The yields were greatly improved by an application of ethephon (Table 2). The 6095 line was very late, followed closely by 6034. The 1050-1 and 1050-2 lines were early with round to oblate fruit and had a good uniform red color. Based on the evaluation of stem scar size and depth of single plant selections (Table 3) the three best lines were grown in replicated trials in the 1973 spring season.

The 1973 spring test grown on Vorlex treated soil produced satisfactory yields for all varieties (Table 4) and the evaluations of fruit characteristics show that at least one of the Florida lines (1050-2-13) should be considered for varietal status. It has the J_2 character, is resistant to races 1 and 2 of the fusarium wilt fungus, has round to oblate fruit, good red color, acceptable stem scar and extremely good core depth.

Evaluation of processing quality of varieties and Florida lines for the 1973 Spring crop (Table 5) showed that the 3 Florida lines were equivalent to or superior in color to the whole pack varieties which were grown for comparison. Acidity was below pH 4.6 which is required for processing as an acid food. The titratable acidity was very close to or at the .35 level which allows processing under standard conditions. Soluble solids and vitamin C contents were in the range generally associated with Florida produced tomatoes (4). Florida lines had superior color.

Literature Cited

1. Bates, R. P. and J. W. Strobel. 1969. Evaluation of Florida-grown tomato cultivars and breeding stocks for thermal processing. **Proc. Fla. State Hort. Soc.** 82:173-177.
2. Crill, Pat and D. S. Burgis. 1972. Report to the Georgia-Florida Canners Associations concerning processing tomato varieties for production in Florida. AREC-Bradenton Mimeo Report GC1972-9. 6 pp.
3. Matthews, R. F. and H. H. Bryan. 1972. Processing Florida tomatoes—the impact of mechanical harvest. **Fla. State Hort. Soc. Proc.** 81:178-181.
4. Matthews, R. F., Pat Crill and D. S. Burgis. 1973. Ascorbic acid content of tomato varieties. **Fla. State Hort. Soc. Proc.** 82: (in press).

CUCUMBER RESPONSE TO COPPER RATE AND FERTILIZER PLACEMENT[1]

A. A. NAVARRO AND S. J. LOCASCIO

IFAS, Vegetable Crops Department
Gainesville

Abstract. **The effects of Cu rates and fertilizer placements on fruit yield and foliage Cu content of cucumber were evaluated in two field studies. In both years, early and total marketable yields were increased by application of increased rates of Cu from zero to 8 lb/acre. Interactions between Cu rate and fertilizer placement on Cu content in plant foliage, on early yield and on total yields were significant. Similar yields were obtained with both broadcast and band placement of fertilizer without Cu. With an increase in the rate of Cu application, yield increased with both placements. However, mean yield increases in response to increased rates of Cu were 141 percent with the band placement and 243 percent with the broadcast placement during the two seasons. The Cu concentrations of leaf tissue also increased with increased rates of applied Cu and were greater with the broadcast than with band placement.**

Although Cu is an essential element, plants are easily injured by excess rates of application (6). Since differences in adequate and toxic levels are small, placement of fertilizer that contain large amount of Cu is critical (6). In work with watermelons, Locascio *et al.* (5) reported that yield response to Cu rate interacted with fertilizer placements. They found that as the rate of Cu fertilization increased to 8 lb/acre, watermelon yields were reduced with band placement but increased with broadcast placement. Similar responses were obtained with $CuSo_4.5H_2O$ and with F.T.E. 503 as the Cu source.

The purpose of this study was to evaluate the effects of Cu rate and fertilizer placement on yield and mineral composition of cucumber tissues.

Experimental Procedure

Experiments were conducted during 1971 and 1972 on two newly cleared areas at the Horticultural Unit in Gainesville. The soil was a Leon fine

[1]Florida Agricultural Experiment Stations Journal Series No. 5117.

sand with an approximate pH of 3.9 and an organic matter content of 3.2 percent.

