Bumpiness problem and its remedy in Papaya (*Carica Papaya*)

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ABSTRACT

Papaya (pawpaw) Carica papaya L. belongs to family Caricaceae. Papaya is a very good source of fruit sugar, vitamin A, B and C. This fruit is rich in minerals and salts and makes very good food. Fiji's climate is very suitable to grow papaya and Fijian grown papaya has a big export market. Main importing countries so far are New Zealand, Japan and Canada. Another potential country for exporting papaya from Fiji is Australia. However, strict quality control and high sanitary requirements must be met to export papaya to Australia. Papaya export has gone up in last few years but unfortunately there has been no export so far to Australia. Fruit's shape, size and smoothness are important determinant factors for export market. Misshapen fruits with bumps are not acceptable in overseas market. Similarly most importing countries prefer medium sized fruits. To get good quality papaya particularly fruits without bumps, it is necessary to apply Boron in soil. Results obtained in the present investigation showed that 5.0kg Boron (applied as borax pentahydrate) per hectare was very effective in reducing bumpiness to a very minimum thus improving the quality of fruits. Boron as such showed no effect on papaya yield per plant. Three cultivars tested for average fruit weight showed acceptable fruit weight for local and export market. However, Solo Sunrise was identified as the highest average fruit yielding cultivar (tons/hectare). Improvement in quality of papaya will open up new markets for export.

Keywords: *Hawaiian papaya, cropping system, bumpy-fruits, plant nutrients*

1. INTRODUCTION

Papaya (also called pawpaw) has long been known to grow well throughout Fiji, but only recently attempts have been made at commercial production. These attempts are made to meet an increasing demand of papaya fruits for hotels, local consumption and also for export as fresh fruit to Australia, New Zealand, Japan and Canada. Japan is the most profitable market, but requires a very high standard of fruit quality, uniformity and packaging. But Australia requires more stringent quality control and quarantine regulations for fruit import from other countries.

At present there are only a few large-scale papaya farmers growing papayas for export and for local market. Also there are individual small-scale farmers growing papaya for only local market. Large-scale farmers are growing papaya for either Southern Development Company (SDC) or other exporters who provide the necessary inputs so that the marketable quality of fruits and production level is sustained. The main problem in exporting papaya to developed countries is poor quality. Bumpiness (uneven surface) on the skin of fruits, fruit shape, and size affect the quality and thus export market particularly Australia. Preliminary trial conducted to improve the quality particularly to reduce or minimize bumpiness in papaya fruits showed that bumpiness is caused by boron (a plant nutrient) deficiency. It is estimated that up to 15% of the fruits are rejected due to deformity in fruits mainly caused by boron deficiency. The symptoms are enhanced in cool dry season. Lack of water slows growing of roots and reaching to boron because boron is immobile in soil. Therefore a trial was conducted with different levels of applications of boron (applied as borax Pentahydrate 14.85% boron) using three Hawaiian papaya cultivars extensively grown by farmers in Fiji.

2 MATERIALS AND METHODS

2.1 PLANTING MATERIAL

Plant material included three Hawaiian cultivars namely; Solo-Sunset, Solo-Sunrise and Solo-Waimanalo were raised at Sigatoka Research Station nursery in polythene bags for planting. Because seeds produced by selfing hermaphrodite plants produce two-third hermaphrodite and one-third pistillate papaya plants (Shafiya *et al*. 2002) therefore at least three seeds were planted in each pot and watered daily. Seedlings were raised in black polythene bags (planter bags) of 20x12.5cm, which have a number of holes for proper aeration and water drainage. Riverbank soil was used as potting medium after treatment with basamid^{TM} or soil pasteurization before potting. Nitrogen, Phosphorous and Potash (NPK) were applied at the rate of 1g/plant fortnightly until the plants were ready for transplanting. Plants were raised under shade-cloth (Sarton). The shade cloth was removed during the last week in nursary for hardening of seedlings before the papaya plants were ready for transplanting in the field. Enough seedlings of each cultivar were raised for conducting field trials.

2.2 FIELD LAY OUT AND PLANTING

After 8 to 10 weeks from sowing, seedlings were ready for planting (about 20cm in height). Holes were dug about 25cm deep and 20cm wide. Seedlings were planted by tearing off polythene bags but retaining soil around roots. The seedlings were watered at planting and twice per week until the plants start growing. A randomized block design with three replications was used with main treatment levels of Boron application and sub treatments as papaya cultivars. Each replication had 4x3 (12) plots and each plot consisted of one row of 12 plants each. Guard rows were planted to minimize advantage to side plots. Normal agronomic practices including regular irrigation (when there were no rains), fertilizer application, weeding and hoeing were followed until the final harvesting was done.

Four levels of Boron (applied as borax pentahydrate); 0kg, 1.0kg, 2.5kg and 5.0kg per hectare were tested. Fruits were harvested only from 10 plants per row leaving one plant on each side.

2.3 DATA COLLECTION AND ANALYSIS

Data were recorded on average number of fruits with bumps, average fruit weight and average yield per hectare. Variance ratio (F) tests were carried out to determine the effect of Boron application mainly on fruit quality, average fruit weight and average yield per hectare for main treatments and sub-treatments. The average yield per hectare included total harvest for yearlong season when other data were recorded. Data were also collected on papaya export to different countries for the last seven years. The main source of these data was Quarantine Department Sigatoka branch.

