Water Usage and Papaya Growth in Double-Row Systems Established During the Dry Season

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March 31, 2008

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Abstract

Disclaimer

The research on which this report is based was financed in part by the U.S. Department of the Interior, United States Geological Survey, through the Virgin Islands Water Resources Research Institute. The contents of this publication do not necessarily reflect the views and policies of the U.S. Department of the Interior, nor does mention of trade names or commercial products constitute their endorsement by the United States Government.

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Introduction

The crop farms in the U.S. Virgin Islands are mainly comprised of small farmers. The average amount of land for a crop farmer is 4.7 acres (National Agricultural Statistics, 2000). Though this average includes livestock farmers, the crop farmers are less than 2 acres. The small size limits the investment the farmer can make to produce a crop. They have to see a strong benefit to a technology before they invest in it and adapt it to their farming practices. New technologies are being developed for papaya production. Papaya requires nine months from seed, in the early varieties, to have a marketable crop. To have fruits available during the holiday season and peak tourist season, papayas need to be planted in late February through March. However, February through August are normally the driest months of the year in the US Virgin Islands.

Plant spacing from the past project indicated that growth and production were not influenced by plant spacing (Kowalski and Zimmerman, 2006). The plant spacing was 9' x 9', 6' x 9' and a double-row 3' x 9'. The double-row provided a higher planting density and a more efficient use of space and irrigation water.

Drip irrigation technology permits the resourceful use of water and can help maximize the use of semiarid lands for agricultural use. This technology is particularly suited to widely spaced crops as papaya. Though multiple field trials have shown the economic beneficial use of drip irrigation on vegetable and herb production in the Virgin Islands (Palada et al, 1995; Crossman et al, 1997; Palada and O'Keefe, 2001) limited information is available on the use of drip irrigation for papaya production (Kowalski and Zimmerman, 2001; 2006). It has been suggested that the water needs for papaya in Hawaii are ideally supplied with 100 mm of rainfall each month (Nakasone and Paull, 1998). This amount is seldom encountered in the semiarid climate of the Virgin Islands where erratic rainfall patterns and extended dry periods are the norm. Also, the local preference is for large, greater than two pounds, red papayas while most papaya research from Hawaii has focused on small, yellow one pound or smaller fruit. Not only are the varieties different between the Virgin Islands and Hawaii but also the soil. The soils of the Virgin Islands are calcareous, having a high pH around 8 versus volcanic base in Hawaii. Breeding and selection of papayas at the University of the Virgin Islands has resulted in early bearing varieties that meet the fruit preferences of the Virgin Islanders (Zimmernan and Kowalski, 2004).

Description of the Problem

Water is most often the limiting factor to crop production in the U.S. Virgin Islands. The municipal source of water is from desalination of ocean water. Due to the cost of the desalinated municipal water, farmers use the water sparingly. The most efficient use of water can result in economical gains for the local farmers. We wish to develop for farmers proficient ways to manage water usage throughout papaya establishment to ensure quality production during the greatest demand for the product. By establishing the beneficial influence drip irrigation, mulch and plant spacing has on papaya production, the small scale farmers will be encouraged to grow papayas and apply the irrigation technology to the situation and incorporate sustainable production practices, water conservation and improve soil stewardship. The expected benefit to the small scale minority farmer is not only the use of environmentally sound farming practices

but also increase real income from production. The results will be applicable to small scale farmers in the tropical regions both domestic and foreign. This research project expanded on the double-row concept to include closer double-row spacing to determine the best intensive plant spacing for the most efficient use of water for fruit set.

Methodology

The objectives of this research were to develop a commercial papaya producing field plot that incorporates drip irrigation and mulch for growing selected papaya varieties at multiple double-row spacing regimes and determine water usage during the dry season in the U.S. Virgin Islands. Specifically to integrate water conservation through drip irrigation and mulching into papaya production, determine water requirements of papaya grown under multiple double-row plant spacing regimes and determine the growth and production potential of papaya as influenced by spacing under drip irrigation and biodegradable mulch

Papaya plants were established in double-row spacings during February from greenhouse grown seedlings. Water usage was recorded over a six month period which corresponds to the annual dry season from March through August with the assistance of a prebaccalaureate student. Tensiometers were used to record soil moisture levels and determine when irrigation water needed to be applied.