Treatments consisted of factorial combinations of four Cu rates, 0, 2, 4, and 8 lb/acre; and two fertilizer placements, band and broadcast. Cu was applied as copper sulfate with the N-P-K fertilizer formulated from ammonium nitrate, diammonium phosphate, potassium chloride and potassium sulfate. Before planting, fertilizer was applied at the rate of 120-45-120 lb/acre N-P-K. Broadcast fertilizer was applied on the entire surface area of the plot and incorporated to a depth of 6 to 8 inches. Band fertilizer was applied by hand in a single furrow 2½ inches to the side and 2½ inches below the seed level on the bed. Treatments were replicated 3 times in a randomized block design in plots 4 by 25 ft. In both seasons, lime was applied before planting to bring the soil pH above 5.5.

'Poinsett' cucumber seeds were planted on single rows with the use of a Planet Junior seeder. Seedlings were thinned to one plant per two feet. At the last cultivation, an addition N application was made in a band at the rate of 30 lb/acre N from ammonium nitrate.

Fruit harvests began 55 days after seeding and were made at 3 to 4 day intervals. A total of eight harvests were made in 1971 and five in 1972. The yields obtained in the first three harvests were considered as early yield.

Whole plant samples were collected 30 days after planting for tissue analysis. At harvest, recently mature leaves were sampled. Plant tissue was dried, and ground with a Willey-Mill. Two-g samples of the tissues were dry ashed at approximately 550 C. The ash was dissolved in 1N HCl and analyzed for Cu and P by the Soil Science Department Analytical Laboratory. Cu was determined by atomic absorption and P was determined colorimetrically.

Results and Discussion

Early and total cucumber yields were increased in both 1971 and 1972 in response to increased rates of applied Cu (Table 1). Yields were higher in 1972, but the magnitude of response was greater in 1971. Yield increased 433 percent in 1971 and 285 percent in 1972 in response to increased rates of Cu application from zero to 8 lb/acre. At the zero Cu and 2 lb/acre Cu rates, Cu deficiency symptoms were evident in many young seedlings. In several occurrences, death of the seedling followed. Maximum yields in both years were produced at the 8 lb/acre rate. However, near maximum yields were produced at the 2 and 4 lb/acre Cu rate in 1972. The main effects of Cu rate on plant tissue Cu and P concentrations are shown in Table 2. Positive yield responses to increased rates of Cu were accompanied by linear increases in tissue Cu early and late in the season and a reduction of P in the plant tissue sampled at harvest. Cu rates had no effect on P in the tissue at the earlier sampling. Similar responses to increased rates of Cu have been reported for watermelons (1, 2, 3, 4). Cucumber responses to Cu are probably related to both the low level of available Cu in this soil, which was less than 1 ppm Cu extractable with 0.1N HCl, and to an apparently high Cu requirement of the crop.

In both seasons, the effects of Cu rate interacted with fertilizer placement on yield and com-

Table 1. Main effects of Cu rates on early and total marketable fruit yields.

Cu rate	Yield, ton/acre			
	1971		1972	
lb/acre	Early	Total	Early	Total
0	0.41	2.01	3.94	10.57
2	1.74	5.95	8.07	17.99
4	1.95	6.41	8.25	17.57
8	2.57	8.53	8.67	19.17
F value[z]	L**	L**Q**	L**Q** C**	L**Q** C**

[z]Rate effects were linear (L), quadratic (Q) and cubic (C) at the 5% (*) and 1% (**) levels of significance.

Table 2. Main effects of Cu rate on Cu and P composition in cucumber plants.

