HORTICULTURE SERIES 596 JANUARY 1989

CULTURAL RESEARCH WITH PROCESSING VEGETABLES 1988

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Studies on culture and physiology of tomatoes for processing were conducted at 2 locations of OARDC--Main Campus, Wooster, and the Vegetable Crops Branch (VCB), Fremont.

Research on the Wooster campus is usually of a preliminary nature and requires frequent observations and data collection. The soil is a silt loam with good uniformity throughout the experimental area. The plots received 600 lbs/A of 10-20-20 fertilizer after plowing, but before final fitting for planting. No additional fertilizer was applied except for specific treatments. Pesticides for weeds, insects and diseases were applied according to recommended practice. No serious problems occurred during the study.

Soil at VCB ranges from a sandy loam to a clay loam and every effort is made to have maximum uniformity within a particular study. The clay loam soil is fall bedded using a power bedder. The sandy soil is bedded in the spring prior to planting. The beds are on 60-inch centers with 48-inch tops and furrows 6-8 inches deep. The P & K fertilizer is applied after plowing in the fall or spring, but before bed formation. Nitrogen is applied in the spring immediately prior to planting and usually incorporated 1-2 inches deep at the same time as the herbicide incorporation. The herbicides used were napropamide (Devrinol) and/or metribuzin (Sencor or Lexone) at recommended rates. Insecticides and fungicides were also used according to standard recommendations. Generally, no serious weed, insect or disease problems occurred. Ethephon at 2 to 3 pts/A was applied to all plots at the mature-green stage of fruit development.

Generally, plot rows were 30 ft. long at both locations and plants are spaced 12 in. apart where single rows are used. Beds were used at the VCB, but not at Wooster, but single rows were on 5-ft. centers at both locations. Additional specific details are given with each study.

Special Note: This is to gratefully acknowledge the support in the form of monetary gifts from The Ohio Food Processors Association, the Fremont Pickle and Tomato Growers Association and the National Crop Insurance Association and Crop Insurance Research Bureau, Inc. Further, much appreciation is expressed to personnel of the H.J. Heinz Co. for providing transplants for most of these studies, and especially to Stan Gahn and Reuben Peterson for coordinating the shipment and receipt of the plants.

H-464/1-89/350

TABLE 1. Temperature and Rainfall Data

	Temperature (°)						Rainfall (in).	
	1988 Means			Long Term Means				Long Term
Month	Min	Max	Avg	Min	Max	Avg	1988	Avg.
				Wooster				
April	38.8	61.9	50.1	36.9	59.5	48.1	2.19	3.34
May	45.7	73.6	60.2	46.5	70.4	58.4	1.26	3.98
June	51.3	82.9	68.4	55.5	79.2	67.4	0.52	3.98
July	60.6	90.0	75.0	59.5	83.3	71.4	6.37	4.18
August	61.3	84.1	72.3	57.7	81.9	69.6	3.40	3.73
Sept.	50.9	74.1	62.4	51.5	75.7	63.3	2.97	3.15
				VCB				
April	36.9	58.3	47.6	38.3	58.5	48.4	1.57	3.36
May	50.1	74.0	62.0	48.1	69.6	58.9	0.91	3.65
June	55.9	83.3	69.6	57.6	78.6	68.1	0.63	3.91
July	63.6	89.1	76.4	61.8	82.8	72.3	2.84	4.01
August	62.6	84.3	73.5	59.5	80.8	70.1	5.68	3.66
Sept.	50.5	74.3	62.4	53.0	74.9	64.0	1.81	3.05

The season was hot and dry in May and June and early July. A total of 8.25 inches of irrigation was applied on the Wooster plots and 2.25 to 4.50 inches on the VCB plots.

A. Plant Nutrition Studies - Tomatoes:

1. Potassium

The potassium rate and time of application study was held in the same area at the VCB for 3 seasons and the results are summarized in Tables 1 through 4. Data indicate that K_2O applications do, indeed, influence yields of processing tomatoes under Ohio conditions, even though after 2 season of no fertilization with K_2O the soil still had 230 lbs/acre of K_2O available by OARDC-REAL soil analysis. It does appear that the 200 lbs/A rate of K_2O was as effective on yield as the 400 or 600 lb rates. Although not statistically significant, it appears that the fall application may be a preferrable time of application than spring and that high rates of a spring application (600 lbs) may result in reduced yield. An examination of data in Table 4 suggests that this high rate may reduce the N content of the leaves (and perhaps other nutrients). One may postulate that this high rate of potassium sulfate may adversely affect root growth. If muriate of potash (potassium chloride) would have been used as a K source in this study, the harmful effects could have been more severe.

Leaf analyses data (Table 3) indicate that the K_2O applications did increase the K content of the leaves of tomatoes, but the increase was not as great as was anticipated considering the high rate of K_2O applied. There was also an influence on the % base saturation of K in the plots after 2 years of treatment (the 1988 data has not yet been analyzed) and in available K_2O in the soil (Table 3). However, the changes were not as great as anticipated in view of the high rates of K fertilizer applied. These results again point to the high buffering capacity of the clay loam soils in northwestern Ohio.

