arise later from the base of the plant. These shoots are not *caught in the* first or second tying strings and may lay on the mulch or into the middles and present problems with disease and/or weed control operations.

New cultivars should be evaluated on a limited basis to see how they react to pruning. Without knowledge of a new cultivar's vine characteristic, pruning heavy could result in reduced yields and quality.

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DOUBLE-CROPPING CUCUMBER AND TOMATOES TO MINIMIZE THE COST OF STAKING CUCUMBER

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Abstract. **Cucumber (*Cucumis sativus* L.) double-cropped with tomato (*Lycoperscum esculentum* Mill.) and staked with the double-cropping system needed less than half the man-hours to stake than the standard system. Tomato rods and tomato plants were not removed which could result in further cost reduction. Glyphosate [N-(phosphonomethyl) glycine] was used to kill all the vegetation at a cost of $45-$50/acre. Double-cropped cucumber produced comparable yields of high quality fruits to cucumber staked by the standard system. The standard system produced more No. 2 fruits resulting in more marketable yield. The 2 systems produced an equal percentage of culls or rots. In-row spacing of 9 or 12 inches appeared to be the best choice when cucumber was staked by the double-cropping system. The side of the row where cucumber was planted did not affect the yield significantly. However, planting cucumber on both sides gave the highest yield. It appears that there was enough residual fertilizer left over after tomatoes to produce the cucumber crop.**

The demand for staked cucumbers is growing rapidly because of the superior quality of the fruit. Increased yield and good quality fruit has been reported by several investigators (1, 2, 4). However, the expense to train the plants up, and the frequent occurrence of low market prices during some periods of the year, may discourage cucumber growers from using this system (referred to in this manuscript as the standard system). On the other hand, staking fresh market tomatoes is a popular cultural system, and in many cases, polyethylene mulch and drip irrigation are used in staked tomato production. These expensive installations are normally removed after the last harvest of tomatoes.

Planting cucumbers following tomatoes on the same rows without removing any of the mentioned installations (referred to in this manuscript as the double-cropping system), may reduce the cost of staking cucumber. Also, return per acre can be enhanced by using tomato stakes, polyethylene mulch, and drip irrigation installation to produce 2 crops instead of 1. The objectives of this study were to 1) compare the standard and double-cropping systems for man-hours needed to stake cucumber and yield, 2) investigate the influence of in-row spacing and row side on yield of cucumber staked by the double-cropping system, and 3) determine the response of staked cucumber to N-P-K when double-cropped with tomatoes.

Materials and Methods

Three studies were conducted in the summer (July-Oct.) of 1988 and 2 in 1989. In each study, cucumber was planted on same tomato rows. Tomato plants were sprayed with glyphosate at 3 lb./acre approximately 3 weeks before planting cucumber. Plot size used in all studies was 12 x 10 feet and cucumber plants were spaced 18 inches apart except when otherwise specified. Cucumber was irrigated using polyethylene distribution lines one-half inch in diameter. They were connected to the main water line with a pressure regulator and had in-line emitters spaced 12 inches apart. Irrigations were applied as needed on Mon., Wed., and Fri. Tensiometers placed 6-12 inches deep in the plant row were used to indicate when and how much to irrigate. Readings of 25-30 centibars were used to initiate irrigation.

In the first study, 'Poinsett 76', 'Dasher II', and 'Maximore 101' cucumber were planted in 3 x 2 factorial experiment arranged in a randomized complete block design with 3 and 4 replications in 1988 and 1989, respectively. Treatments were cultivars and support (standard system vs. double-cropping system). In the standard system, tomato plants and stakes (using 6 ft x 0.5 inch reinforcing rods) were removed. Rods were then installed again every 3-4 ft to simulate staking cucumber by the standard system. Four levels of string were tied to the rods 10 to 12 inches upward. The first string was tied 10 inches above the row surface and the fourth close to the rod top. Cucumber plants were tied to the string 3 to 4 times until they reached

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the top string using a Max Tapener tier Model HT B-2 (A. M. Leonard, Inc.). In the double-cropping system, no tomato plants or rods were removed. Cucumber plants were tied 1 to 2 times to the dead tomato plants and left to climb up on the skeleton of the dead tomato plants. The time needed to install 100 rods in the standard system was recorded. Also, tying string to the rods and tying cucumber plants to the string in the standard system, and to the dead tomato plants in the double-cropping system times were recorded. This information was used to calculate the man-hours needed to stake an acre of cucumber by the 2 systems.

