Feasibility of Trellised Cucumber Production

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Abstract. Trellising was evaluated for its effects on yields of cucumber (*Cucumis sativus* L.) cultivars Dasher II, Marketmore 76, and PetoTripleMech at Lane and Wilburton, Okla. Trellising improved total and marketable yield at both locations compared with ground culture. 'PetoTripleMech', evaluated as a fresh-market cultivar, produced yields equal to, or higher than, the other cultivars. Average marketable fruit weight was not affected by trellising but was affected by cultivar at Lane, with 'PetoTripleMech' having the heaviest fruit. Economic analysis indicated that trellising is a viable management system for small-scale cucumber production.

Fresh-market cucumbers are hand-harvested several times during a season. Trellising has been suggested to increase harvesting efficiency in cucumber while improving yield by reducing damage to vines and improving net photosynthetic rate (Hanna and Adams, 1984; Konsler and Strider, 1973; Swingle and Mullins, 1976). Although combinations of twine and wire or wire alone were used to support the plants in the foregoing studies, wire exposed to direct sun can burn cucumber plants (Baker, 1977). Since these reports were published, new trellising materials (reusable, unknotted, woven nylon mesh), cucumber cultivars, and cultural methods (bedding and mulching with black plastic) have been developed. To the best of our knowledge, there is no information concerning the response of cucumbers grown with trellises on raised beds, drip irrigation, and plastic mulch.

This study was designed to determine if trellising, in combination with improved cultural practices, could increase yield of selected cucumber cultivars relative to unsupported plants. Cultivar trials (Makus, 1986; OSU, 1988) and an economic assessment (Schatzer et al., 1986) suggest that cucumber has potential for increasing economic return to producers. The previous studies, with various trellising methods, assumed that the cost of trellising would be compensated for by improved yield. However, these assumptions were not tested. Therefore, a second objective of this study was to examine the economic feasibility of trellising for fresh-market cucumber production.

Experiments were conducted concurrently

on a Bernow fine sandy loam (thermic Glosic Paleudalf) at Lane, Okla., and a Counts silt loam (thermic Albaquic Paleudalf) at Wilburton, Okla. Preplant fertilizer applications were 56N-62P-155K kg·ha⁻¹ at Lane and 200N-77P-22K kg·ha⁻¹ at Wilburton. Additional N, 17 kg·ha⁻¹ at Lane and 45 kg·ha⁻¹ at Wilburton, was added in one application through the drip irrigation system during the fourth harvest week. In all cases, urea was the N source. The gynoecious slicing cultivar Dasher II and the monoecious slicing cultivar Marketmore 76 were compared. In previous observational trials (1989) in Wilburton, the gynoecious cultivar PetoTripleMech, primarily used as a pickling cucumber, produced fruit of a size, quality, and quantity that would allow it to be considered as a slicing cucumber. For these reasons, 'PetoTripleMech' was included in this study to evaluate its performance against

established slicing cultivars.

Beds (≈ 20 cm high, 6.1 m long, 76 cm wide) were formed on 1.8-m centers. Drip irrigation (0.38 mm, 30.5-cm orifice spacing) and black plastic mulch (0.025 mm thick) were applied concurrently. Holes were punched through the mulch and seed planted on 46-cm centers in a single row per bed on 26 May 1989. Plants were reduced to one per hill, 1 week after emergence. Woven, reusable, unknotted, nylon trellis netting (Dalen Products, Knoxville) was attached to two steel T-posts, one on each end of the plots, at a height of 1.5 m. The experiment incorporated a factorial design (three cultivars and two trellis treatments) in randomized blocks with eight replications at Lane and six at Wilburton. Although randomization caused trellised and ground culture plots to sometimes be adjacent to each other, effects of shading were minimal since plots were 1.8 m apart arranged in an east-west orientation at both locations. Ground culture guard rows surrounded the field at both locations. Because harvests were not necessarily made on the same days at both locations, totals for harvests in a week, instead of each harvest, are reported for both locations for 6 weeks (10 July to 12 Aug.). Fruit were graded in accordance with the U.S. Dept. of Agriculture standards (U.S. Dept. Agr., 1958). Total and marketable fruit (U.S. grade no. 1 and better) yields were recorded. Fruit were considered to be unmarketable if noticeably damaged (including disease). Analyses of variance were performed for each measured variable, using General Linear Models procedures of the Statistical Analysis System (SAS Institute, Inc., Cary, N.C.). Mean separations were performed using Fisher's LSD.

