 to evaluate the effect of quantity of soil application of Zinc, Boron and Iron on growth and yield in papaya cv. Red Lady. Different micronutrient treatments *i.e.*, T_1-3g Zinc, T_2- 5g Zinc, T_3- 10g Zinc, T_4- 15g Zinc, T_5-2g Boron, T_6 -5g Boron, T_7-8g Boron, T_8-3g Iron, T_9-5g Iron, T_{10}-10g Iron, T_{11}-15g Iron, T_{12}- 10g Zn + 5g B + 10g Fe, T_{13}-Ranadey Mixture (20g), T_{14}-Control (RDF only). Among the micronutrient application, the treatment T_{12} *i.e.*, plants soil applied with 10g Zn + 5g B + 10g Fe was found to be effective to improve the growth and yield in papaya cv. Red Lady.

Introduction

Papaya (*Carica papaya* L.) is an important fruit crop of tropical world and has long been known as wonder fruit of the tropics. The highest productivity and its ability to produce fruits throughout the year have added to gain popularity and commercial importance. Besides this, papaya is a wholesome fruit with high nutritive value and therapeutic value. The fruit contains high amount of vitamin A, vitamin C and iron (Rashid *et al.*, 1987). Ripe fruits are largely used as a fresh desert, while green fruits are often used in salads and pickles or cooked as a vegetable. Papain, a proteolytic enzyme present in the latex, collected mainly from the fruits, has various uses in the beverage, food, pharmaceutical and tanning industries. Also, papaya leaves have medicinal values. Because of these, papaya has been called as “common man’s fruit”.

Micronutrients play a major role in crop production due to their essentiality in plant metabolism and adverse effects that manifest due to their deficiency. These trace elements also play a major role in disease resistance in cultivated crop species. Furthermore, these micro-nutrients also help in uptake of major nutrients and play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity, hormone synthesis, nitrogen fixation and reduction etc. (Das, 2003). Nevertheless, micronutrients can tremendously boost horticultural crop yield and improve quality and post-harvest life of horticultural produce (Raja, 2009). Hence, micronutrients are essentially as important as macronutrients to have better growth, yield and quality in plants. In spite of few studies have been taken up in papaya nutrition, there is very meager information about micronutrients in papaya. Further, agroclimatic zone wise, there will be a lot of difference in soils and their nutrient content. Also, as papaya grows and sets flowers and fruits continuously, it appears, there is a necessity of generation of information regarding requirement of quantity of each micronutrient. In this view, the present investigation was carried out to study the effect of quantity of soil application of Zn, B and Fe on growth and yield in papaya cv. Red Lady.

Materials and Methods

The field experiment was conducted at Haveli, College of Horticulture, Bagalkot. The seeds of papaya (var. Red Lady) were sown in small polythene bags. Forty-five day-old seedlings of uniform size and vigour were planted within field during first week of July during morning in the pits of 45 × 45 × 45 cm dimension at a distance of 1.8 m in both directions. Soil application of fertilizers (250 g N, 250 g P and 500 g K per plant) were done in four equal split doses at two months interval starting from transplanting of seedlings. The experiment waslaid out in Randomized Block Design (RBD) with 14 treatments, which were replicated two times. The treatments were, T_1-3g Zinc, T_2- 5g Zinc, T_3- 10g Zinc, T_4- 15g Zinc, T_5-2g Boron, T_6-5g Boron, T_7-8g Boron, T_8-3g Iron, T_9-5g Iron, T_{10}-10g Iron, T_{11}-15g Iron, T_{12}- 10g Zn + 5g B + 10g Fe, T_{13}-Ranadey Mixture (20g), T_{14}-Control (RDF only).The micronutrients soil applied at 1,3,5 and 7 months after transplanting. Observations on growth parameters (plant height, stem girth and number of leaves), reproductive parameters (number of flowers and fruits per plant), fruit parameters (weight of fruits, fruit length and width) and yield parameters (kg plant $^{-1}$ and tonnesha^{-1}) were recorded at eight months after transplanting.

Plant height was recorded by using scale. A mark was made in the trunk, ten cm above the ground level as a reference point. The plant height was recorded from this reference point to the tip of the growing shoot. Stem girth was recorded by using measuring tape. Number of leaves, flowers was recorded by visual counting. The number of fruits per plant was physically counted after maturity and was expressed as numbers per tree. Five randomly selected papaya fruits were weighed using digital analytical balance and the average value of fruit was expressed in kilo grams**.** Fruit length and width in each treatment was measured with the help of scale and it was expressed in centimeters (cm). The fruit yield was recorded at the time of harvest and expressed in kilograms per plant. The fruit yield per hectare was computed by multiplying the yield per plant with the number of plants that can be accommodated in one hectare and was expressed in tonnes per hectare.

