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GROWTH AND YIELD OF HOT PEPPER IN HEDGEROW INTERCROPPING WITH *MORINDA CITRIFOLIA* L. DURING EARLY ESTABLISHMENT

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ABSTRACT: Intercropping high-value horticultural crops with tree crops is an economically attractive, but little studied, agroforestry option in the U.S. Virgin Islands. A study was conducted to evaluate growth and yield performance of hot pepper (*Capsicum chinense* L.) under hedgerow intercropping with Morinda (*Morinda citrifolia* L.), a popular medicinal tree in the Virgin Islands. Morinda hedgerows were established at 5-m spacing forming 5-m wide alleys between hedgerows. One year after hedgerow establishment, seedlings of hot pepper cultivar 'West Indies Red' were transplanted in alleys at 1 m row spacing and 0.60 m plant spacing within rows. Similar spacing was used for plots planted with monoculture hot pepper (no hedgerows). The experiment was designed using a randomized block with four replications. The Morinda hedgerows were not pruned during the cropping year. Data were collected on hot pepper height, number and weight of marketable fruits. Hedgerow plant height and canopy width were also determined at 3-month interval. Treatment effect of hedgerow on growth and yield of hot pepper was compared with monoculture crop. Analysis of data indicated that during the early establishment of hedgerows, plant height and marketable yield were not significantly *(P>0.05)* reduced in hedgerow intercropping. Differences in height and yield by rows relative to distance from hedgerows were not significant *(P>0.05).* However, average yield under hedgerow intercropping was slightly lower than monoculture (no hedgerow) crop. This study would indicate that during the early stage of hedgerow establishment, tree-crop competition is not critical in reducing growth and yield of hot pepper. Long term effects of hedgerows on productivity of intercrops will be further investigated.

INTRODUCTION

The Virgin Islands is endowed with tropical climate and natural resources that provide opportunities for year-round cultivation of high value crops. However, in spite of the ideal conditions, agricultural productivity and overall economy of the islands are declining. The decline in agricultural output can be attributed to several factors including the after effects of hurricanes, decrease in the number of farms and disappearance of important plant species such as medicinal plants, indigenous herbs and medicinal trees with economic potentials. Despite the general decline in farming activity, there has been a slow but increasing trend in the number of farms (McElroy and Albuquerque 1985; Moore 1991). For example, in 1998 a combined total of 134 farms were growing vegetables and herbs in the island of St. Croix alone. Part-time farmers manage most farms with farm size averaging less than two hectares (U.S. Dept. of Commerce 2000; D'Souza 2002).

The high cost of inputs (fertilizers, pesticides, irrigation and labor) for vegetable production tends to discourage small-scale farmers to invest and expand their farming operation. Vegetable crops are no longer profitable to grow in the Virgin Islands since aside from high cost of production, imported produce from the U.S. mainland and neighboring islands are cheaper than locally grown vegetables. This gives local farmers a competitive disadvantage. It is estimated that local production constitutes only 5 to 10% of the total produce sold in the local market (Dominique 1990; D'Souza 2002).

Alternative high value horticultural crops such as medicinal plants, culinary herbs and spices may have economic advantage over common and traditional vegetable crops. Medicinal plants, for example, are important horticultural crops in the Virgin Islands. About half of the farmers are involved in growing and producing herbs, spices and medicinal plants (Palada et al., 2003). The economic importance of these plants indicates that more research and development efforts must be pursued to maintain and conserve germplasm materials. The growing interest in medicinal plants and trees among farmers in the Virgin Islands signifies that these crops may offer better alternative to traditional vegetable crops. In addition, intercropping medicinal plants or trees with high value horticultural crops such as hot peppers may increase economic returns and improve income of small-scale farmers. Medicinal trees like Neem (*Azadirachta indica*), Moringa (*Moringa oleifera*), and Noni (*Morinda citrifolia*) are becoming popular in home gardens on St. Croix and St. Thomas (Thomas and Palada 1994; Thomas 1997; Palada and Davis 2000; Palada et al., 2002). Some of these trees have been grown with vegetable crops in agroforestry systems (Palada et al., 1994; O'Donnell et al., 1995; Rao et al., 2004).

Hot peppers are specialty crops with high market value both for local and export markets. Studies indicate that hot pepper is an ideal crop for Virgin Islands and that production is increasing (Crossman et al., 1999; Palada and O'Keefe 2001). It is one of the most popular cash crops with excellent market opportunity. Morinda or popularly known as Noni is becoming an important medicinal tree in the Virgin Islands. Almost all plants parts (leaves, fruits, flowers, seeds and roots) of Morinda have wide medicinal uses. Intercropping Morinda with hot pepper may provide high combined economic returns for the disadvantaged small-scale farmers of the Virgin Islands.

