Effects of planting density on canopy dynamics and yield of pickling cucumber grown for once-over machine harvest

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Introduction

- Michigan is the leader in U.S. pickling cucumber (*Cucumis sativus* L.) production with about 30% of the total national production.
- Pickling cucumber producers use row spacings ranging from 30 to 76 cm and planting densities of 87,000 to over 350,000 plants/ha. High densities are used to maximize yield of machine-harvested cucumbers.
- Narrow rows and high densities in pickling cucumber production have been reported to increase relative humidity in the plant canopy, a situation that promotes fruit rot caused by diseases, especially *Phytophthora capsici*.
- However, most growers of once-over machine-harvested cucumbers have not adopted wide rows (and low planting densities) because of potential yield reductions.
- A quantitative study of the continuous response of cucumber plant canopy and yield to changes in plant density could improve our understanding of intra-specific competition and the interactions between plant density and biotic or abiotic factors.

Objective

Measure the impact of pickling cucumber planting density on canopy dynamics and determine optimum plant density for maximum yield and economic value.

Materials and Methods

- Field experiments were conducted at the Michigan State University, Horticulture Teaching and Research Center in East Lansing, MI in 2003 and 2004.
- Cucumber planting densities were obtained using a combination of four row spacings (30, 46, 61, and 76 cm) and three plant spacings inside the row (10, 13, and 15 cm), corresponding to 330,000 to 88,000 plants/ha.
- Digital photos were taken weekly at a height of 1.5 m above each plot and the photos were analyzed to obtain percent ground cover.
- Data on cucumber canopy evolution over time were fitted to a logistic response equation:

$$C(T) = \frac{C_i C_m}{C_i + (C_m - C_i)e^{-rT}}$$

where $C(T)$ is instant canopy cover at a specific temperature sum T, C_m and C_i are maximum and initial canopy cover, and r is the intrinsic canopy growth rate.

- Cucumbers yield (Y) was fitted to equation:

$$Y = \frac{Dw_m}{1 + aD}$$

where D is density, w_m and a are regression parameters.

- Economic value was calculated using an average of $1.65 per thousand seeds and range of cucumber selling prices. The value was obtained by multiplying marketable yield by selling price and subtracting the cost of the seed.

Table 1. Cucumber planting densities (plants/ha) resulting from different combinations of row spacings and plant spacings inside the row

Row spacing (cm)	In-row spacing (cm)		
	10	13	15
30	330,000	255,000	220,000
46	215,000	165,000	145,000
61	160,000	125,000	110,000
76	130,000	100,000	88,000

Results

- Cucumber canopy evolution over time followed a logistic response regardless of the planting density (Fig. 2).
- Planting density affected canopy dynamics. As expected, when density increased, canopy cover also increased (Fig. 2).
- Cucumber yield increased with increasing planting density. However, the rate of yield increase was progressively lower as density increased. Marketable cucumber yield reached a maximum at about 300,000 plants/ha (Fig. 3).
- In addition to seed price, the planting density required to maximize economic value varied with cucumbers selling price (Fig. 4).

Fig. 1. Pickling Cucumber grown using 30, 46, 61, and 76 cm row spacing

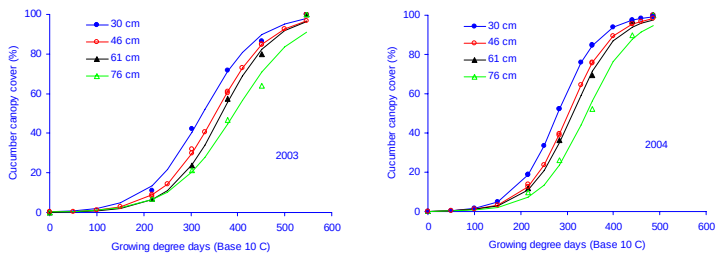

Fig. 2. Cucumber canopy dynamics under various row spacings

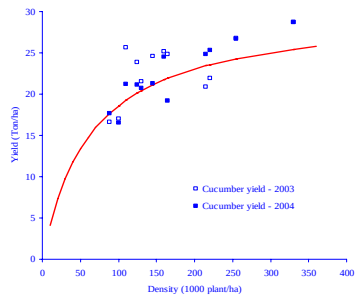

Fig. 3. Cucumber yield as affected by planting density

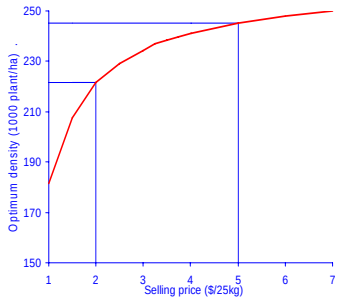

Fig. 4. Optimum density (maximum economic return) of cucumber as affected by selling price

Conclusion

- Pickling cucumber planting density could be reduced significantly without reducing economic value.
- The canopy remains open longer under low planting densities.
- Low planting densities, especially in wide rows, could help reduce relative humidity in the plant canopy and potentially reduce the incidence of fruit rot.

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