There were differences in total and marketable yields due to cultivars at both locations (Table 1). 'PetoTripleMech' and 'Dasher II' produced the highest total yields at Lane and Wilburton. The highest marketable yield was produced by 'PetoTripleMech' at both locations. 'Dasher II' had higher marketable yields than 'Marketmore 76' at Wilburton, but not at Lane. Total and marketable yields for all cultivars at Wilburton were consis-

Table 1. Mean total and marketable yields and mean marketable individual fruit weights for cucumber grown with and without trellising at two locations in southeastern Oklahoma.

Source	Location ²					
	Lane			Wilburton		
	Total yield (Mg·ha ⁻¹)	Marketable Yield (Mg·ha ⁻¹)	Fruit wt (kg)	Total yield (Mg·ha ⁻¹)	Marketable Yield (Mg·ha ⁻¹)	Fruit wt (kg)
Cultivar (C)						
PetoTripleMech	70.84 a	41.38 a	0.31 a	89.05 a	71.32 a	0.31 a
Dasher II	64.21 a	25.20 b	0.25 b	83.37 a	62.57 b	0.33 a
Marketmore 76	49.65 b	23.06 b	0.22 b	55.07 b	41.93 c	0.31 a
	**	**	*	**	**	NS
Trellis (T)						
Yes	65.32 a	32.84 a	0.27 a	84.34 a	65.10 a	0.32 a
No	57.81 b	26.93 b	0.27 a	67.32 b	52.11 b	0.31 a
	*	**	NS	**	**	NS

¹Mean separation in columns by LSD, *P* = 0.05. None of the interactions of T × C were significant. ²NS, ***, Nonsignificant, or significant at *P* = 0.05 or 0.01, respectively.

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Table 2. Effects of trellising of cucumbers on profits/ha when material costs are recovered over 5 years, as estimated by average marketable yields for two trellis support systems.

Item	Amount	Value		Profit or (loss) value
		Per unit	Total	
Steel T-post				
Yield increase ^z (Mg)	9.45	\$448.00 ^y	\$4234	\$4234
Cost				
Support (no.)	1297	\$2.00	(\$2595)	
Mesh netting (m)	5536	0.46	(\$2546)	
Wire (ha)	1	50.00	(\$ 50)	
Total material cost			(\$5191)	
Annual cost*				(\$1335)
Profit over material cost				\$2899
Labor ^w (h)	250	\$4.50	(\$1125)	(\$1125)
Net profit increase ^u				\$1774
Concrete reinforcing bar				
Yield increase ^z (Mg)	9.45	\$448.00 ^y	\$4234	\$4234
Cost				
Support (no.)	1297	\$1.33	(\$1725)	
Mesh netting (m)	5536	0.46	(\$2546)	
Wire (ha)	1	50.00	(\$ 50)	
Total material cost			(\$4321)	
Annual cost*				(\$1112)
Profit over material cost				\$3122
Labor ^w (h)	250	\$4.50	(\$1125)	(\$1125)
Net profit increase ^u				\$1997

^zBased on average marketable yield from experimental data.

^yValue is net to producer after reduction by harvesting, grading, packing, and transportation costs.

^wWith 5-year capital recovery at 9% according to the method of Boeheje and Eidman (1984).

^xSupport erection and dismantling.

^uNet profit increase = yield increase - (annual material costs + labor).

tently higher than at Lane. At Lane, $\approx 48\%$ of fruit were marketable (range: 39%, 'Dasher II' to 58% 'PetoTripleMech'). At Wilburton, $\approx 77\%$ of fruit were marketable (range: 75%, 'Marketmore' to 80% 'PetoTripleMech'). Average marketable fruit weight differed among cultivars only at Lane, with 'PetoTripleMech' having the heaviest fruit.

Trellising significantly increased total and marketable yield at both locations. The marketable yield averaged across both locations was 39.52 Mg·ha⁻¹ for ground-cultured and 48.9 Mg·ha⁻¹ for trellised plants. The increase in marketable yield due to trellising was 5.91 Mg·ha⁻¹ at Lane and 12.99 Mg·ha⁻¹ at Wilburton with an average of 9.45 Mg·ha⁻¹ overall. There were no significant interactions between cultivars and cultural (trellising vs. ground culture) treatments for total and marketable yield and average marketable fruit weight.

