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THE EFFECT OF TYPE OF TRELLIS AND PRUNING ON PASSION FRUIT YIELDS IN DOMINICA

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THE EFFECT OF TRELLIS AND PRUNING ON PASSIONFRUIT YIELDS

ABSTRACT

The effects of selective pruning and non-pruning on "Fence" and "T" trellis systems, were evaluated over a two year period in the Commonwealth of Dominica. The "T" trellis gave higher fresh weight yields 3,511 and 6,916kg/ha in year 1 and 2, as compared to the "Fence"-trellis which gave yields of 1,170 and 3,830 kg/ha for years 1 and 2 respectively. The nonpruned treatments gave higher yields i.e. 2,660 and 5,958 kg/ha when compared with the pruned treatments 1,596 and 4,682 kg/ha for years one and two respectively. Economic evaluation of the different trellis systems and pruning treatments, indicated that the "T"-trellis with the non-pruned treatments gave the highest returns EC$7,235/ha (US$2,680) and EC$8,913/ha (US$330/ha) when sold to the processor and huckster respectively, over the two year period. Correlations between fresh weight and pulp weight were ($r=0.945$) in year one.

Keywords: Passionfruit (*Passiflora edulis f. flavicarpa*); Dominica; West Indies; trellis; pruning.

INTRODUCTION

Passion fruit (*Pasiflora edulis f. flavicarpa*) has been identified as one of the major diversification crops for the Organisation of Eastern Caribbean States (OECS) (Anon., 1988) . As a result the sub- region has experienced a *substantial increase* in its production acreage over the past five years.

In the Caribbean Community (CARICOM), Dominica has the largest acreage (120ha) of passion fruit (Andrews, 1991) and ranks among the top ten world producers (Menzel, et al., 1988). With the increasing capacity for processing and fresh fruit export, the Ministry of Agriculture (MOA) proposed to increase the area for its production to 200 ha over the next two years.

Expansion of the passion fruit acreage has been supported by a number of externally-funded projects: the High Impact Agricultural Marketing Project (HIAMP), the Ministry of Agriculture's Tree Crop Project and, most recently, the Caribbean Agricultural Research and Development Institute's (CARDI) Exportable Fruit Crops Project. The objectives of the projects were to increase production either by expansion of acreages and/or introduction of new technologies. This resulted in the movement away from the more traditional methods of production (i.e. growing on gliricidia trees and other non productive trees) to more commercialized methods of production, the "Fence" and "T"-trellis systems.

The "Fence" and "T" trellis systems were used to establish approximately 90 percent of the passion fruit acreage during the 5 year period, 1985-1990. The "canopy" system was used to establish the remainder. Recommended crop husbandry techniques, viz. pruning, fertilizer application, pest and disease control were obtained from the literature (Rajkumar, 1987, Anon, 1991; Akamine et al., 1974; Gachanja and Gurah, 1980) . However, farmers were concerned that the number of potential bearing laterals that were removed due to pruning would reduce yields. This coupled with the unavailability of productivity data for the recommended systems of production in local conditions were also cause for concern in the Ministry of Agriculture. It therefore became necessary to evaluate the "Fence" and "T"-trellis systems and

the effects of selective pruning and no pruning had on yield and yield components. An economic assessment of both systems was also conducted, when fruit was sold to the processor and the huckster.

MATERIALS AND METHODS

The experiment was conducted at the Portsmouth Agricultural Station on kandoid soils. This location is approximately 60m above sea level. Mean annual temperatures range between 26 and 29°C. Moisture regimes are described as udic and annual rainfall is between 1240 and 2500mm.

Secondary forest was cleared and debris windrowed at the base of the gently sloping 0.25 ha plot. The plot was then lined with stakes spaced at 3.0m x 3.7m along the contour.

The experiment was laid out as a split plot design. The main treatments consisted of the "Fence" and "T"-trellis systems with selectively pruned or unpruned sub-plots. There were four replicates, each replicate had two "Fence" and "T"-trellis systems randomly established on which the selective pruning and unpruned treatments were superimposed.

All trellis posts (local hard woods) were treated with the wood preservative Solignum$^{(R)}$. Twelve gauge steel wire was used for establishing the trellises. The "Fence" system contained a single line of trellis wire, whereas the "T" system contained three lines of wire one on top of the trellis post and the other two on either side of the "crosspiece" which was placed 30 - 45cm from the top of the pole Appendix 1 & 2. The cross piece was 90cm long.