To study the integrate water conservation through drip irrigation and mulching into papaya production, papaya were established from seed in a greenhouse one and a half months prior to transplantation to the field at the University of the Virgin Islands Agricultural Experiment Station on St. Croix. The three varieties used were 'Maradol', 'Tianung 5' and 'Yuen Nong 1'. 'Maradol' is a compact variety producing red 4-5 lb fruit. 'Tianung 5' and 'Yuen Nong 1'are standard sized trees that produce large red and yellow fruit respectively.

A double-row plant spacing regime was followed. A nine foot distance was between double-rows to allow for tractor cultivation until the plants attain three feet. Each double-row was three feet apart. The distance between each plant within a row of the double-row varied from three feet, six feet or nine feet which corresponds to 2,400, 1,200, or 800 plants per acre respectively. Each plant spacing was replicated three times and had ten plants of each variety per replication. Guard rows were planted on both sides of the field and between replications. Guard plants were also planted at the end of each row.

One drip line of irrigation was installed at the time of transplanting six-eight inch tall seedlings into the field. The spacing of the orifices in the linear irrigation tubing was three feet and exude one gallon per hour. The drip lines were placed near the plant base and moved outward to a distance of 1.5 feet from the base of the plant. A final drip line was added between the double rows when the plants were at three feet in height. The double rows then had a drip line outside of each row and one between the double-rows for a total of three lines per double-row. Hay mulch was applied to the whole field after the third drip line was installed. The drip lines were under the mulch and in contact with the soil. The hay mulch was spread to a depth of the three inches between plants and rows. The straw/hay was obtained from the VI Department of Agriculture as large round bales.

To determine water requirements of papaya grown under double-row plant spacing regimes soil moisture tensiometers were placed throughout the plots at a depth of 15 cm and 30 cm. The tensiometers were used to determine soil moisture content. Water meters were installed for each plant spacing plots and the amount of water applied recorded over time. Rainfall information was obtained from the IVI-AES weather station.

During the initial six month growth of the papaya plot corresponding to the dry season, data was collected on plant height, height to first flower, height to first set fruit, stem diameter at three feet from the soil surface and number of fruit set when the first fruit was ripening. This growth and production data was obtained to determine the influence of spacing and drip irrigation on papaya yield.

A prebaccalaureate student assisted in data collection and entered the data into a computer spread sheet. The student was involved in all aspects of the research and was be an integral part throughout the project.

Findings

Papaya were established under field plot conditions in early 2007 from seeds germinated in a greenhouse. The first six months of 2007, during the establishment of the papaya plot, a typical dry season was experienced on St Croix (Figure 1). Low rainfall started in January and when plant establishment occurred in early February, the soil was dry. During the initial six months of papaya growth, water was applied as indicated in Figure 2 and corresponded with soil moisture levels. The mulch was very effective in controlling weeds, conserving soil moisture and protecting the soil from erosion during sudden short heavy tropical rains. The total amount of water given to each plant was 62 gallons over seven and one half months for the 1 m x 2 m plant spacing.

The plant spacing did have a significant influence on the stem diameter of the plant. The stem diameter is important in supporting a column of fruit as well as tolerance to wind. The close double row spacing 1 m x 1 m had the narrowest stems on average 6.8 cm while the widest spacing, 1 m x 3 m, had an average stem diameter of 9.1 cm (Table 1). The stem diameter was recorded 1 m above the ground and after six months of growth. There was a trend that the hermaphroditic plants had thicker stems then the female plants. The plants in the close 1 m x 1 m spacing also tended to bend outward and not be perpendicular to the ground.

Addendum

A papaya workshop and field tour was conducted on Sunday September 9, 2007 from 2 - 4 pm that was open to the public and included farmers from St Thomas.

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Table 1. Diameter of papaya stems taken at a one meter height for three varieties as influenced by plant spacing.

	Spacing (m)*		
Variety	3x3	3x6	3x9
Maradol	6.70 a	7.80 ab	9.01 b
Tianung 5	6.49 a	8.67 b	9.36 b
Yuen Nong 1	7.01 a	8.35 ab	9.86 b

*Mean separation by variety conducted using LSD P=0.05

Table 2. Number of fruit set at the time of the first ripe fruit for three papaya varieties as influenced by plant spacing.