Results and Discussion

The vegetative parameters such as plant height and stem girth at 8 months after transplanting showed non-significant differences and number of leaves showed significant differences with micronutrient treatments (Table 1). However, maximum plant height (1.52 m) and stem girth (35.97 cm) and highest number of leaves (41.34) were recorded with the treatment T_{12} (10g Zn + 5g B + 10g Fe) whereas no micronutrient treatment recorded minimum values of vegetative parameters. The increased vegetative parameters is due to the application of micronutrients like Zn, Fe and B which influence on growth attributes and improved photosynthetic efficiency and respiration of plant. The zinc sulphate on enhancing the vegetative growth may be ascribed for role of zinc in synthesis of tryptophan, which is the precursor of auxin as confirmed by Singh *et al.*, (2010) in papaya. The combinations of boron and zinc increased the metabolites activities, which lead to increase plant metabolites responsible for cell division, cell elongation and plant growth (Bhalerao and Patel, 2015). Fe is also necessary for vital plant metabolic functions such as chlorophyll synthesis, enzymatic reactions, respiration and photosynthesis. In addition, boron regulates metabolism involved in translocation of carbohydrates and cell wall development. The results are in close conformity with the findings of Ram and Bose (2000).

On the contrary, the days taken for flowering, fruit set and fruit harvest after fruit set (Table 2) was utmost advanced (days) under the treatment receiving boron 8g (103.00, 122.83 and 146.83 days respectively). This earliness may be due boron plays vital role in early flower initiation, flower bud formation and production of indigenous and florigenic substances. Besides stimulation of pollen germination, growth of pollen tube, fertilization process, it also involved in glucose metabolism, hydrocarbons and their transport. Similar findings were in conformity with the findings of Singh *et al.*, (2010) in cv. Ranchi. With respect to reproductive parameters, the plants treated with soil application of T_{12} (10g Zn + 5g B + 10g Fe) showed higher number of flowers plant^{-1} (49.50) at 8 months after transplanting (Table 1). It may be due to the positive combined effect of zinc, iron and boron on flowering. Zinc enhanced the synthesis of auxin in plants which stimulate the flowering (Ryugo, 1988). Iron is credited with a definite role in the synthesis of chlorophyll molecule (Pandey and Sinha, 2006). Boron regulates metabolism involved in translocation of carbohydrates, cell wall development and RNA synthesis (Brown *et al.*, 1995).Similar results were observed by Venu *et al.*, (2014) in kagzi lime.

Table.1 Effect of micronutrients on growth parameters at eight months after transplanting

Treatment			Plant height (m)	Stem girth(cm)	Leaves plant^{-1}	Flowers plant^{-1}	Fruits plant^{-1}
T_1		3g Zinc	1.25	31.95	29.5	34.17	23.42
T_2	-	5g Zinc	1.32	32.75	28.5	38	23.67
T_3	-	10g Zinc	1.38	34.78	29	38.67	24
T_4	-	15 g Zinc	1.43	34.92	35.5	42.83	27
T_5	-	2g Boron	1.25	30.23	27.17	34.33	23.83
T_6	-	5g Boron	1.27	32.52	27.5	34.17	24.33
T_7	-	8g Boron	1.38	34.1	28	38.17	24.5
T_8	-	3g Iron	1.26	32.12	27.67	38.5	23.5
T_9	-	5g Iron	1.37	32.93	28.17	39.5	22.33
T_{10}	-	10g Iron	1.4	34.9	35.17	40.33	25.34
T_{11}	-	15g Iron	1.38	34.85	27.17	39.67	24.34
T_{12}	-	10g Zn + 5g B + 10g Fe	1.52	35.97	41.34	49.5	28.67
T_{13}	-	Ranadey Mixture (20g)	1.47	32.55	28.84	36.33	23.33
T_{14}	-	Control (RDF only)	1.23	29.4	26.67	33.67	20.67
S Em±			0.07	2.02	1.75	2.16	1.12
CD @ 5%			NS	NS	5.34	6.59	3.41

Table.2 Effect of micronutrients on days to first flowering, fruit set and Fruit harvest after fruit set

Treatment	Days taken for first flowering	Days taken to first fruit set	Days to fruit harvest after fruit set
T_1 - 3g Zinc	110.17	136.67	158.00
T_2 - 5g Zinc	109.67	136.33	157.17
T_3 - 10g Zinc	110.17	136.83	154.67
T_4 - 15 g Zinc	110.33	137.50	149.67
T_5 - 2g Boron	109.17	126.33	153.17
T_6 - 5g Boron	108.67	123.33	150.17
T_7 - 8g Boron	103.00	122.83	146.83
T_8 - 3g Iron	109.67	135.33	157.83
T_9 - 5g Iron	110.00	137.50	156.67
T_{10} - 10g Iron	110.83	137.67	155.33
T_{11} - 15g Iron	111.67	138.00	156.50
T_{12} - 10g Zn + 5g B + 10g Fe	107.67	123.00	147.17
T_{13} - Ranadey Mixture (20g)	108.50	126.00	156.33
T_{14} - Control (RDF only)	114.67	145.17	161.17
S Em+_	1.13	0.56	0.54
CD@5%	3.45	1.71	1.64