Costs for site preparation through planting are the same for ground-cultured or trellised plants. Trellising requires additional inputs over ground culture. The feasibility of incorporating these additional inputs into the production scheme is analyzed here. The materials used for trellising included support posts, wire, and netting (Table 2). If steel T-posts are used to support the trellis, as in the experimental plots, the initial costs for the materials would be \$5191/ha. One of the major material costs is the T-posts. Concrete reinforcing bar (1.6 cm diameter) could be substituted for the T-posts and would reduce the total cost of materials by \$870/ha. The wire and steel T-posts assembly could be projected to last a minimum of 10 growing seasons, while the useful life of the netting

material is rated by the manufacturer at five growing seasons. If yield increases from trellising are consistent over the 5-year life of the netting, and the T-posts are assigned a zero salvage value after 5 years, the annual costs of the trellis materials can be recovered using the capital recovery method (Boehlje and Eidman, 1984). An annual interest rate of 9% was used to determine capital recovery. If a salvage value was included, the annual costs of materials would decline.

There is no information concerning the amount of labor required to perform the various functions involved with trellising of cucumbers. Labor requirements for small-scale, randomized experimental plots are difficult to extrapolate to commercial-sized operations. Labor estimates for this experiment are based on observations of the time required to perform operations in the two cultural systems. Labor requirements on experimental plots should only be compared to labor requirements for commercial production systems with the understanding that there are relative differences between experimental and commercial systems and the extrapolation is at best only an estimate.

Based on observations from experimental plots, ≈ 250 h·ha⁻¹ of additional labor is estimated to be associated with a trellis system vs. ground culture. This labor would be for construction and later disassembly of the trellis, and for training the plants to the trellis. The netting materials used here (14 x 14-cm mesh) allows the cucumber vines to climb and weave throughout the netting with some hand training. With the system employed here, labor for training vines is likely to be less than for the trellising systems de-

scribed by Hanna and Adams (1984), Konsler and Strider (1973), or Swingle and Mullins (1976).

The observations of this research suggest that trellised cucumbers are easier to harvest than ground-cultured cucumbers. With trellising, harvesting is more efficient because a large percentage of fruit are supported off the ground with easier access than that provided by ground culture, which requires stoop labor and movement of the canopy to expose and harvest fruit. With the same limitations on interpretation of labor requirements obtained from experimental plots, the savings in harvest labor would offset some of the labor required for construction and maintenance of the trellis system.

For the entire harvest period, an average return to the producer (based on prices at the nearby Dallas market) would have been \$448/Mg after deduction of harvesting, packing, and transportation charges. The average increase in marketable yield (Table 2) due to trellising would have increased gross returns by \$4234/ha (9.45 Mg·ha⁻¹ x \$448/Mg). If 250 additional hours of labor were required for trellis construction and maintenance, and even if harvesting labor were not reduced by the trellising system, the increase in profits would still be substantial. If harvesting costs were reduced, further increases in grower profits would be realized.

To determine the net effect on profit, the added costs of the trellis production system were subtracted from the gross returns of the trellised system (Table 2). Trellising increased profits when compared with ground-cultured plants by \$1774/ha and \$1997/ha for steel T-posts and concrete reinforcing bar, respectively, at the 9% interest rate. If the interest rate is increased to 12%, the profit would be reduced an additional \$105 and \$88/ha, respectively. To recover materials costs, an additional 2.98 Mg·ha⁻¹ of cucumber would have to be produced when using T-posts and 2.48 Mg·ha⁻¹ when using concrete reinforcing bar for support of the trellis. These levels of increase were achieved at both locations.

Before an alternative production practice is implemented, it should be at least as profitable as the system already in place. Trellising using steel T-posts increased marketable yield over ground culture and returned a profit over the costs of the materials. The total material costs of the trellis could be recovered in 2 years if the additional labor required for erecting and dismantling are ignored. The profitability of trellising can be enhanced by growing more than one crop. Once erected, the trellis can be used for sequential plantings of compatible crops (Hanna et al., 1990).

Of interest is the performance of 'PetoTripleMech', which is normally used as a pickling cucumber. Although previous studies (V.M.R., unpublished) indicated that yield was comparatively high, yields were further improved by trellising. If taste and quality are acceptable, this cultivar also could be used for fresh-market consumption.

Trellising is used to reduce contact of cu-

cumber vines and fruit with bare soil to promote growth and limit mechanical and disease damage to fruit. Black plastic mulch is a cultural tool used, in part, to keep plants from contact with the soil. Even when black plastic mulch is used, trellising improved yields over ground-cultured plants. This improvement can be translated into potentially greater profits for the producer.

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