	Spacing (m)*		
Variety	3x3	3x6	3x9
Maradol	23.3 a	35.9 b	38.8 b
Tianung 5	27.9 a	46.1 b	49.0 b
Yuen Nong 1	23.1 a	36.5 b	39.1 b

*Mean separation by variety conducted using LSD P=0.05

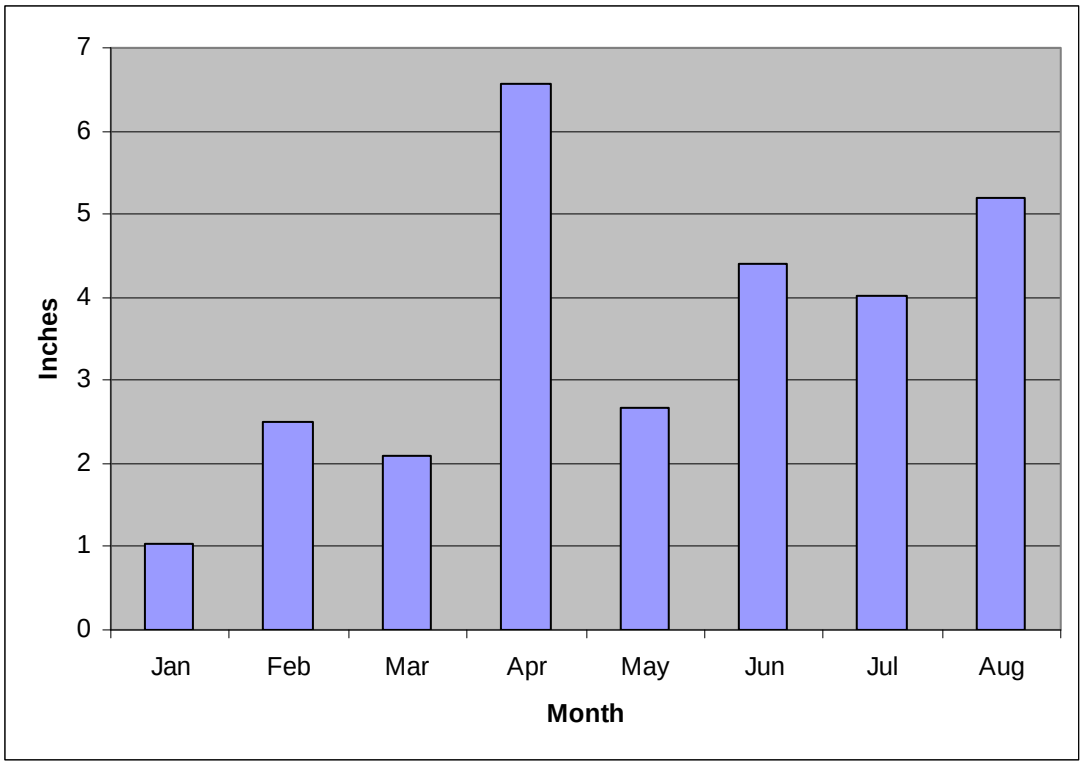

Fig. 1. Average monthly rainfall during 2007.