Table.3 Effect of micronutrients on fruit and fruit yield parameters in papaya

Treatment	Fruit weight(kg)	Fruit length (cm)	Fruit width (cm)	Yield (kg plant^{-1})	Yield (t ha^{-1})
T_1 3g Zinc	1.16	15.3	10.68	26.97	83.23
T_2 - 5g Zinc	1.18	16.65	10.85	28.01	86.44
T_3 - 10g Zinc	1.17	17.55	11.6	28.04	86.53
T_4 - 15 g Zinc	1.35	18.6	11.75	36.30	112.02
T_5 - 2g Boron	1.12	16.65	10.78	26.46	81.65
T_6 - 5g Boron	1.14	16.9	11.18	27.63	85.26
T_7 - 8g Boron	1.15	17.6	11.35	28.23	87.13
T_8 - 3g Iron	1.2	15.5	11.6	28.09	86.70
T_9 - 5g Iron	1.22	17.13	11.75	27.12	83.68
T_{10} - 10g Iron	1.34	17.75	12	33.80	104.30
T_{11} - 15g Iron	1.36	17.5	11.55	33.00	101.83
T_{12} - 10g Zn + 5g B + 10g Fe	1.54	20.95	13.5	43.99	135.77
T_{13} - Ranadey Mixture (20g)	1.14	16.8	11.68	26.47	81.69
T_{14} - Control (RDF only)	1.1	14.45	10.6	22.74	70.17
S Em±	0.03	0.94	0.45	1.39	4.29
CD @ 5%	0.09	2.87	1.36	4.25	13.11

Significantly highest number of fruits were recorded in T_{12}(28.67) which was on par with treatments T_4(27.00) and T_{10}(25.34), whereas least number of fruits were found in T_{14}(Control).The increase in number of fruits per tree due to combined application of micronutrients either through foliar or soil application might be due to production of auxins which were probably helpful for retention of fruits by reducing flower drops there by increasing number of fruits. The result was in agreement with the findings of Tamboli *et al.,* (2015) in fig. Similar results were also found by in Dhinesh *et al.,* (2007) Kinnow mandarin. The results showed highest values for weight of fruits (1.54 kg), fruit length (20.95 cm) and width (13.50 cm) in the plants treated with 10g Zinc + 5g Boron + 10g Iron (T_{12}). However, fruit length on par with T_4 (18.6 cm). However, the lowest values were observed in control (Table 3). Cumulative effect of combined treatment of zinc, boron and iron might have resulted into higher fruit weight. The possible reason for increase in fruit weight by the micronutrients might be due to faster loading and mobilization of photo assimilates to fruits and involvement in cell division and cell expansion which ultimately reflected into more weight of fruit in treated plants (Gurjar *et al.,* 2015). Similar results were also found by Banik *et al.*, (1997), Dutta and Dhua (2002), Dutta (2004) in mango and Ghanta and Mitra (1993) in banana which are in agreement with the present findings. The increase in fruit length was possibly due to accumulation of more food material in the tree that lead to efficient utilization for fruits development (Ram and Bose, 2000). The highest values for mean fruit yield per plant was recorded in T_{12} (43.99 kg) in the same way highest yield ha^{-1} was recorded in T_{12} (135.77 tonnes) whereas, significantly least values were recorded in control (Table 3). Micronutrients played a pivotal role in vegetative growth, flowering, development of plants and are also directly involved in the process of photosynthesis, this means that a possibility of increasing dry matter percentage as well as yield. These results are in conformity with the findings of Tamboli *et al.,* (2015) in fig. The beneficial effects of micronutrients on growth and nutrition were also observed by earlier workers in sapota (Saraswathy *et al.,* 2004), in Kinnowmandrian (Dhinesh *et al.,* 2007), in mandarin orange (Saraswathi *et al.,* 1998) and in guava (Rathore *et al.,* 2008). The findings of the study indicated the importance of zinc, boron and iron to increase the plant growth and yield in papaya cv. Red Lady.

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How to cite this article:

Preethi, M., D.P. Prakash, Kulapati Hipparagi, I.B. Biradar, S.G. Gollagi and Shivayogi Ryavalad. 2017. Effect of Quantity of Soil Application of Zinc, Boron and Iron on Growth and Yield in Papaya cv. Red Lady. *Int.J.Curr.Microbiol.App.Sci.* 6(9): 2081-2086.
doi: https://doi.org/10.20546/ijcmas.2017.609.255