Table 1. Effect of boron application on average number of fruits with bumps per tree, average fruit weight (g) and average yield (tons/hectare)

Treatment	Cultivar	Average # of fruits with bumps	Average fruit weight (g)	Average yield per hectare
0 kg / hectare	Solo Sunset	1.07	420	57.6
	Solo Sunrise	1.02	410	61.7
	Solo Waimanalo	1.04	600	45.2
	Average	**1.04**	**476.7**	**54.83**
1 kg / hectare	Solo Sunset	0.47	429	58.4
	Solo Sunrise	0.49	417	63.7
	Solo Waimanalo	0.43	598	49.3
	Average	**0.46**	**481.3**	**57.1**
2.5 kg / hectare	Solo Sunset	0.29	418	56.9
	Solo Sunrise	0.31	411	62.5
	Solo Waimanalo	0.32	608	44.6
	Average	**0.31**	**612.3**	**54.7**
5 kg / hectare	Solo Sunset	0.15	425	60.5
	Solo Sunrise	0.17	416	61.9
	Solo Waimanalo	0.16	602	43.2
	Average	**0.16**	**481**	**55.2**

Calculated F values: 1. For main treatments (Boron effect on bumpiness) - $F = 9.8^{**}$
2. For sub treatments (Average fruit weight) - $F = 2425^{***}$
3. For sub treatment (Average yield tons / hectare) - $F = 18.37^{**}$

3 RESULTS AND DISCUSSION

Results of the Boron trial with three papaya cultivars are presented in Table 1. Average number of fruits per plant with bumps were highest (1.04) in control (no boron was applied) followed by 1.0kg and 2.5kg boron application per hectare. The lowest average number of fruits per plant with bumps was recorded in 5.0kg boron application per hectare. The difference was highly significant ($F = 9.8^{**}$) among four levels of boron application. Chan and Raveendranathan (1984) reported differential sensitivity of papaya cultivars in expression of boron deficiency symptoms. Dry cool climate reduces the uptake of Boron from soil thus increasing the incidence of bumpiness in papaya fruits. Chand *et al.* (1998) reported the effect of various levels of nitrogen application, irrigation levels and boron application on fruit yield and bumpiness. With regard to average number of fruits per plant with bumps, their results were very similar to as presented in Table 1. However in their experiment of Boron application Ucuboi *et al.* (2001) did not observe significant differences between 2.5kg and 5kg Boron application (applied as Borax) per hectare in average number of fruits with bumps per plant. Three cultivars showed very little variation in average number of fruits with bumps per plant with different levels of boron application (Table 1) under present investigation.

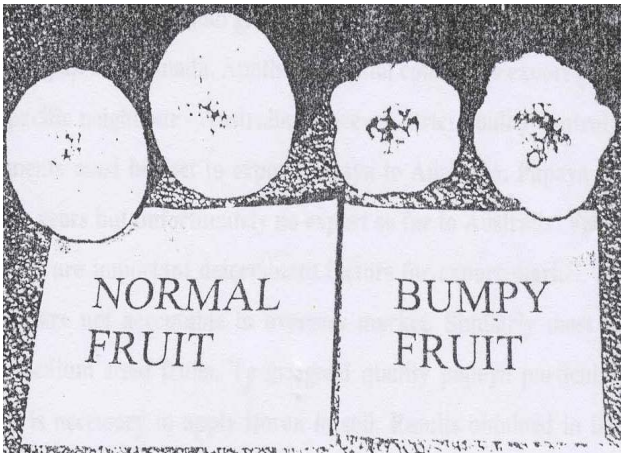

Figure 1. Normal and bumpy Fruits in Papaya.

Differences were observed in average fruit size in three cultivars (F 2425**) highest being in cultivar Solo Waimanolo followed by Solo Sunset and Solo Sunrise. Export market requirements are medium sized fruits between 400g and 600g (Datt-Personal Communication) which are easy for packaging and handling. Therefore the most suitable size of fruits for export should be All three cultivars produce fruits within this range and thus fit for export market. Three papaya cultivars differ highly significantly (F 18.73**) in their yielding ability (fruit yield per plant). Solo-Sunrise was the highest yielding cultivar followed by Solo Sunset and Solo Waimanalo. Similar results with regard to yielding potential of these three cultiwars were reported by Chand *et al.* (1998) and Ucuboi *et al.* (2001).

Papaya export from Fiji is limited to only New Zealand and Japan (Table 2). The increase in papaya export was made possible by the installation of the high temperature forced air treatment (HTFA) facility at Nadi airport in 1996. The largest importing country is New Zealand so far. There is no export to Fiji's bigger neighbour Australia, where quality control is very strict and sanitary and quarantine requirement are demanding. Efforts are being made to meet the Australian and Canadian quality and quarantine requirements.

Table 2. Papaya exports from Fiji during 1997 - 2003*

Year	Countries			
	New Zealand (Kg)	**Japan (Kg)**	**Canada (Kg)**	**Total (Kg)**
1997	97,257	26,120	89	123,495
1998	73,874	93,416	-	167,290
1999	145,342	40,443	-	185,785
2000	67,961	2,693	-	70,654
2001	156,736	13,117	-	169,853
2002	168, 374	17,214	-	185,588
2003	152,486	15,189	-	167,675

*These are consignments certified by Quarantine Sigatoka. Figures may not be reflective of total export from Fiji to mentioned countries in this table.

4 CONCLUSION

Although three cultivated Hawaiian papaya varieties; Silo Waimanalo, Solo Sunrise and Solo Sunset are very good in fruit production, however, bumpiness in papaya fruits (uneven surface and bumps) reduces the quality of fruits, which render them unsuitable for export market. Boron application, when applied as boron pentahydrate art the rate of 5.00kg per hectare can reduce and minimize bumpiness problem in papaya fruits. Such fruits are better in quality and acceptable in overseas markets. New Zealand, Japan and Canada are the main papaya importing countries of Fijian papaya so far. Improvement in quality, better sanitation conditions and observance of quarantine regulations will soon make an impact on papaya export to other neighbouring countries including Australia.

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