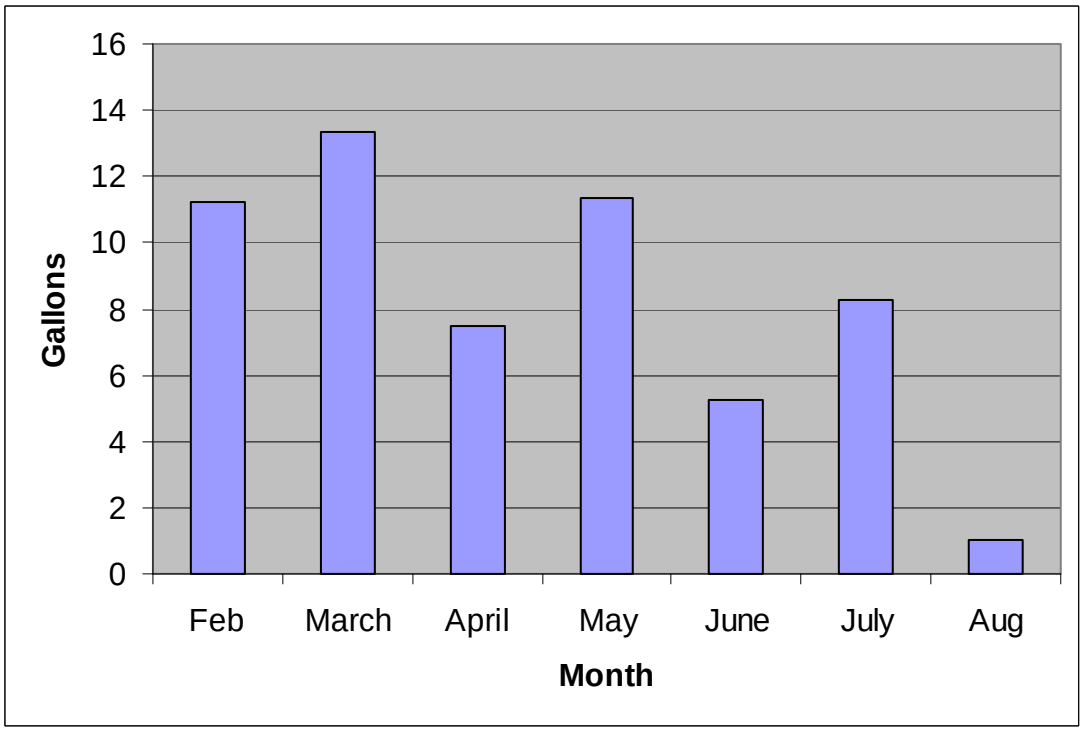

Fig. 2. Average gallons of water applied to each papaya plant.

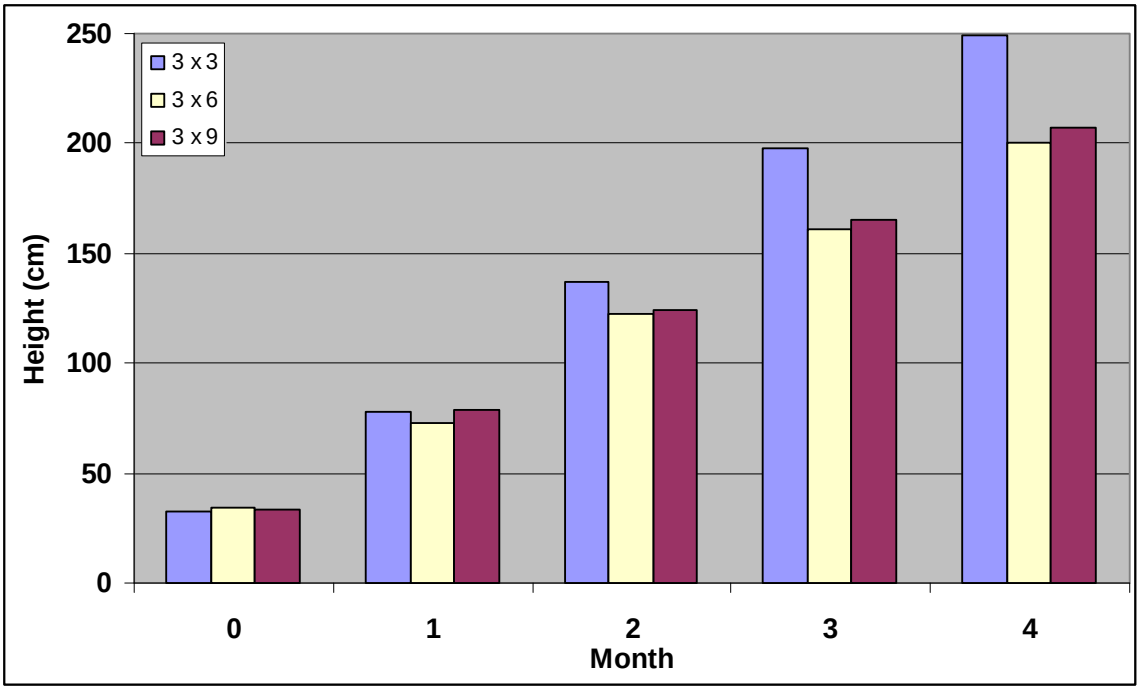

Fig. 3. Plant height of the 'Maradol' papaya plants during the first four months.