The plot sizes were 1.85m^2 for the "Fence" trellis and 3.7m^2 for the "T"-trellis. Trellis posts were placed 3.0m x 3.7m.

The crop was established on November 17, 1988. One seedling 25-30cm long was placed in each hole. Holes, 20cm deep with diameter of 10cm, were dug 45cm away from the trellis post. "Training" stakes leading to the trellis wire were placed about 10 -

15cm away from the plant. Seedlings were fixed loosely to the training stakes with twine.

The two most vigorous shoots (leaders) from all plants were allowed to climb the training stake onto the trellis. Leaders were trained in opposite directions, and allowed to run 3.7m on the trellis wire before the tips were cut. Lateral shoots on all leaders, between the ground and the trellis were removed. The other laterals were allowed to develop along the wire and hang down freely by removing the tendrils. All laterals were cut 15cm above the ground.

Selective pruning involved removal of every other lateral along the trellis, during the first crop cycle. After the first crop cycle, dead vines were removed from the trellis; laterals which had borne fruit were cut back allowing young ones to progress.

Vines were sprayed on three occasions with Diazinon$^{(R)}$ 4ml/litre to control leaf chewing larvae of the *Dione* spp. On the first sign of rat damage, rat bait was placed on the periphery of the experimental plot as a preventative measure . This was done on two occasions.

in the early stages of establishment the experiment was sprayed with Gramoxone$^{(R)}$ (25/ha). On all other occasions brush weeding was carried out to control weeds.

Fertilizer (NPK; 16:8:24+2MgO) at the rate of 160kg/ha, was applied in a split application (at planting and 5 months after planting) during the first crop cycle. The fertilizer was applied in a circle about 0.3m from the base of the vine. After the first crop cycle, fertilizer was applied after pruning and before flowering.

Data was collected weekly on fruit set (when fruit were at marble-size stage), number of fruit harvested, fresh weight, pulp weight (taken from a random sample of individual fruit which amounted to 40 % of each harvest) . Cost of production studies involved costings of all material, labour and yields. The trellis systems were amortized over a 3 year period.

RESULTS

Yields

Table 1 shows the effects of trellising and pruning on fruit set, number of fruits harvested and fresh weight over the period 1988-1990. In year 1, plants on the "T"-trellises produced three times (6.6 kg) the fresh weight of fruits as those on the "Fence"-trellises (2.2 kg) ($P < 0.01$). Unpruned plants yielded more (5.0 kg) than those selectively pruned (3.0 kg) after the first crop cycle ($P < 0.05$). On the "Fence" trellises the pruned plants had half the fruitset (34) ($P < .05$) compared to those that had been selectively pruned (76) ($P < 0.05$), but his was not apparent on the "T"-trellises. There was 50% difference in fruit set and fruit harvested.

In Year 2 these effects were no longer significant except that unpruned plants continued to have a higher fruitset and fresh weight ($P < 0.05$). Though "T"- trellis yields were almost twice as high (13.0 kg/plot) as those from the "Fence"-trellis (7.2 kg/plot), this was not statistically significant. There were no significant effects due to interaction. There was a 38% difference between fruit set and fruit harvested.

Table 2 shows the extrapolated yields. Overall, first year yields were very (low 1,170 and 3,511 kg/ha for the "Fence" and "T"-trellis respectively); compared to the second year yields which were 3,830 kg/ha and 6,916 kg/ha for the "Fence" and "T"-trellis respectively.

Overall, the highest yields of 3,724 kg/ha in Year 1 and 7,235 kg/ha in Year 2 were obtained from the unpruned treatments on the "T"-trellis.

Cost of Production

Cost of production studies and margins of returns are shown in Table 3 using the processor's price and in Table 4 using the huckster's price. Table 3 shows revenue losses for all treatments in Year 1. The least returns of $745 EC and $3,298 EC were obtained with the pruned treatments on both the "Fence" and "T"-trellises respectively. The highest returns of $3,724 EC was incurred on the "T"- trellis without

Table 1. The effect of two different types of trellis and pruning on plot yields of passion fruit grown in Dominica from November 1988 to November 1990.