In the second study, 'Dasher II' cucumber was planted in 2 x 3 and 3 x 3 factorial experiment arranged in a randomized complete block design with 4 replications in 1988 and 1989 respectively. Treatments were in-row plant spacing (9 vs. 18 inches in 1988 and 6, 12, 18 inches in 1989) and row side (cucumber was planted on the right side, left side, and both sides of the dead tomato row). Cucumber plants were tied 1 to 2 times to the dead tomato plants and left to climb up on their own.

The third study was a fertility study conducted in 1988 only. 'Dasher II' cucumber was planted in a randomized complete block design with 4 replications. Treatments were control (no fertilizer applied), 0-0-0, 16-21-40, 32-42-80, 48-63-120, 64-84-160 lb. N-P-K/acre incorporated before planting. Also, each treatment excluding the control received 34 lb. N/acre as a side dress (SD) applied when plants began to run. Cucumber plants were tied to the dead tomato plants as in the previous test. Soil sample analysis revealed that test location contained 521, 178 PPM P and K respectively.

Fruits were harvested 3 times a week for a total of 3 and 6 weeks in 1988 and 1989, respectively. The 1988 harvest season was shortened because of an active hurricane season. Fruits were graded to U.S. Fancy, U.S. No. 1, U.S. No. 2 and culls. Fancy and No. 1 grades were combined and classified as quality yield. Marketable yield was the total of fancy, No. 1 and No. 2 grades.

Results

An estimated 63 man-hours were needed to stake 1 acre of cucumber using the standard system compared to 28 man-hours in the double-cropping system (Table 1). There was no significant difference in quality yield of cucumber staked by the 2 methods (Table 2). The standard system produced significantly higher marketable yield in both years. However, the increase in marketable yield resulted from more No. 2 fruits produced with the standard system. There were no significant differences in percentage of culls or rots between the 2 systems of staking except in 1989. The standard system produced significantly more culls in 1989.

Table 1. Estimates of man-hours needed to stake one acre of cucumber by two systems.

Activity	Standard	Double-cropping
Driving rods in ground (1500)	11	—
Tying string to rods (4 levels)	15	—
Tying plant to string		
1st time	10	12
2nd time	12	16
3rd time	15	—
Total	63	28

Reducing in-row spacing between plants from 18 to 9 inches increased quality and marketable yield in 1988 (Table 3). In 1989, the 12 inch spacing produced significantly higher quality yield than the 6 or 18 inch spacing. The 12 inch spacing also produced significantly higher marketable yield than the 18 inches but did not differ significantly from the 6 inch spacing. Spacing had no effect on percentage of rots in both years, but the 6 inch spacing produced more culls in 1989 (Table 3).

Planting cucumber on the right or left side of the dead tomato row had no significant effect on quality or marketable yield in either year (Table 4). However, planting cucumber on both sides of the row significantly increased quality and marketable yields in 1988. It significantly increased the marketable yield over the right side in 1989 and had no effect on the quality yield. Row side had no significant effect on percentage of culls or rots in either year (Table 4).

Fertilizer rates had no significant effect on any yield category (Table 5). The control produced equal yield to any other treatment.

Discussion

Double-cropping cucumber and tomatoes was investigated during a two-year period. Staking cucumber using the double-cropping system needed less than half the man-hours required to stake the same area using the standard system. The average quality yield, which is a money-maker, was comparable for the 2 systems. The results were consistent over the two-year period of study indicating that the double-cropping system can compete with the standard system in producing good quality cucumber at reduced cost for staking. In 1988, the yield was low for both systems

Table 2. Average yield of 3 cucumber cultivars staked by two methods.

Method	1988 Yield[z] (bu/acre)				1989 Yield[y] (bu/acre)			
	Quality	Marketable	% Culls	% Rot	Quality	Marketable	% Culls	% Rot
Standard	130.7 a[x]	154.9 a	7.4 a	16.7 a	606.5 a	734.4 a	15.4 a	3.3 a
Double-cropping	119.2 a	132.2 b	7.6 a	23.2 a	561.3 a	627.0 b	9.5 b	5.8 a
LSD (0.05)	13.8	5.0	5.1	6.6	62.0	67.5	2.3	3.3

[z]Harvested for 3 weeks.
[y]Harvested for 6 weeks.
[x]Means within a column followed by different letters are significantly different at the 0.05 level, using LSD.