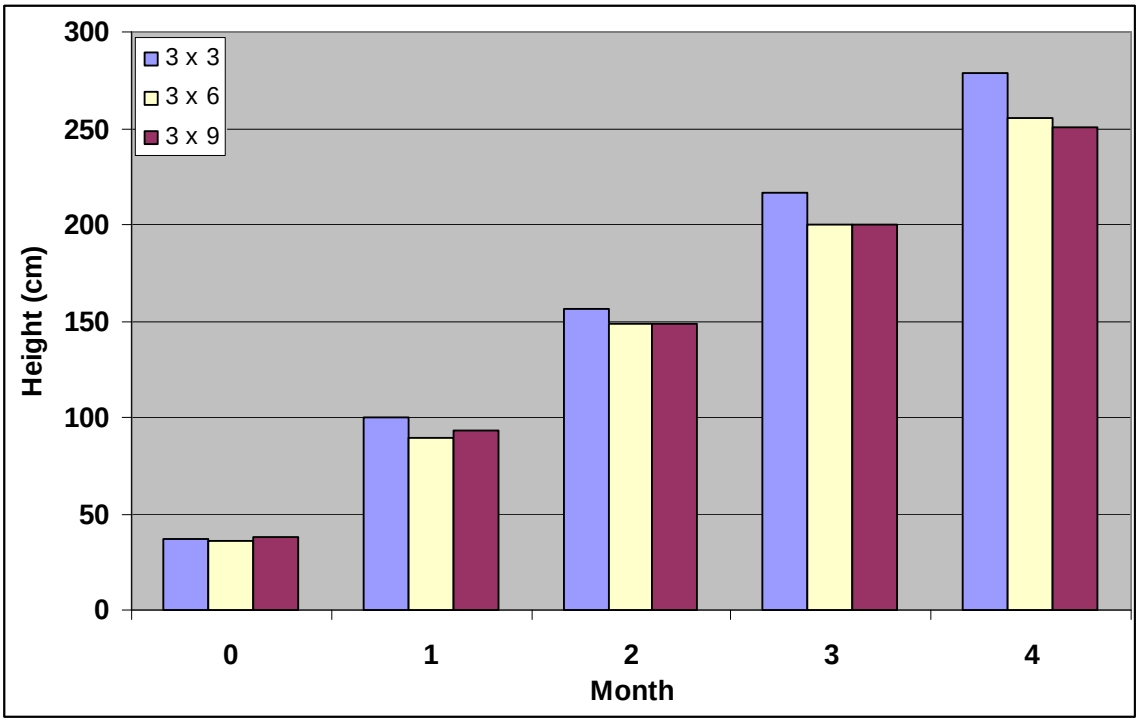

Fig. 4. Plant height of the 'Tainung 5' papaya plants during the first four months.

