Reprint **ISSN 1991-3036 (Web Version)**

International Journal of Sustainable Crop Production (IJSCP)

(*Int. J. Sustain. Crop Prod.*)

Volume: 8	**Issue: 1**	**August 2013**

Int. J. Sustain. Crop Prod. 8(1): 25-27 (August 2013)

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http://ggfjournals.com/ejournals/current issue

IJSCP** issn 1991-3036, HQ:19-10 cantral place, saskatoon, saskatchewan, s7n 2s2, Canada

ISSN-1991-3036 (Online)
Int. J. Sustain. Crop Prod. 8(1):25-27(August 2013)

GROWTH AND YIELD OF PAPAYA SUBJECTED TO NUTRIENT DEPRIVATION

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Accepted for publication on 22 July 2013

ABSTRACT

Kaisar MO, Ara N, Sadat MA, Khalequzzaman KM (2013) Growth and yield of papaya subjected to nutrient deprivation. *Int. J. Sustain. Crop Prod.* 8(1), 25-27.

In order to evaluate nutritional requirements and the effect of nutrient deprivation on the growth and yield of papaya, an experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during the growing season of 2008. The experiment included one complete treatment (provided N, P, K, S, Mg, B, Mo and Zn), besides deprivation of each nutrient (-N, -P, -K, -S, -Mg, -B, -Mo and -Zn), and one absolute control treatment (natural soil). Papaya has high nutritional requirements, and nutrients N, P, K, S, B and Mo, in that order, were found to be limiting factors to plant growth. Mg and Zn deprivation did not affect plant growth. B, N, P, Mo, S and K are essential to obtain higher yield in papaya.

Key words: *missing element, soil fertility, nutritional deficiency, papaya*

INTRODUCTION

Papaya (*Carica papaya*) is an important quick growing delicious and nutritious fruit. It is not only needed as a fresh fruit but also used as vegetable for cooking. It contains high amount of vitamin A and C. It is also a very rich source of iron and has got some medicinal values as well (Rashid *et al*. 1987). Papaya is available round the year and grown easily in the homesteads as well as large scale farms (Ahmad 1984). Bangladesh produces 38000 tons of papaya from an area of about 4500 hectares of land having an average yield of 7.75 t/ha (BBS 2008). This yield is very low considering that of other papaya growing countries. This is due to a number of reasons and imbalance fertilization of the crop is the major one. Both macro- and micro-nutrients have important role in increasing yield of papaya through their effects on the plant (Lkhande and Moghe, 1991). One ton of papaya fruit remove 989 mg B, 1847 mg Mn, and 8 gm Mo with necessary micro- and macro-nutrients (Cunha and Haag, 1980). In general, application of trace elements increases plant height, girth, number and yield of fruits (Chattopadhyay and Gogoi, 1990). It was also reported that deformed fruit is caused due to B deficiency and deformed fruits contained only c. ¼ as much B as the levels of healthy plant (Wang and Ko., 1975). Purposefully, a particular nutrient stress created through missing element technique from complete treatment effect in increasing yield was considered as a measuring stick of nutrient efficacy. The experiment was undertaken to measure the extent of each nutrient exclusion effect and simultaneously their application in soil to increase the yield of papaya.

MATERIALS AND METHODS

The missing element technique experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during the growing season 2008 with 10 treatment combinations (N, P, K, S, Mg, B, Mo and Zn as complete treatment, omission of one nutrient from complete nutrient i.e., -N, -P, -K, -S, -Mg, -B, -Mo and -Zn, including one absolute control treatment). The local papaya was used as planting material in this study. The experiment was laid out in RCB design with three replications. The unit plot size was 4 m × 4 m and the seedlings were planted at a spacing of 2 m × 2 m. The 30 days old seedlings were transplanted in the main plot. The beds were prepared and pits measuring 50 × 50 × 50 cm were dug. Fertilizer was applied at the rate of 225, 60, 225, 36, 0.4, 0.2 and 2.5 g/pit of N, P, K, S, Mg, B, Mo and Zn, respectively. Cowdung was used at the rate of $^1/_2$ kg/pit. Whole amount of cowdung and fertilizers except urea and MOP were applied to each pit and mixed with the soil. Planting was done on May 03, 2008. Three seedlings were transplanted in each pit at 20 cm apart. There were 4 pits in each bed which constituted one treatment. When flower was appeared to the plants kept one female plant in each pit and one male plant in each bed were maintained. First top dressing of urea and MOP @ 50 g per pit was applied one month after transplanting, the second and third at 45 days interval was followed with the same dose. At 4th, 5th and 6th top dressing the dose of urea and MOP was double. The intercultural operations (weeding, irrigation, mulching, insecticide spray etc.) were done as and when necessary. Data on plant height, base girth, days to 1st flowering, days to 1st harvest, number of fruits per plant, fruit length and breadth, single fruit weight, flesh thickness, TSS% and yield per plant were recorded and statistically analyzed.

RESULT AND DISCUSSION

It appears from the Table 1 that the missing of nutrient individually from the complete treatment significantly decreased yield and still significantly higher than absolute control treatment. The plant height at harvest of different treatment ranged from 1.72-2.67 m. The tallest plants (2.67 m) were observed in T_1 (all elements *viz.* N, P, K, S, Mg, B, Mo and Zn) followed by T_9 (T_1-Zn), T_6 (T_1-Mg), T_5 (T_1-S) and T_4 (T_1-K) while the shortest plants (1.72 m) were recorded in T_{10} (control). It indicates that Zn and Mg alone had no effect on plant height.