Table 3. Influence of in-row spacing on yield of 'Dasher II' cucumber double-cropped with tomatoes.

Spacing	1988 Yield[z] (bu/acre)				1989 Yield[y] (bu/acre)			
	Quality	Marketable	% Culls	% Rot	Quality	Marketable	% Culls	% Rot
6 inches	—	—	—	—	506.8 b	585.8 ab	15.6 a	8.2 a
9 inches	173.0 a[x]	200.9 a	5.4 a	36.3 a	—	—	—	—
12 inches	—	—	—	—	569.1 a	646.0 a	10.6 b	8.0 a
18 inches	129.8 b	150.2 b	3.4 a	39.9 a	505.1 b	573.1 b	11.3 b	10.1 a
LSD (0.05)	24.8	28.5	2.6	5.9	58.2	64.3	2.3	3.9

[z]Harvested for 3 weeks.
[y]Harvested for 6 weeks.
[x]Means within a column followed by different letters are significantly different at the 0.5 level, using LSD.

Table 4. Influence of row side on yield of 'Dasher II' cucumber double-cropped with tomato.

Position	1988 Yield[z] (bu/acre)				1989 Yield[y] (bu/acre)			
	Quality	Marketable	% Culls	% Rot	Quality	Marketable	% Culls	% Rot
Left side	131.4 b[x]	156.6 b	4.6 a	40.1 a	525.7 a	604.3 ab	11.9 a	9.3 a
Right side	137.1 b	154.3 b	3.7 a	37.7 a	498.9 a	561.6 b	11.9 a	8.0 a
Both sides	185.7 a	215.8 a	4.8 a	36.4 a	556.3 a	639.0 a	13.7 a	8.9 a
LSD (0.05)	30.4	34.9	3.1	7.2	58.2	64.3	2.3	3.9

[z]Harvested for 3 weeks.
[y]Harvested for 6 weeks.
[x]Means within a column followed by different letters are significantly different at the 0.05 level, using LSD.

because of the active hurricane season which shortened the harvest season. Staking cucumber by the standard system resulted in significantly higher marketable yield, but the increase resulted from more No. 2 cucumber produced by plants staked by the standard method. No. 2 cucumber was a small portion of the marketable yield. The percentage of rotted fruits was higher for the 2 systems in 1988 because of the wet season due to the storms.

In-row spacing had a significant effect on cucumber yield staked by the double-cropping system. The in-row spacing of 9 or 12 inches appeared to increase quality and marketable yields with few exceptions. Wider spacing of 18 inches was the least productive in both years, and the closer spacing of 6 inches was less productive of quality yield and comparable to 12 inches spacing in marketable yield. Previous work (3) indicated that 6 inch spacing was more productive than 12 inches in cucumber staked by the standard system.

Under the test conditions, the left side of the dead tomato row was subject to more sunlight in the morning. The right side was more sunny in the afternoon. Yield data in both years indicate that the row side had no influence on quality or marketable yield of cucumber double-cropped with tomatoes. Both sides always produced more yield than either side, though the difference was not always significant.

The response to N-P-K fertilizer was not positive. It appears that enough N-P-K was left over from the tomato crop to produce the maximum yield of cucumber. Indeed, soil analysis before planting cucumber indicated that test site had high content of P and K (no analysis was done for N). Previous work (3) indicated that cucumber staked by the standard system did not respond positively to N-P-K when the test site was high in the 3 elements.

Table 5. Influence of 5 rates of fertilizer and a control on yield of 'Dasher II' cucumber double-cropped with tomatoes.

N-P-K rates (lb./acre)	1988 Yield (bu/acre)			
	Quality	Marketable	% Culls	% Rot
Control	129.3 a[y]	141.9 a	9.2 a	31.7 a
0-0-0 + SD[z]	119.3 a	136.6 a	11.5 a	32.6 a
16-21-40 + SD	139.8 a	155.2 a	10.4 a	33.9 a
32-42-80 + SD	127.5 a	143.8 a	10.1 a	28.7 a
48-63-120 + SD	132.0 a	143.2 a	10.2 a	35.0 a
64-84-160 + SD	120.7 a	136.6 a	9.4 a	38.7 a
LSD (0.05)	48.1	50.1	6.5	14.4

[z]Side dress with 34-0-0 lb./acre.
[y]Means within a column followed by same letters are not significantly different at the 0.05 level, using LSD.

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