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Influence of N and Plant Spacing on Mechanically Harvested Tabasco Pepper

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Abstract. **Nitrogen rate and in-row plant spacing significantly influenced yields of mechanically harvested red Tabasco (*Capsicum frutescens* L.) pepper. Red pepper yields increased with an increase in N rate from 0 to 112 kg N/ha, and a decrease in in-row plant spacing from 81 to 10 cm. The percentage of machine harvested red pepper in relation to green and orange fruit removal was enhanced with 20 cm in-row spaced plants. Tabasco plant height increased with an increase in N rate from 0 to 112 kg N/ha, while plant diameter decreased with a decrease in in-row spacing from 81 to 10 cm. Conventionally spaced (81 cm in-row spacing) Tabasco plants were damaged substantially more during mechanical harvesting than 10 cm in-row spaced plants. Early season leaf-petiole tissue N concentrations had higher correlations with red pepper yields than did late season tissue N concentrations. Multiple harvests of red Tabasco pepper with a flail-type machine produced yields similar to those obtained with hand harvesting.**

Pepper growers often face high production and harvesting costs for crops which are often sold for processing purposes at low prices. Attempts have been made to minimize production costs through management. Determination of optimum crop N requirements has been made for bell (1, 2, 8, 9, 10, 13, 14, 17, 19, 24, 25), chile (5, 16, 20, 22), and pimiento pepper (3, 6). Plant density and/or spacing studies have been conducted on banana (12, 17), bell (1, 2, 12, 17, 18), cherry (12, 17), and pimiento pepper (4, 6). The only data concerning fertility and plant spacing on Tabasco pepper (21) showed no significant increases in crop yield when in-row spacing was reduced from 50 to 25 cm. Furthermore, when fertilizer was increased from 96N–42P–80K kg/ha to 192N–84P–160K kg/ha, crop yield was reduced significantly.

To date, little work (12) has been done on coordinating pepper cultural practices with the designs and needs of mechanical harvesters. This study was undertaken to determine if N fertilization and plant spacing could influence yields of mechanically harvested Tabasco pepper.

Materials and Methods

'McIlhenny Select' Tabasco pepper was seeded in cell packs in Jiffy Mix Plus in the greenhouse in late Jan. of 1982. All transplant cultural operations were performed according to commercial standards. In early April, transplants were set in the field at Avery Island and Baton Rouge, La. At both locations, soil was an Olivier Silt Loam (fine-silty, mixed, thermic aquic, Fragiudalfs) with 0.41% and 0.48% organic matter at Avery Island and Baton Rouge, respectively.

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At both locations, N (as NH_4NO_3), at 0, 28, 56, 112 kg/ha rates, was banded 50% preplant 10–12 cm under row center, and 50% as a sidedress on bed shoulder at about 90 days after transplanting. In-row plant spacings were 10, 20, 41, and 81 cm. All treatments received 28 kg P and 91 kg K/ha banded preplant with initial N applications. Treatments, arranged in a randomized complete block with 4 replications, were 46 m in length and established on rows 1.67 m apart.

Tissue samples containing about 100 of the most recently matured leaves and petioles, were taken at transplanting and every 30 days thereafter at both locations until 1st harvest. Samples were dried, ground in a Wiley mill and analyzed for total N by the Kjeldahl method (7). Plant height and width were taken just prior to 1st harvest at Baton Rouge.

Peppers were first harvested in August, at which time about 50% of the fruit was red, and every 21 days thereafter until 1st frost. Fruit were harvested with a flail type machine (23) mounted on the front of a Hagie 647 tractor. The harvesting unit straddled the plant row. The flail action of the machine was provided by wire-braid reinforced hydraulic hoses mounted on inclined (30°) spindles, one on either side of the plant row, rotated such that the flails moved vertically upward through the plant. Peppers were dislodged and fell to a collection unit of 4 aluminum disks on each side of the row. The disks were spring loaded to move in and out around the plants, and rotated pushing the fruit to a conveyer belt. Harvester aggressiveness was adjusted hydraulically by spindle speed (about 150 rpm) and tractor ground speed (about 0.8 km/hr). Peppers and trash were collected and hand sorted. Red peppers were separated from green and orange fruit and all vegetative material. Red pepper weight, the percentage of red pepper relative to orange and green fruit, and the percentage of trash relative to the total sample weight on a fresh weight basis were determined. A total of 4 harvests were made at each location in 1982.

Results and Discussion

Main effects of N rate and plant in-row spacing on mechanically harvested red pepper yields were significant at both locations (Tables 1 and 2). In these experiments, only tissue N was influenced significantly by an N rate × spacing interaction. As N rate increased, red pepper yields increased linearly at Avery Island and linearly and quadratically at Baton Rouge. Red pepper yield increased from 1.21 to 1.98 MT/ha at Avery Island, and from 0.87 to 2.01 MT/ha at Baton Rouge with an increase in N rate from 0 to 112 kg/ha. In preliminary work, 112 kg N/ha was found to be excessive for Tabasco pepper. Significant linear trends at both locations in 1983, however, indicated that additional increases in yield may result from the use of higher N rates than those employed in this study.