Table 2. Influence of rate and time of application of potassium fertilizer from potassium sulfate on yield of processing tomatoes.

Rate (lbs/A K_2O)	Time of appl.	Yield (Tons/Acre) Ripe	Green	Rots	Total
1986					
0	---	30.1	2.2	5.3	37.6
200	Spring	38.2	2.3	6.3	47.2
400	Spring	33.3	2.1	6.3	41.7
600	Spring	34.3	2.1	6.1	42.6
	LSD 5%	5.1	0.7	0.8	5.0
1987					
0	---	16.8	1.8	9.3	27.9
200	Fall	19.7	3.4	9.4	32.5
400	Fall	20.5	2.3	9.7	32.5
600	Fall	19.9	2.0	10.1	32.0
200	Spring	19.6	2.5	9.0	31.1
400	Spring	20.4	3.1	8.4	31.9
600	Spring	18.8	1.9	9.1	29.8
	LSD 5%	3.1	1.6	2.2	3.5
1988					
0	---	13.0	2.8	4.6	20.5
200	Fall	15.6	3.8	4.9	24.3
400	Fall	17.5	4.9	4.9	27.4
600	Fall	16.9	4.1	5.2	26.2
200	Spring	15.3	4.5	3.9	23.6
400	Spring	15.9	4.9	4.0	24.8
600	Spring	15.5	5.9	3.3	24.7
	LSD 5%	3.2	2.4	2.1	3.3

Table 3. Influence of rate and timing of application of potassium fertilization from potassium sulfate on K content of mature tomato leaves.

Rate (lbs/A K_2O	Time of Appl.	K in Leaves (% of dry weight) 6/17	7/1	7/15	7/30	8/6	8/14
1986							
0	---	0.78	2.23	1.33	0.99	0.93	0.96
200	Spring	1.07	2.34	1.67	1.31	1.59	1.34
400	Spring	1.45	2.37	1.63	1.57	1.59	1.59
600	Spring	1.28	2.60	2.21	1.54	1.46	1.94
	LSD 5%	0.58	NS	0.50	0.42	0.42	0.47
1987		6/15	7/9	7/20	7/27	8/4	
0	---	1.94	2.24	2.06	1.01	0.96	
200	Fall	2.38	2.75	2.49	1.56	1.47	
400	Fall	2.60	3.15	2.86	1.77	1.69	
600	Fall	2.67	3.02	3.06	1.83	1.84	
200	Spring	2.49	2.86	2.53	1.78	1.45	
400	Spring	2.69	2.91	2.83	1.64	1.89	
600	Spring	2.40	3.21	3.09	1.70	1.73	
	LSD 5%	0.26	0.31	0.23	0.43	0.35	
1988		6/23	7/7	7/21	8/4		
0	--	1.49	1.37	1.67	1.01		
200	Fall	2.17	1.39	1.84	1.45		
400	Fall	2.30	1.66	2.13	1.78		
600	Fall	2.47	1.75	2.10	1.86		
200	Spring	1.99	1.46	2.05	1.47		
400	Spring	2.21	1.66	2.24	1.86		
600	Spring	2.37	1.79	2.23	1.97		
	LSD 5%	0.28	0.26	NS	0.30		

Table 4. The influence of soil applications of potassium sulfate on pH, base saturation, and available K_2O in a clay loam soil at the Vegetable Crops Branch near Fremont, OH.

K_2O applied*	Time of applic.	Base Saturation Ca	Mg	K	pH	K_2O Available lbs/A
0	---	63	16	1.6	6.1	234
200	Fall	61	16	1.9	6.1	289
400	Fall	62	16	2.1	6.0	315
600	Fall	62	16	2.6	6.1	368
200	Spring	61	16	1.8	5.9	273
400	Spring	61	16	2.2	5.9	327
600	Spring	59	15	2.7	5.8	401

*Applied to same plots for 2 years - 1986 & 1987.

2. Nitrogen

A nitrogen rate variable was included with the K study because some previous work with greenhouse tomatoes indicated that nitrogen influenced the uptake of K and that K influenced N uptake. However, we found no significant interactions other than the possibility of highest rate of K resulting in a lower amount of N in the foliage. We are presenting, therefore, the separate effects of N rate on yield and leaf N content from this study (Tables 5 and 6).

Yields were influenced by rate of N as would be expected. Yields were generally higher from the 100 lb. rate, but not increased further from the 150 lb. rate. Also, the maturity was delayed as the rate of N fertilization increased.

Leaf N levels from 1987 data only were generally increased as N rate of fertilization increased and there was a general decline in N content of mature tomato leaves as the season progressed (Table Ø).

Table 5. Relationship of N and K fertilization to N content in mature tomato leaves (1987).

K rate (lbs/A K O)	Time of applic.	Sample Date	Leaf N - % of Dry Weight 6/25	7/9	7/20	7/27	8/4
0	---		4.56	4.39	3.95	2.33	2.44
200	Fall		4.33	4.53	4.04	2.86	2.56
400	Fall		4.59	4.50	3.96	2.49	2.51
600	Fall		4.53	4.40	3.89	2.41	2.69
200	Spring		4.23	4.51	3.89	2.77	2.30
400	Spring		4.45	4.35	3.96	2.44	2.53
600	Spring		4.14	4.50	3.98	2.36	2.16
		LSD 5%	0.41	NS	NS	NS	0.44

Table 6. Influence of N fertilization on yield of processing tomatoes, Cv. 1810.