Cultivation of medicinal plants and high value crops may offer a potential alternative to conventional fruit and vegetable production in the Virgin Islands. Although it can be a viable option for small-scale farmers, little research information is available on the limitations and benefits of this system. This study was conducted with the following objectives: 1) study the interaction between Morinda hedgerows and hot peppers at early establishment; and 2) determine the effect of Morinda hedgerows on growth and yield parameters of hot peppers.

MATERIALS AND METHODS

This study was conducted at the Agricultural Experiment Station, University of the Virgin Islands, St. Croix, U.S. Virgin Islands, Eastern Caribbean (17°42'N, Long. 64°48'W). Annual rainfall ranges from 1000 to 1100 mm. Morinda tree hedgerows were established on August 2001 using two-month old seedlings. Hedgerows were spaced 5 m with in-row spacing of 1 m. Each plot was planted to three hedgerows forming two 5 m alleys. Hot pepper cultivar Habanero was planted in alleys between Morinda hedgerows on September 13, 2002. Each alley was planted to four rows giving a total of eight rows per plot (Figure 1). Because of unusual

heavy rainfall and incidence of virus disease, this crop failed and complete harvesting was not possible.

A second hot pepper crop using cultivar West Indies Red was planted on February 10, 2003. Hot pepper was planted at row spacing of 1 m and plant spacing (in-row) at 0.61 m. Based on the spacing used plant population density of hot pepper was 16,393 plants/ha. The trial was established using a randomized block design with 4 replications. Treatments consisted of hedgerow and no hedgerow (control) plots.

Composted cow manure (2-1-2) at the rate of 5.0 t ha^{-1} was applied as basal fertilizer for hot peppers. This was followed by 15 weekly fertigations of soluble fertilizer 20-20-20 NPK at a total rate of 100 kg NPK/ha. Hot peppers were drip irrigated based on soil moisture tension maintained at -30 kPa. Insect pests were managed with regular spraying of organic and chemical pesticides including Dipel, Mpede, Pyrelin, Azatin, Malathion and Botanicguard using recommended levels.

For Morinda hedgerows, data were collected on canopy and plant height at three months interval. At harvest of hot pepper, data were collected on plant height, number and weight of fruits that were classified into marketable and non-marketable. To determine the effect of Morinda hedgerows on plant growth and yield parameters of hot pepper, two rows of hot pepper adjacent to center hedgerow were sampled for these measurements. Thus, rows 2 and 3 were rows directly adjacent to hedgerow while rows 1 and 4 were considered outer rows (Figure 2).

RESULTS AND DISCUSSION

The effect of Morinda hedgerows on hot pepper plant height was not significant ($P>0.05$) as shown in Table 1. In fact, the average plant height of hot pepper was slightly taller in hedgerow intercropping compared to control (no hedgerow). Differences in plant height between plants adjacent to hedgerows and outer rows or in control plots were small (Table 1) indicating that during the early establishment of Morinda hedgerows, tree-crop competition is not significant to influence plant growth of intercrops. This result is consistent to those reported by Palada et al., (2003) under Moringa hedgerow intercropping system with medicinal plants. They reported no significant effect of Moringa hedgerows on plant height of basil (*Ocimum basilicum*) and lemongrass (*Cymbopogon citratus*). At early establishment stage, growth rate of hedgerow species is slow and interaction between trees and crops are minimal in terms of competition for light (shading effect) and soil moisture.

The number and weight of fruits per plot also were not significantly ($P>0.05$) influenced by hedgerow intercropping (Table 1). However, both the average number and weight of fruits in hedgerow intercropping were slightly lower than the control (no hedgerow). Hedgerow intercropping reduced fruit number and weight by 10 and 30%, respectively. A 10% reduction in fruit number may not be significant to small-scale farmers since during off-season when there is low supply of hot peppers in the market; farmers sell their produce by the number regardless of size and weight. For example, hot pepper can sell at three fruits for a dollar in St. Thomas (Crossman et al., 1999; Palada and O'Keefe 2002).

On a per hectare basis, the number of fruits and marketable yield of hot pepper were also not significantly influenced (reduced) by hedgerow intercropping with Morinda (Table 2). The number of fruits was reduced by 5% whereas marketable yield was reduced by almost 10%. This again indicates that during early establishment of hedgerows, there is no significant effect on

yield of intercrops. This result is similar to those obtained in hedgerow intercropping medicinal plants with Moringa as reported by Palada et al., (2003).