Plant spacing also influenced red pepper yields significantly at the 2 locations (Table 2). Improved yields were found with 20 cm in-row plant spacing at Avery Island and with 10 cm in-row plant spacing at Baton Rouge. Saamin (21), however, found no difference in Tabasco yield when plant spacing varied from 50 to 25 cm. At Avery Island and Baton Rouge, the lowest yields were obtained with conventionally spaced (81 cm) plants.

Acceptable multiple hand-harvested Tabasco red pepper yields are about 3 MT/ha. At Avery Island and Baton Rouge, observed mechanically harvested yields from 10 cm in-row spaced plants that received 112 kg N/ha, were competitive (2.4 MT/ha) with hand-harvested returns.

The percentage of machine harvested red pepper in relation to green and orange fruit removal (percentage of red pepper), was influenced significantly only by N rate at Baton Rouge (Table 1). The influence of N on the percentage of red pepper harvested was not consistent at the 2 locations.

The effect of spacing on the percentage of red pepper was linear and quadratic at Avery Island and at Baton Rouge (Table

Table 1. Effect of N rate on yield of mechanically harvested Tabasco red pepper, percentage of red pepper and the percentage of trash at Avery Island and Baton Rouge.

	Avery Island			Baton Rouge		
N rate (kg/ha)	Red pepper yield (MT/ha)	Red pepper (%)	Trash (%)	Red pepper yield (MT/ha)	Red pepper (%)	Trash (%)
0	1.21	53.3	29.2	0.87	56.9	30.1
28	1.53	53.2	32.2	1.65	56.0	28.3
56	1.72	50.1	28.7	1.78	58.2	28.0
112	1.98	51.4	31.5	2.01	53.6	27.5
Significance[z]	L**	NS	C**	L**,Q**	C**	L*,Q**

[z]Linear (L), quadratic (Q), cubic (C), or nonsignificant (NS) or significant at 5% (*) or 1% (**) level.

Table 2. Effect of in-row plant spacing on yield of mechanically harvested Tabasco red pepper, percentage of red pepper and the percentage of trash at Avery Island and Baton Rouge.

		Avery Island			Baton Rouge		
Spacing (cm)	Plants/ha	Red pepper yield (MT/ha)	Red pepper (%)	Trash (%)	Red pepper yield (MT/ha)	Red pepper (%)	Trash (%)
10	65,300	1.65	51.6	32.8	1.69	55.7	30.5
20	32,700	1.92	54.6	30.5	1.65	59.2	29.6
41	16,300	1.56	52.5	29.6	1.58	56.4	25.8
81	8,200	1.31	50.3	28.8	1.38	53.3	27.6
Significance[z]		L**,C**	L*,Q*	L*,Q**	L**	L*,Q*	L*,Q**

[z]Linear (L), quadratic (Q), cubic (C), or significant at 5% (*) or 1% (**) level.

Table 3. Influence of N rate and in-row plant spacing on Tabasco plant height and diameter at Baton Rouge.

Treatment	Plant ht (cm)	Plant diameter (cm)
N rate (kg/ha)		
0	25.6	28.6
28	30.9	34.9
56	32.8	36.3
112	33.6	37.2
Spacing (cm)		
10	30.4	33.4
20	30.7	33.0
41	29.8	33.6
81	32.0	37.0
Significance[z]		
N rate	L**,Q*	L**
Spacing	NS	L*

[z]Linear (L), quadratic (Q), or nonsignificant (NS) or significant at 5% (*) or 1% (**) level.

2). At both locations, increased red pepper removal was found at in-row plant spacings of 20 cm.

Crop damage due to mechanical fruit removal was measured by the percentage of fresh weight of vegetative material found in each harvesting sample, and was determined as the percentage of trash. Increasing the N rate to 112 kg/ha did not seem to increase crop succulence to the point where the harvester damage was significantly greater than at reduced N rates (Table 1).

Spacing influences on the percentage of trash were linear and quadratic at both locations (Table 2). Generally, percentages of vegetative material mechanically removed/damaged increased at close plant spacings. Although plant population from the 81 cm spacing to the 10 cm spacing treatment was increased by 700%, the increase in plant damage between spacing treatments was only 14% at Avery Island and 10% at Baton Rouge. Stem breakage appeared substantially reduced with the 10 cm plant spacing. The data suggest, therefore, that adjacent plant support in closely spaced treatments played a significant role in reducing mechanical harvesting damage to a given plant. This observation is similar to that made by Dempsey (4) when hand-harvesting pimiento peppers.

