

## Effects of foliar application of boron on leaf boron content and yield of papaya cv. Red Lady

Srilatha Vasanthu<sup>1\*</sup>, K. Sunil Kumar<sup>1</sup>, B. Padmodaya<sup>1</sup> and C. Kiran Kumar Reddy<sup>2</sup>

<sup>1</sup>KVK, ANGR Agricultural University, Utukur, Kadapa, Andhra Pradesh-516003. <sup>2</sup>ARS, ANGR Agricultural University, Utukur, Kadapa Andhra Pradesh-516003. \*E-mail: latha\_scientist@yahoo.com

### Abstract

Boron deficiency in papaya causes deformation of apical meristem, distortion of young leaves, dwarfing of plants, fruit deformities and uneven fruit ripening that severely reduces the yield and quality. Hence, an experiment on effects of foliar application of boron on yield and quality of papaya with a commercially important variety Red lady was conducted at fifteen locations of Andhra Pradesh where the boron deficiency is wide spread due to tropical climate and high soil pH. Foliar application of 0.03 % borax at every 60 days interval from planting to harvest recorded significant increase in the leaf boron content from 18.44 mg kg<sup>-1</sup> to 26.62 mg kg<sup>-1</sup>. Borax application recorded 29 % more number of fruits per plant, 37 % higher yields (65.28 kg plant<sup>-1</sup>) and reduced deformed fruits (13.58 %) compared to control (21.34 %). The study clearly indicated that, the regular supply of boron through foliar application in tropical climate is vital for realizing higher yields in papaya.

**Key words:** Papaya, boron deficiency, leaf boron, deformed fruits and yield

### Introduction

Papaya (*Carica papaya*) is a tropical fruit crop, regarded as the wonder fruit of the tropics and sub tropics due to its high nutritive value and production potential. The area under papaya cultivation increased during the last few decades owing to its increasing demand for fresh fruit as it is a rich source of carbohydrates, minerals and vitamins A, B and C. Fast growing and continuous fruiting habit of papaya demands continuous supply of nutrients. Deficiency of major and micro nutrients has been widely reported in papaya (Jayakumar, 2003) which hampers its production. Among the micronutrients, boron is vital for growth and development of papaya, and considered to be more sensitive to boron deficiency that effects the growth and production by involving in nitrogen metabolism, protein formation, cell division and cell wall formation (Ahmad *et al.*, 2009) and metabolic functions like translocation of carbohydrates to sink, germination of pollen tube (Gupta *et al.*, 1985), movement of potassium to the guard cells of stomata (Cakmak and Romheld, 1997).

The deficiency of boron occurs worldwide and also observed as one of the most common among plant micronutrient deficiencies (Ganie *et al.*, 2013). In India also, boron deficiency has been widely reported in tropical and subtropical regions due to high soil pH, low organic matter, high boron adsorption and poor crop management (Anonymous, 2002; Singh, 2001). Boron deficiency was also reported elsewhere in calcareous soils (Borkakati and Takkar, 2000), soils with low organic matter content, coarse and sandy structure, high pH, drought and more intense cultivation without replenishment of boron (Rashid and Rayan, 2004). Sharrocks (1997) reported that, boron deficiency in papaya causes deformation of new growth, young leaf distortion, plant dwarfing, reduced fruit set, fruit deformation, reduction in fruit size, reduced yields and affect the fruit quality with lot of lumps in pulp and uneven ripening (Raja, 2010). Under extreme deficiency, the yield losses may be very high. Therefore, this study was carried out to

elucidate the importance of foliar application of borax for realizing higher yields in commercially important variety Red Lady papaya at 15 locations in Kadapa District of Andhra Pradesh.

### Materials and methods

The study was conducted during the year 2011-12 in fifteen different locations at Kadapa district of Andhra Pradesh with a commercially important variety 'Red Lady'. Prior to the experimentation, the soils were analyzed for pH, total boron as well as for available boron content. The total and available boron in soils were measured according to curcumin method and hot water soluble method, respectively (Gupta, 1967).

Forty to forty five days old papaya seedlings were transplanted in the pits of 0.3 x 0.3 x 0.3 m dimensions at a distance of 2 x 2 m at all the locations during the first week of July, 2011. Soil application of fertilizers (200 g N, 200 g P<sub>2</sub>O<sub>5</sub> and 250 g K<sub>2</sub>O per plant) was done at every 4 months interval starting from transplanting. The study was initiated with two treatments (T<sub>1</sub> - foliar spraying of 0.03 % borax five times at every 60 days interval starting from transplanting and T<sub>2</sub> - control). The boron content in leaves was analyzed in 6<sup>th</sup> apex leaf petiole before and 10 months after foliar application of borax by spectrophotometric technique using a colorimetric reaction with azomethine-H (Lohse, 1982). The fruits were harvested at weekly interval on appearance of yellow streak at blossom end and yield per plant was recorded by taking the average of five individual plants. Number of bumpy fruits were separately recorded and % deformed fruits was calculated. The data were statistically analyzed by t- test.

### Results and discussion

The data regarding the soil pH, soil boron status and leaf boron levels and yield parameters in papaya variety 'Red Lady' is presented in the Table 1 and 2.