Cu rate	Tissue composition			
	30 days after planting		At harvest	
lb/acre	Cu, ppm	P, %	Cu, ppm	P, %
		1971		
0	6.70	0.74	3.15	0.47
2	8.14	0.77	3.72	0.40
4	8.65	0.75	3.50	0.39
8	10.21	0.74	3.92	0.37
F value[z]	L**	N.S.	L**C**	L**Q*
		1972		
0	4.94	0.74	2.18	0.48
2	5.40	0.74	2.86	0.45
4	6.31	0.76	2.82	0.45
8	7.45	0.75	3.19	0.43
F value[z]	L**	N.S.	L**	L**

[z]Rate effects were linear (L), quadratic (Q) and cubic (C) at the 5% (*) and 1% (**) levels of significance.

Table 3. Interactions of Cu rate and placement on total yield and on tissue Cu concentration 30 days after planting. 1971.

Placement[z]	Cu rate, lb/acre 0	2	4	8	Mean
	Total yield, ton/acre				
Band	1.75	4.60	3.67	5.94	3.99
Broadcast	2.30	7.23	9.15	11.11	7.46
		*	*	*	
	Tissue Cu, ppm				
Band	6.29	8.03	7.69	9.08	7.77
Broadcast	7.12	8.25	9.61	11.34	9.08
			*	*	

[z]Difference between placement is significant (*).

Table 4. Interactions of Cu rate and placement on early and total yields and on tissue Cu 30 days after planting. 1972.

Placement[z]	Cu rate, lb/acre 0	2	4	8	Mean
	Early yield, ton/acre				
Band	3.37	5.50	5.53	5.33	4.93
Broadcast	4.50	10.65	10.96	12.00	9.53
		*	*	*	
	Total yield, ton/acre				
Band	10.10	15.22	15.76	15.60	14.17
Broadcast	11.03	20.75	21.01	22.73	18.88
		*	*	*	
	Tissue Cu, ppm				
Band	5.58	5.12	5.57	6.08	5.59
Broadcast	4.29	5.68	7.04	8.82	6.46
	*		*	*	

[z]Difference between placement is significant (*).

position of Cu in the plant tissue (Table 3 and 4). Where no Cu was applied, fertilizer placement had no effect on yield. Plants grew poorly and yields were low. With an increase in the rate of Cu application, yield and Cu concentration of the tissue increased with both placements. The magnitude of this increase, however, was greater with the broadcast than band placement. In 1971, fruit yields increased 383 with broadcast placement and 240 percent with band placement with an increase in the Cu rate from zero to 8 lb/acre. In 1972, the respective yield increases were 106 percent and 43 percent.

This interaction between Cu rate and fertilizer placement was probably due to the small difference between the adequate and toxic levels of Cu and is similar to that reported on watermelons by Locascio *et al.* (5). With band fertilizer placement, high concentrations of Cu and macronutrients may induce root injury to young emerging seedling. The resultant injury and reduced growth with band placement may be reflected by lower tissue Cu concentration and lower yields (Table 3 and 4).

Literature Cited

1. Everett, P. H., S. J. Locascio and J. G. A. Fiskell. 1966. Phosphorus and copper effects on growth and yields of watermelons. **Proc. Fla. State Hort. Soc.** 79:155-159.

2. Locascio, S. J., P. H. Everett and J. G. A. Fiskell. 1964. Copper as a factor in watermellon fertilization. **Proc. Fla. State Hort. Soc.** 77:190-194.

3. ———— and J. G. A. Fiskell. 1966. Copper requirements of watermelons. **Proc. Amer. Soc. Hort. Soc.** 88:568-575.

4. ————, P. H. Everett and J. G. A. Fiskell. 1968. Effects of phosphorus source and copper rates on watermelons. **Proc. Amer. Soc. Hort. Sci.** 92:583-589.

5. ————, J. G. A. Fiskell and F. G. Martin. 1972. Influence of fertilizer placement and micronutrient rate on watermelon composition and yield. **J. Amer. Soc. Hort. Sci.** 97:119-123.

6. Salisbury, F. B. and C. Ross. 1969. Plant physiology. Wadsworth Publishing Co., Inc., Belmont, California.