Mo alone or in combination of all nutrients plays an important role on plant height. N had a direct relationship with plant height. Base girth differed significantly among the treatments, the highest was found in T_1 (36.67 cm) followed by T_4, T_9 and T_6, while the lowest (26.33) was in T_{10}. It revealed that N and S enhanced the plant to be stout. The effect of N on plant growth was supported by Viegas *et al.* (1999) and Shukla *et al*. (2001). Oliveira *et al*. (2007) reported significant effect in plant growth by N, P and K. There was no significant variation among the treatments in respect of days to first flowering and days to first harvest. The highest number of fruits per plant (27.67) was obtained from T_1 which contained all the elements and was statistically similar to T_9 (25.35) and T_6 (23.16), and rest of the treatments was significantly different. From the result it was indicated that combination of all macro and micro nutrients increased the number of fruits per plant. The highest single fruit weight (1.69 kg) was found in T_1 followed by T_9 (1.53 kg). The lowest fruit weight (0.65 kg) was recorded in the control treatment. Lower fruit weight in treatment T_7 might be due to lack of boron reducing fruit size. Chattopadhytay and Gogoi (1990), and Wang and Ko. (1975) reported that boron deficiency significantly decreased fruit size with deformed shape of fruit. Flesh thickness was reduced significantly due to missing of B, Mo, N and S. The quality of the most of the fruits is judged by TSS content. The taste in general and sweetness in a particular fruit depend largely on the percentage of total soluble solids. The TSS percentage among the treatments varied from 4.20 to 7.12. T_2 contained the highest percentage of TSS (7.12) and lowest was in treatments missing P and Mg. Agarwala *et al*. (1986) reported similar observation with TSS. The lack of B also reduced TSS in some extent which was supported by Kavitha *et al*. (2000). The highest yield per plant (46.78 kg) was recorded from the treatment T_1 which was contained all the macro- and micro-nutrients and was significantly different from rest of the treatments. Besides the control treatment, T_7 (T_1-B) produced the lowest yield per plant (8.14 kg) due to the absence of boron. Ghanta *et al.* (1992) and Talukder *et al.* (2001) also made similar observation with boron. Jeyakumar *et al*. (2001) suggested that Z and B increased growth and fruit yield of papaya. Anjaneyulu (2007) observed that the most common yield-limiting nutrient was zinc, followed by potassium. These reports also supported the present study.

Table 1. Effect of nutrients on growth and yield of papaya

Treatments	Plant height (m)	Base girth (cm)	Days to 1st flowering	Days to 1st harvest	No. fruit/plant
T_1 = All elements	2.67 a	36.67 a	102.34	226.33	27.00 a
T_2 = T_1-N	1.97 cd	27.00 de	94.72	238.67	19.25 cd
T_3 = T_1-P	2.02 b-d	29.67c-e	80.10	222.33	19.10 cd
T_4 = T_1-K	2.30 a-c	35.33 ab	84.37	230.33	22.03 b-d
T_5 = T_1-S	2.32 a-c	28.00 de	105.38	242.33	21.51 b-d
T_6 = T_1-Mg	2.35 a-c	32.33 a-d	91.98	239.00	23.16 a-c
T_7 = T_1-B	2.17 bc	30.00 b-e	102.95	238.33	18.64 d
T_8 = T_1-Mo	2.17 bc	30.67 b-e	92.59	227.67	21.18 cd
T_9 = T_1-Zn	2.37 ab	34.00 a-c	87.11	239.67	25.35 ab
T_{10} = Control	1.72 d	26.33 e	108.43	220.33	12.58 e
CV (%)	9.13	9.29	9.23	4.87	10.39

Table 1. Contd.

Treatments	Fruit length (cm)	Fruit breadth (cm)	Single fruit wt. (kg)	Flesh thickness (cm)	TSS %	Yield /plant (kg)
T_1 = All elements	31.83 a	21.52 a	1.69 a	2.98 ab	6.25 abc	46.78 a
T_2 = T_1-N	25.58 bc	17.35 b	1.03 ef	2.54 cd	7.12 a	19.82 f
T_3 = T_1-P	27.57 bc	17.94 b	1.07 ef	3.14 a	4.21 f	20.41 ef
T_4 = T_1-K	28.36 ab	18.80 b	1.33 cd	2.89 ab	5.07 d-f	28.59 cd
T_5 = T_1-S	29.07 ab	19.16 b	1.18 de	2.76 bc	5.83 b-d	25.46 de
T_6 = T_1-Mg	28.96 ab	18.94 b	1.41 bc	3.10 a	4.20 f	32.55 c
T_7 = T_1-B	23.94 c	17.32 b	0.98 f	2.38 d	5.58 b-e	18.36 f
T_8 = T_1-Mo	25.31 bc	17.60 b	1.01 ef	2.45 cd	5.51 c-e	21.34 ef
T_9 = T_1-Zn	29.32 ab	19.07 b	1.53 ab	2.96 ab	6.56 ab	38.83 b
T_{10} = Control	15.05 d	8.54 c	0.65 g	0.90 e	4.65 ef	8.14 g
CV (%)	8.25	6.94	8.29	6.64	10.04	10.89

All elements = N, P, K, S, Mg, B, Mo and Zn

Means within a column followed by common letter(s) are not significantly different from each other by DMRT at 5% level of probability

CONCLUSION

Response of macro- and micro-nutrient in yield of papaya was predominant. Absence of those elements in Ishurdi soil each reduced substantial amount of yield. N, P, K, S, B and Mo, in that order, were found to be limiting factors to plant growth. Mg and Zn deprivation did not affect plant growth. B, N, P, Mo, S and K are essential to obtain higher yield in papaya. The study also highlights the importance of complete or balance fertilization for maximizing yield of papaya.

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