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Evaluation of Planting Densities and Shoot Pruning Practices for Indeterminate Bell Pepper Production in Dominican Republic, Honduras, and Costa Rica

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Indeterminate bell pepper (*Capsicum annuum*) production in Central America under protected agriculture has steadily increased over the last 10 years. The Protected Agriculture Information Network (PAINet) was created in 2009 as a free-of-charge network to assist on research, education, and information exchange among protected agriculture growers in seven countries in Central America and the Caribbean. The objective of this study was to determine the effects of diverse plant densities and pruning practices on the performance of indeterminate bell pepper in commercial greenhouses in Honduras, Costa Rica, and the Dominican Republic. In Costa Rica and Dominican Republic, treatments were combinations of planting densities and pruning practices. In Honduras, only the pruning practices were compared. The results indicated that pruning has little effect on total marketable yields for indeterminate bell pepper, regardless of the cultivars and planting densities. Similarly, the effects of planting densities on bell pepper total marketable yield were barely measured in all locations, which indicated that the lowest planting densities (26,000 and 27,500 plants/ha) have the lowest investment among all tested densities. Therefore, producing colored bell peppers in Central America and the Caribbean under protective structures may not need pruning for sustainable production, which may save major labor costs.

Bell pepper exports into the U.S. from Central America and the Caribbean was more than 10,500 tons in total in 2009 (Reho, 2010). The entirety of the production of indeterminate yellow, red, and orange bell peppers in those countries occurs under protective structures, such as greenhouses, high tunnels, and screen houses, which allows improved fruit quality in comparison with open field production. The main contributors to this volume were the Dominican Republic, Honduras, Nicaragua, and Guatemala. Although reliable statistics are lacking, it is estimated that more than 600 ha of protective structures are present in those countries.

Among the multiple cultural practices needed in indeterminate bell pepper operations, shoot pruning is one of the most time- and labor-consuming activities. It is regularly performed weekly starting at 2 weeks after transplanting and up to 12 months. This practice is conducted by removing lateral and axillary shoots and it is believed to help regulate dominance of the main stem and to concentrate flowering in less flower clusters. However, more information is needed to determine the true effect of this practice on bell pepper fruit weight under the growing conditions of Costa Rica, Honduras, and the Dominican Republic.

Another cultural practice of importance on indeterminate bell pepper production under protected culture is planting density, which has a profound influence on plant architecture and resource allocation within the plant. Planting density is a combination of between and in-row planting distances and the most common in the region are 20,000 and 30,000 plants/ha. Nevertheless, the use of these densities is the result of direct field observations and not the product of systematic research. Therefore, these studies were conducted to determine the effects of diverse plant densities and pruning practices on the performance of indeterminate bell pepper in Honduras, Costa Rica, and the Dominican Republic.

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Materials and Methods

Three commercial greenhouse studies were conducted in three Central America and the Caribbean locations (San Jose de Ocoa, Dominican Republic; Alajuela, Costa Rica; and Comayagua, Honduras) between Aug. 2010 and Mar. 2011. Data from each study were analyzed separately because of the differences in climates, cultivars, and practices of each location. In Costa Rica, the treatments consisted of combinations of two factors: planting densities and pruning practices. The densities were 26,000, 32,500, and 39,000 plants/ha, whereas plants were either weekly pruned (control) or non-pruned plots. The study was established in a split-plot design with four replications and the pruning practices were in the main plots. Two indeterminate bell pepper hybrids (F-1026 and V-1023) were used in separate subsets of this study and each was analyzed independently. Planting densities were obtained from changing in-row distances while between-row distance was fixed at 1.80 m. Depending on the planting density, plots had at least eight plants. Plants were grown in a 1:1 coconut coir to organic compost medium and they harvested 25 times during the season (once or twice per week). Fruit were weighed and graded into total marketable and non-marketable. Data were analyzed for interactions among factors with a mixed model and means were separated with a Fisher's protected least significant difference at the 5% level.

In the Dominican Republic, treatments were combinations of planting densities (27,500, 34,400, and 41,300 plants/ha) and weekly pruning practices (pruned and non-pruned). A split-plot design was used to establish the study with four replications and planting densities in the main plots. Plots had 20 plants. The indeterminate red bell pepper cultivar Alegria was used in this study and plants were transplanted into a 3:1 burned rice hulls to fine gravel medium. Planting densities were the result of a between-row spacing of 1.50 m and variable in-row distances. Twelve weekly harvests were collected for data analysis and fruit were split into extra-large (220 g/fruit) and total marketable weight. Data were analyzed as described before.