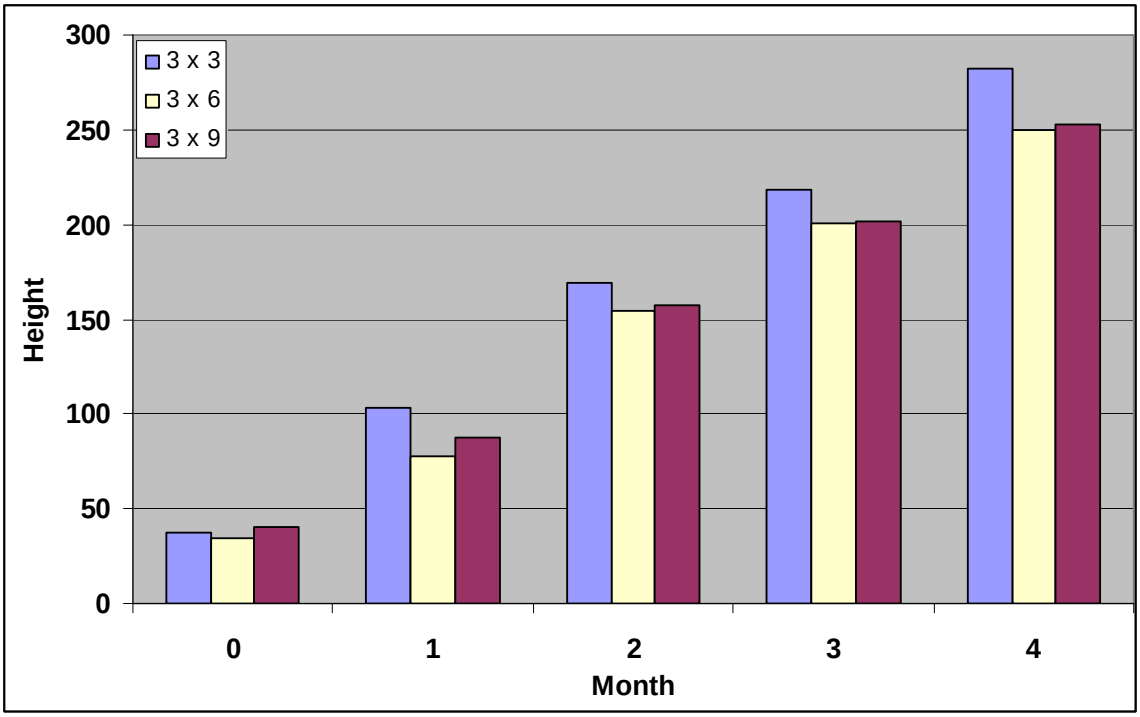

Fig. 5. Plant height of the 'Yuen Nong 1' papaya plants during the first four months.

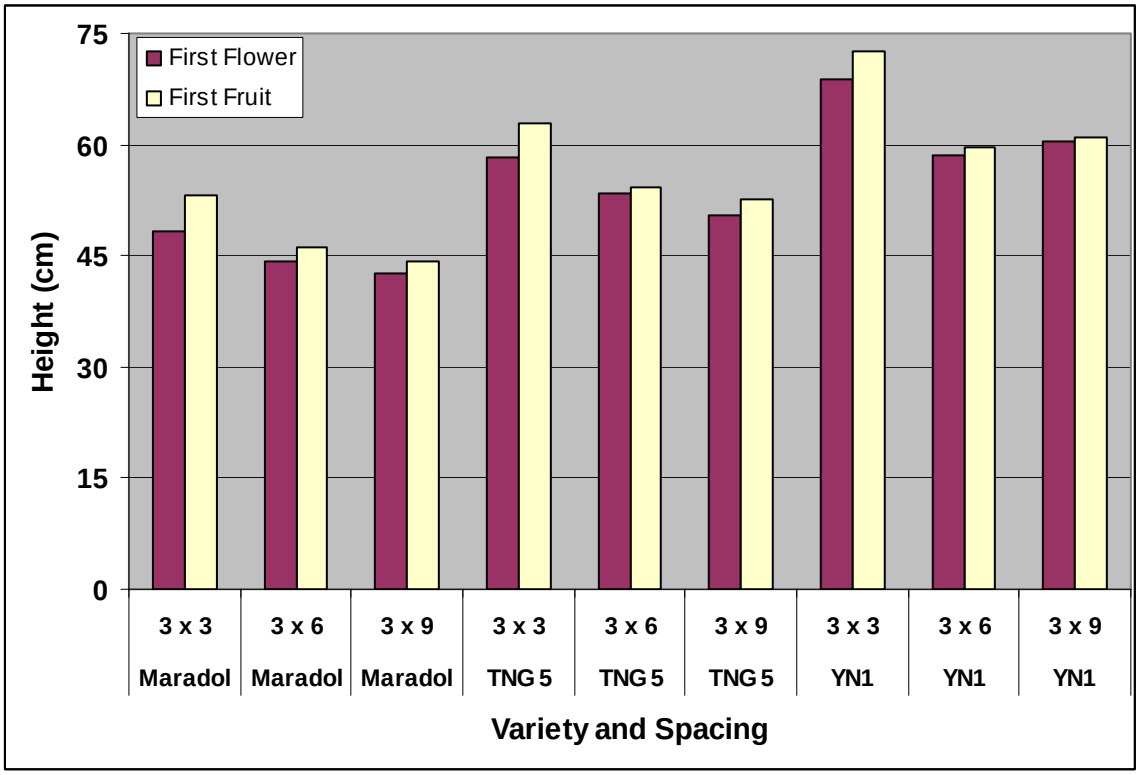

Fig. 6. Effect of plant spacing on the initiation of the first flower and setting of the first fruit for three papaya varieties.