	YEAR 1 (1988-1989)			YEAR 2 (1989-1990)		
TREATMENTS	No. of Fruitset	No. of Fruit harvested	Fresh Weight (kg)	No. of Fruitset	No. of Fruit harvested	Fresh Weight (kg)
Trellis						
"Fence"	55	27	2.2	123	89	7.2
"T"	160	82	6.6	208	151	13.0
Level of significance	**	*	**	NS	NS	NS
SED (3 d.f.)	9.56	11.91	0.715	37.73	29.86	1.83
Pruning						
Pruning	98	37	3.0	151	120	8.8
No pruning	118	61	5.0	180	131	11.2
level of significance	*	*	**	*	NS	*
SED (50 d.f.)	8.45	11.42	0.453	12.69	11.42	1.06
Interaction						
"Fence" & Pruning	34	18	1.4	110	80	6.4
"Fence" & no pruning	76	37	3.0	136	93	8.8
Level of significance	*	NS	NS	NS	NS	NS
SED (50 d.f.)	11.96	7.81	0.64	17.95	16.15	1.50
"T" and pruning	159	77	6.2	191	139	11.2
"T" & no pruning	161	86	7.0	224	164	13.6
Level of significance	NS	NS	NS	NS	NS	NS
SED (50 d.f.)	11.96	7.81	0.64	17.95	16.15	1.50

* = Significant at the 5% level
** = Significant at the 1% level

Table 2. The effect of two different types of trellis and pruning, yields (ha) of passion fruit grown in Dominica from Nov. 1988 to Nov. 1990.

	YEAR 1 (1988-1989)			YEAR 2 (1989-1990)		
TREATMENTS	No. of Fruitset	No. of Fruit harvested	Fresh Weight (kg/ha)	No. of Fruitset	No. of Fruit harvested	Fresh Weight (kg/ha)
Trellis type						
"Fence"	29,260	14,364	1,170	65,486	47,384	3,830
"T"	85,120	43,624	3,511	110,656	80,332	6,916
Pruning						
Pruning	52,136	19,684	1,596	80,332	63,840	4,682
No pruning	62,776	32,452	2,660	95,760	69,692	5,958
Interaction						
"Fene" & Pruning	18,088	9,576	7,458	58,520	42,560	3,405
"Fence" & np pruning	40,432	19,684	1,596	72,352	59,476	4,682
"T" and pruning	82,588	40,964	3,298	101,612	73,948	5,958
:T" & no pruning	85,652	45,752	3,724	119,168	87,248	7,235

pruning In Table 4, all systems except the "T"-trellis $1,303 EC profit without pruning showed losses in the first year.

Table 3 shows that in Year 2 all the treatments were profitable. However, cumulative margin was positive ($1,520, EC) for the "Fence"-trellis with the unpruned plants. In the case of the "T"- trellis, both un-pruned and pruned treatments showed positive cumulative margins. In Table 4 all the systems were also profitable and cumulative margins were negative ($259) only for the "Fence"-system with pruning.

Fresh weight and pulp weight

Correlations (0.9732) were obtained between fresh weight and pulp weight in Year one ($P < 0.001$). The regression model was as follows:

Pulp wt- = 5.13 + 0.355 (Fresh wt.) $r^2 = 0.945$

The standard error of co-efficient of fresh weight = 0.0062 at 61 degrees of freedom.

Table 3: Comparison of per hectare costs and returns for passion fruit production in Dominica using two different trellis systems and prunig methods using the processor's price of EC$1.00/kg.

	FENCE TRELLIS				T-TRELLIS			
	No Pruning		Pruning		No Pruning		Pruning	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Capital Cost	2074		2074		2775		2775	
Maintenance cost	1050	1050	1950	1950	1050	1050	1950	1950
Harvest cost	93	272	43	191	216	420	191	347
Transport cost	56	164	26	119	130	253	115	209
Total COST	3272	1485	4093	2267	4171	1723	5032	2507
Yield (kilo)	1596	4682	745	3405	3724	7235	3298	5985
REVENUE $	1596	4682	745	3405	3724	7235	3298	5985
ANNUAL MARGIN	-1676	3197	-3348	1138	-447	5512	-1734	3478
CUMULATIVE MARGIN	-1676	1520	-3348	-2210	-447	5065	-1734	1745

Table 4: Comparison of per hectare cost and returns for passion fruit production in Dominica usin two different trellis systems and pruning methods using the huckster price of EC$1.47/kg