Tabasco pepper above-ground plant development also was significantly influenced by N rate and spacing (Table 3). As N rate increased, plant height and diameter increased significantly. As in-row spacing decreased, plant diameter decreased (21). The data indicate, therefore, that one is able to increase plant height by increasing N rate, and control plant diameter by decreasing in-row spacing. Such manipulation approaches the "ideal" plant type described by Marshall (11) for mechanical harvest. Stroehlein and Oebker (22) were unable to produce a chile pepper plant of this type when supplying high rates of N with conventionally spaced chile. Past data (12) also have shown that pepper types vary considerably in their response to increased plant populations. In this study, high N rate and high plant populations not only produced a favorable plant structure, but also increased mechanically retrievable red pepper yields.

Tissue N generally increased linearly at all sampling dates with increasing N rate at Avery Island (Table 4) and at Baton Rouge (data not shown). Tissue N decreased with time, except after N was sidedressed in the middle of July. Where no N was applied, tissue N values ranged from 4.14% to 5.72% at Avery Island, and from 4.1% to 5.36% at Baton Rouge. When N was applied at 112 kg/ha, tissue N concentrations increased and ranged from 5.14% to 6.38% at Avery Island, and from 5.69% to 6.13% at Baton Rouge.

The influence of plant density on tissue N is evident by averaging N concentrations at 10 and 81 cm spacings. At Avery Island, conventionally spaced treatments averaged 5.75% N, while 10 cm spaced treatments averaged only 5.16% N. At Baton Rouge, 81 cm spaced treatments averaged 5.54% N while 10 cm spaced treatments averaged 5.14% N. The data suggest that as plant population increased, crop fertilizer N requirements increased accordingly.

Tissue N values taken in June at both locations gave the highest significant correlations (r = 0.34 and r = 0.28 for Avery Island and Baton Rouge, respectively) with red pepper yield. The June sampling date corresponds with the period of most vigorous Tabasco vegetative development, and is similar to N uptake patterns of bell pepper (15).

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Table 4. Influence of N rate, plant spacing, and sampling date on Tabasco leaf-petiole tissue N concentration at Avery Island.[z]

N rate (kg/ha)	Leaf N concn (%)											
	10 June				8 July				9 Aug.			
	In-row spacing (cm)				In-row spacing (cm)				In-row spacing (cm)			
	10	20	41	81	10	20	41	81	10	20	41	81
0	5.23	5.72	5.54	5.67	4.16	4.75	4.84	5.05	4.62	5.26	5.40	5.53
28	5.55	6.00	5.92	5.96	4.36	4.50	5.02	5.40	5.11	5.80	5.10	6.13
56	5.67	5.93	5.98	5.80	4.61	4.86	5.30	5.30	5.27	5.51	6.01	6.16
112	5.80	6.00	6.02	6.30	5.31	5.14	5.26	5.40	6.19	6.38	5.98	6.27
Significance[y]	L*	NS	L*	L*	L**	NS	L*	NS	L**	L*	L*	L**

[z]N rate × spacing interaction significant at 5% level for 9 Aug. sampling date only.
[y]Linear (L) or nonsignificant (NS) or significant at 5% (*) or 1% (**) level.

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The Effects of Corn Leaf Rust on Maturity and Quality of Fresh Market Ears of Sweet Corn

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Abstract. **The influence of common leaf rust (*Puccinia sorghi* Schw.) on 2 sweet corn (*Zea mays* L.) hybrids was compared in rusted and nonrusted plots for several maturity and ear quality characters. Differences were found for time of silking, ear length, ear diameter, and percentage of moisture between rusted and nonrusted plots. The percentage of Brix ranged from 4% to 25%, with the rusted plots always having reduced mean values. Correlations (P = 0.01) were found between ear diameter and percentage of moisture, percentage of Brix and percentage of moisture, and between ear length and ear diameter.**

Historically, severe common leaf rust (*Puccinia sorghi*) epidemics on corn (*Zea mays*) have been rare in the Midwest and eastern United States (5, 7, 9, 12, 14, 15). Over the past several years, however, this disease has become of major concern on sweet corn in many regions (NE-124 USDA-CSRS Technical Committee, personal communication). On sweet corn produced for processing in the states of Minnesota and Wisconsin, enough damage has been caused by epidemic levels of leaf rust in recent years, that it is now considered to be a major disease of that crop (1).

Yield losses following artificial inoculation with leaf rust in field corn have been reported. Russell (10) indicated losses of 20% could be expected with field corn under moderately severe epidemics, while a 17% overall yield loss was reported for a flint-type hybrid (6). When the single dominant gene, Rpd, which confers complete resistance, was used to compare resistant versus susceptible double cross hybrids, Kim and Brewbaker observed yield losses as dry seed weight ranging from 17.9% to 57.4% (3).

In commercial sweet corn hybrids, partial resistance to leaf rust, although variable, has been reported to be quite low (1).

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