**Soil properties:** Soil pH in 15 different locations varied from 7.98 to 8.35 (Table 1) depicts the high soil pH. Total soil boron content in these locations ranged from 4.03 to 5.46 mg kg<sup>-1</sup> which was higher than the critical limit of 4.0 mg kg<sup>-1</sup> of soil (Singh, 2001). Similarly, the available boron content in soils ranged from 0.38 to 0.41 mg kg<sup>-1</sup> in different locations, which is below the critical limits 0.65 mg kg<sup>-1</sup> of soil (Rashid and Rayan, 2004). The lower available boron in these soils was because of restricted mineralization of organically bound soil boron as a result of drought and slightly high pH levels in tropical regions. The findings were in agreement with Rashid and Rayan (2004) and Singh (2001).

**Boron content in papaya leaves:** The leaf boron content before foliar application of borax varied from 16.48 to 20.01 mg kg<sup>-1</sup> (Table 2). Foliar application of 0.03 % borax at every 60 days interval had pronounced effect on leaf boron status and the mean boron content increased significantly from 18.44 mg kg<sup>-1</sup> to 26.62 mg kg<sup>-1</sup>. The increase in leaf boron status following boron fertilization was also reported in papaya by Raja (2010) and Bhalerao and Patel (2012) in different varieties. Boron is a phloem immobile element and cannot readily transport throughout the plant and hence foliar spraying is an effective means for maintaining the optimum boron required for growth and development (Sharrocks, 1997).

**Number of fruits per plant:** Significantly 29 % higher fruit number per plant was recorded with foliar application of 0.03 % borax at every 60 days interval (47.21) compared to control (36.57) (Table 2). Since the fruits are major competitive sinks, flowering and fruiting stages are more sensitive to boron deficiency. It is well established fact that, boron plays an important role in reproductive growth by involving in pollen tube germination and translocation of carbohydrates to the sink thereby increasing the fruit set, which result in higher fruit number per plant. Jayakumar *et al.* (2003) and Raja (2010) also reported more number of fruits per plant with boron fertilization in papaya.

**Per cent deformed fruits:** A distinct deficiency disease of papaya is distortion of fruits caused by lack of boron. Foliar spraying of 0.03 % borax recorded significant decline in deformed fruits (13.58 %) than control (21.38 %) (Table 2). As the boron

Table 1. Soil pH, boron content and available boron content in the soils at different locations in Andhrapradesh.

Location. No	Soil pH	Boron content in soil (mg kg <sup>-1</sup> )	Available boron content in soil (mg kg <sup>-1</sup> )
1	8.16	4.39	0.41
2	8.06	4.41	0.39
3	8.13	5.46	0.41
4	8.19	4.03	0.39
5	8.26	4.97	0.37
6	8.16	4.65	0.41
7	7.99	4.14	0.40
8	8.08	4.88	0.41
9	8.41	4.39	0.35
10	8.01	4.18	0.38
11	8.19	4.35	0.39
12	7.98	4.07	0.41
13	8.24	4.45	0.38
14	8.17	4.16	0.41
15	8.35	4.32	0.40
Mean	8.158	4.456	0.394

is phloem immobile, continuous supply of boron to the fruits through foliar application reduced the fruit deformities as evident from lower percentage of deformed fruits. Singh *et al.* (2006) also reported that boron spray reduces fruit malformation, albinism as well as grey mould percentage in strawberry. Reduced bumpy fruit formation in papaya with boron application has also been reported by Wang and Ko (1975) and Raja (2010).

**Yield per plant:** Significantly high yield per plant on an average 65.28 kg per plant was recorded at all the locations with boron foliar application compared to 47.63 kg per plant in control without boron spraying. The 37 % increase in yield was mainly due to higher fruit number per plant. The high yields with boron fertilization are supported from the study of Raja (2010) and Bhalerao and Patel (2012) in papaya.

As the boron deficiency is wide spread, particularly in soils with high pH and in areas with high temperatures, correction of boron deficiency can have a pronounced effect on fruit yield and quality of papaya. The present study clearly indicated the importance of boron in increasing the yields of papaya variety 'Red Lady'.

Table 2. Effects of foliar spraying of borax on leaf boron level and yield in papaya var. Red Lady at different locations

Location	Boron content in leaves (mg kg <sup>-1</sup> )		Number of fruits per plant		Deformed fruits (%)		Yield (kg per plant)	
	Before spraying	After spraying	Control	Treated	Control	Treated	Control	Treated
1	18.1	26.31	37.10	41.90	20.1	12.2	44.8	69.15
2	19.8	24.98	38.31	43.40	24.2	16.4	42.5	68.24
3	19.2	26.34	37.59	51.60	22.6	13.5	48.6	63.94
4	18.4	25.08	39.72	43.34	19.9	12.8	49.8	67.51
5	18.9	25.05	32.98	42.80	21.3	14.1	50.3	66.14
6	18.8	25.56	40.21	47.10	19.8	15.3	46.9	67.81
7	20.01	28.98	37.95	52.10	20.6	12.4	49.4	64.94
8	19.16	26.34	32.60	51.90	21.4	13.8	51.3	68.57
9	17.98	28.43	33.62	48.80	23.4	14.1	49.6	61.21
10	19.04	27.58	38.10	47.96	20.5	12.6	51.0	70.14
11	17.48	26.65	32.42	50.80	20.9	13.5	46.9	63.86
12	19.20	26.34	35.60	51.32	21.3	12.9	47.2	53.28
13	16.98	27.08	36.17	46.24	22.1	13.1	44.2	65.04
14	16.48	26.19	36.18	48.14	20.5	14.5	46.5	68.57
15	17.10	28.38	40.10	40.89	21.6	12.6	45.5	60.80
Mean	18.44	26.62	36.57	47.21	21.34	13.58	47.63	65.28
t- statistics		19.2		8.66		17.4		13.4

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