	FENCE TRELLIS				T-TRELLIS			
	No Pruning		Pruning		No Pruning		Pruning	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Capital Cost	2074		2074		2715		2775	
Maintenance cost	1050	1050	1950	1950	1050	1050	1950	1950
Harvest cost	93	272	43	197	216	420	191	347
Transport cost	56	164	26	119	130	253	115	209
TOTAL COST	3272	1485	4093	2267	4171	1723	5032	2507
Yield (kilo)	1596	4682	745	3405	3124	7235	3298	5985
REVENUE $	2346	6883	1095	5005	5474	10635	4848	8798
ANNUAL MARGIN	-926	5397	-2998	2739	1303	8913	-184	6291
CUMULATIVE MARGIN	-926	4471	-2998	-259	1303	10216	-184	6108

US$ = EC$2.10
Assumptions
Cents/kilo
Picking cost 35
Heading cost 23
Transport cost 35

DISCUSSION

Tables 1 and 2 show that first year yields were lower than those of the second year. Average yields of 5-10,000 kg/ha can be expected (Anon, 1987). However, in this trial maximum yields of 3,724 kg/ha were obtained in Year 1. The low yields recorded in Year 1 resulted from the prolonged dry period which followed the mid-November plantings. (Rainfall data is shown in appendix 3). Moisture stress is known to limit vegetative growth, which in turn reduces node production and flowering (Menzel et al; 1986). In addition flowering and fruiting began in April and June respectively, at a period when vine biomass was not fully developed. In Year 2 flowering and fruit set occurred when vine growth was vigorous. As a result yields were much more satisfactory - maximum yields of 7,235 kg/ha were obtained.

Higher yields were obtained from unpruned treatments than the pruned plots in both the first and second years. Similar results were obtained by Gachanja and Gurah (1980) in the first year of a 3-year experiment. Experimental evidence from South Africa where both purple and yellow passion fruit are grown, has shown that unpruned vines consistently out-yielded those which had been pruned (Akamine et al., 1974). The removal of potential flowering vines by pruning seemed to have reduced yield.

Though the results showed that higher yields were obtained from nonpruned treatments it was noticed that as the vines in these treatments got older the canopy became denser and this restricted efficient pruning and spraying against pests and diseases. It was also observed that denser canopies promoted the development of fruit diseases such as anthracnose (Colletotrichum spp.). In the unpruned treatments the increased weight of the vines on the trellis caused the wires to sag from 2.0m to approximately 1 - 1.5m above ground level. This caused increased tangling of vines.

The difference between fruit set and the number of fruit harvested, can be attributed to predial larceny, a limited amount of rat damage and heavy winds which blew fruit of vines making it difficult on ocassion, associated fruit with the various plots. As a result certain fruits on the ground were not included in the harvest.

A review of the economic data showed that the T-trellis system, though more expensive than the " Fence " -type to establish, gave higher economic returns. The "T"-trellis without pruning gave economic returns twice as high as any other treatment.

Table 4 shows that net earnings to the farmer were higher when passion fruit was sold to the hucksters. This was of major concern to the processor who competed directly with the hucksters. Apart from having reduced production, processors obtained half-ripe fruit which were harvested for the fresh fruit trade. These fruit lowered the "brix" and gave the concentrate a greenish yellow colouration rather than the normal reddish yellow. (R. Laronde, 1992; S. Jno.Baptiste, 1992, personal communications) .

Correlations between fresh weight and pulp weight areimportant for the processors to make accurate production projections. First year correlations were favourable, second year correlations were not and therefore not included.

Passion fruit, being a major diversification crop, competes directly with bananas for land, labour and other vital resources. Net returns for the banana plant crop are EC$4,325.00/ha (Oldham, 1989). Thus compared with the passion fruit plant crop which operates at a loss, except for where the "T"-trellis with non-pruned vines showed a profit of EC$379.00/ha bananas would seem to be more lucrative.

Unfortunately, only two years of data were collected. Problems with the trellis systems, root rot and poor plot maintenance caused the experiment to be abandoned in February 1991, instead of February 1992.

CONCLUSIONS AND RECOMMENDATIONS

Profitable production of passion fruit seems to require no pruning in the first two years. However, because vegetative growth in this situation is extremely vigorous, light selective pruning should be carried out at the en of the first crop cycle.

Both the "Fence" trellis and "T"- trellis have various advantages and disadvantages. However, the initial establishment cost of the "T"-trellis, coupled with the increased difficulties experienced when managing vines suggests that the "Fence"-type trellis may be a more appropriate system for farmers.

It seems that the farmers priority will be to sell to the hucksters, unless the processors increase their prices. Since the hucksters and processors require fruits of different grades and quality, it may become necessary to recommend management practices which are less costly and labour intensive with a view to producing mainly for the processor.

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