In Honduras, the two pruning practices were analyzed and a fixed density of 31,200 plant/ha was utilized. The indeterminate red bell pepper cultivar was Aifos and the planting medium was 100% fine-grade coconut coir. The study was conducted in a randomized complete-block design with five replications and experimental units comprised 50 plants. Fruit were harvested 35 times during the season with two to three harvests per week. Harvested fruit were split into premium (jumbo, extra-large, and large) fruit and total marketable fruit weights. Data was analyzed using a *t*-test at the 5% significance level.

Results and Discussion

At the Costa Rica location, there was significant pruning type by planting density interaction for extra-large and total marketable fruit weight. Therefore, each treatment combination was analyzed separately. Each cultivar had distinctive responses to the pruning and planting density combinations. For the F-1026 red hybrid, there were no total marketable fruit weight differences among all treatment combinations, except in plots with plants pruned and planted at planting density of 26,000 plants/ha, which did not differ from the other pruning treatments regardless of their planting density (Table 1). Total fruit weights ranged between 93.8 and 103.8 t/ha. In plots planted with the V-1023 yellow hybrid, there were no total marketable yield differences among most of the treatments, which revealed the relatively small effects of the pruning and planting density combinations. In Honduras, planting densities had a significant effect on premium fruit weight, which comprised the summation of the weights of jumbo, extra-large, and large fruit categories. The largest fruit weight was observed in plots with pruning practice, which averaged approximately 40 t/ha, whereas the plots without pruning practice produced less than 27 t/ha (Table 2). Meanwhile, there was no difference in total marketable fruit weight between plots with or without pruning practice with yields between 52.2 and 54.2 t/ha. In the Dominican Republic location, there was no significant interaction between planting density and pruning types on total marketable and extra-large fruit weights. At the same time, none of the individual factors had a significant effect on the collected variables (Table 3). Average total and extra-large marketable yields were 52.9 and 1.0 t/ha, respectively.

These results indicated that bell pepper pruning has little effect on total marketable yields, regardless of the cultivars and planting densities. However, the effect of this practice on the partitioning

Table 1. Effects of interaction between planting density and pruning practices on the yields of indeterminate bell pepper, Alajuela, Costa Rica, 2010–2011.

Pruning types	Planting densities (plants/ha)	Total marketable fruit wt (t/ha)
	F-1026 red hybrid	
Non-pruned	26,000	94.9 b[z]
Non-pruned	32,500	93.8 b
Non-pruned	39,000	95.2 b
Pruned	26,000	103.8 a
Pruned	32,500	97.4 ab
Pruned	39,000	100.5 ab
Significance ($P < 0.05$)		*
	V-1023 yellow hybrid	
Non-pruned	26,000	201.3 a
Non-pruned	32,500	188.5 ab
Non-pruned	39,000	185.4 ab
Pruned	26,000	187.8 ab
Pruned	32,500	178.9 b
Pruned	39,000	195.2 ab
Significance ($P < 0.05$)		*

[z]Values followed by the same letters do not differ according to Fisher's protected LSD test ($P < 0.05$).
*Significant at $P < 0.05$.

Table 2. Effects of planting density on the yields of indeterminate bell pepper, Comayagua, Honduras, 2010–2011.

Pruning types	Total marketable fruit wt (t/ha)	Premium fruit wt[z] (t/ha)
Non-pruned	52.2	26.6 b[y]
Pruned	54.2	40.1 a
Significance ($P < 0.05$)	NS	*

[z]Premium peppers included jumbo, extra-large, and large categories.
[y]Values followed by the same letters do not differ according to Fisher's protected LSD test ($P < 0.05$).
NS, *Nonsignificant or significant at $P < 0.05$, respectively.

Table 3. Effects of planting density and pruning practices on the yields of indeterminate bell pepper, San Jose de Ocoa, Dominican Republic, 2010–2011.

Planting densities (plants/ha)	Total marketable fruit wt (t/ha)	Extra-large fruit wt (t/ha)
27,500	56.0	1.0
34,400	53.0	0.8
41,300	49.8	1.3
Significance ($P < 0.05$)	NS	NS
Pruning types		
Non-pruned	53.2	0.7
Pruned	52.7	1.4
Significance ($P < 0.05$)	NS	NS

NSNonsignificant at $P < 0.05$.

into different fruit categories was unclear. Similarly, the effects of planting densities on bell pepper total marketable yield were barely measured at all three locations, which indicated that the lowest planting densities (26,000 and 27,500 plants/ha) have the lowest investment among all tested densities. Therefore, producing colored bell peppers in Central America and the Caribbean under protective structures may not need pruning for sustainable production at the planting densities considered in this study, which may save major labor costs.

Literature Cited

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