The real evidence of tree-crop competition is expected to appear when the hedgerows are fully established and start to develop much wider canopy and extensive root system. This is expected to be in the third year after establishment. Therefore, there is a need to continue and extend this experiment beyond three years to generate data for solid conclusion and recommendation. Furthermore, several seasons of yield data are needed to evaluate the economic benefits of this system.

SUMMARY AND CONCLUSIONS

This study demonstrates the initial effect of Morinda tree hedgerows on growth and yield of hot pepper in an alley cropping system. Preliminary results indicate that during the early stage of hedgerow establishment, tree-crop competition was not critical in reducing growth and yield of hot peppers. Farmers will have the option to grow high value crops such as hot peppers with medicinal trees with no immediate or direct effect on crops. However, it is expected that in succeeding years the competitive effect of hedgerows will be manifested and may result in significant yield reduction of intercrops. The yield reduction might be offset by economic returns from hedgerow products that are marketable in the form of fruits and other plant parts used for medicinal purposes. Additional studies are needed to determine the long-term effect of tree-crop competition on total productivity of this system in the tropics.

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Table 1. Row effect of Morinda hedgerow on plant height, fruit number and fruit weight of hot pepper under hedgerow intercropping, St. Croix, U.S. Virgin Islands, 2003.

Treatment	Hot pepper row number	Plant height (cm)	Fruits (no. m^{-2})	Fruit weight (g m^{-2})
Hedgerow	1	56	66	837
	2*	50	106	565
	3*	62	47	534
	4	51	31	351
	Mean	55	63	572
No Hedgerow	1	57	101	1128
	2*	52	63	723
	3*	55	60	683
	4	47	55	694
	Mean	53	70	824

* Rows adjacent to Morinda hedgerows.

Table 2. Plant height, number of fruits and marketable yield of hot pepper in hedgerow intercropping with Morinda, St. Croix, U.S. Virgin Islands, 2003.

Treatment	Plant height (cm)	No. of fruits per ha	Marketable fruit yield (kg ha^{-1})
Hedgerow	58 a	162,106 a	1750 a
No Hedgerow	53 a	171,946 a	1984 a

Mean separation in columns by Duncan's Multiple Range Test (P=0.05).

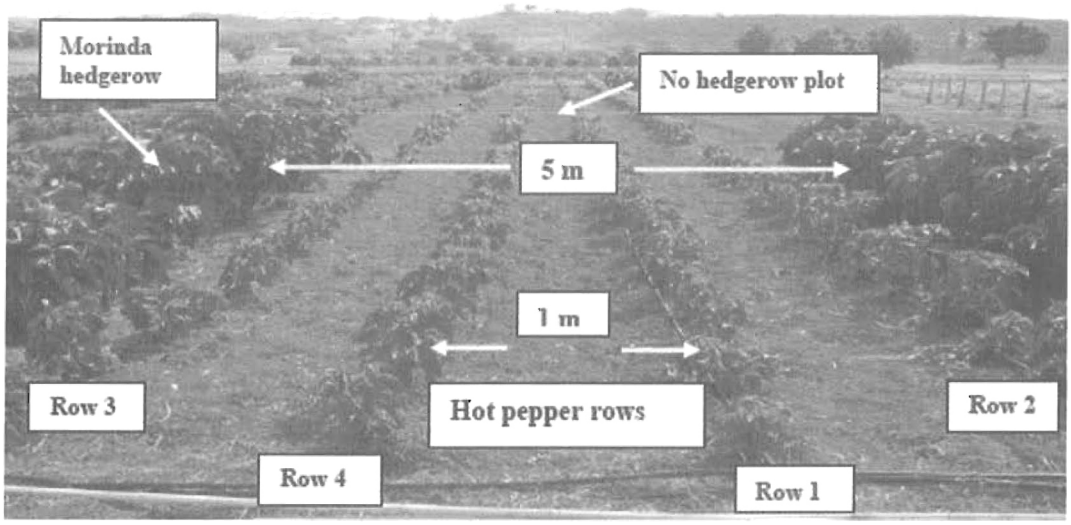

Figure 1. Plot layout of Morinda-hot pepper hedgerow intercropping experiment, UVI Agricultural Experiment Station, St. Croix, U.S. Virgin Islands.

Figure 2. Morinda center hedgerow showing adjacent hot pepper rows R2* (left) and R3* (right) together with outer rows R1 (far left) and R4 (far right) used in sampling for yield estimate.