Year	Rate of N (lbs/A)	Yield - tons/acre Ripe	Green	Rots	Total
1986	0	----	----	---	----
	50	32.7	1.9	6.1	40.7
	100	35.9	2.8	5.2	44.0
	150	33.9	2.1	5.7	41.8
	LSD 5%	2.3	0.4	0.7	2.5
1987	0	17.0	1.9	9.9	28.9
	50	19.1	1.7	10.1	31.0
	100	20.7	2.6	8.8	32.1
	150	20.7	3.4	8.4	32.5
	LSD 5%	1.7	0.5	1.0	1.8
1988	0	14.4	4.1	4.4	22.8
	50	14.9	4.1	4.7	23.7
	100	15.9	4.7	4.6	25.2
	150	17.5	4.8	4.0	26.3
	LSD 5%	1.2	0.6	0.5	1.5
Avg.	0	19.8	2.7	7.1	29.6
	50	20.5	2.7	7.1	30.3
	100	22.2	3.5	6.4	32.1
	150	22.4	3.6	6.1	32.1
	LSD 5%	1.3	0.4	0.6	1.4

Table 7. Influence of rate of N on leaf N content of mature tomato leaves (1987).

N Rate lbs/A N	Sample Date	Leaf N - % of Dry Weight 6/25	7/9	7/20	7/27	8/4
50		4.40	4.30	3.77	2.36	2.23
100		4.47	4.44	3.93	2.46	2.54
150		4.35	4.62	4.16	2.75	2.58
	LSD 5%	NS	0.20	0.13	0.27	0.17

3. Foliar Application of Nutrient Elements

This was the second year of a proposed 3-year study on the influence of foliar applied nutrients on growth and yield of processing tomatoes (Cv. H-1810). These plants were transplanted on May 19 and irrigated with 3/4 inch on May 27 to be sure of stand establishment and to help early growth. The plots were also irrigated on June 14 (1 inch) and July 5 (1.5 inches). The stand was good and plant growth and development was generally good considering the abnormally high temperatures, low relative humidity and low rainfall in May, June and early July.

Some treatments used in 1987 were not used in 1988 and some additional treatments were added, namely X-77 as a surfactant and Bravo which may act synergistically (Table 8).

Results indicate that no treatment resulted in a significant increase in yield over the non-treated control plants. One might be tempted to speculate that the use of Bravo as an additive may help improve yields, but this does not appear real and requires additional work during the third year of this study.

Foliar analysis data from 1987 treatments (Table 9) revealed that there was no treatment influence on leaf nutrient elements except for Mn. The reason for this is unclear and might possibly be related to fungicide spray application and not to foliar nutrient spray.

Table 8. Influence of foliar applied nutrients on yield of transplanted processing tomatoes, Cv. H-1810, 1987-88.

	Yield - Tons/A			
	Ripe		Total	
Treatment	87	88	87	88
Control	25.6	20.2	43.7	23.7
Na-Churs 3-18-18 2 gal/40 gal/A	24.2	17.4	40.4	22.1
Na-Churs 9-18-9 2 gal/40 gal/A	24.8	19.3	41.3	22.7
28% liquid N 1 gal/40 gal/A	26.7	16.5	43.4	20.2
3% N-ammonium nitrate 2 gal/40 gal/A	28.2	22.7	43.3	26.4
9% N-ammonium nitrate 2 gal/40 gal/A	25.6	22.6	40.7	27.3
KNO_3 2 lbs/40 gal/A	25.6	----	39.5	----
$Ca(NO_3)_2$ 2 lbs/40 gal/A	25.1	----	42.3	----
Urea 2 lbs/40 gal/A	27.1	22.2	43.7	25.8
Peters 20-20-20 0.8 lbs/40 gal/A	26.7	20.0	39.3	23.4
Na-Churs 3-18-18 2 gal/40 gal/A + X-77	----	19.9	----	23.2
Na-Churs 9-18-18 2 gal/40 gal/A + X-77	----	19.1	----	22.7
$Ca(NO_3)_2$ 2 lbs/40 gal/A + X-77	----	21.4	----	25.0
Na-Churs 3-18-18 2 gal/40 gal/A + Bravo at 3 pts/40 gal/A	----	21.5	----	25.5
Na-Churs 9-18-9 2 gal/40 gal/A + Bravo at 3 pts/40 gal/A	----	22.7	----	26.5
Na-Churs 3-18-18 + Sorba Spray Mg + Sorba Spray ZBK + X-77 at full bloom + 2 weeks later	24.7	22.6	44.0	26.9
LSD 5%	3.8	4.0	5.4	4.8

Plants transplanted on 5/28/87 and 5/18/88 with treatments starting 3 weeks later and continuing weekly for 8 applications each year, except for the last treatment which was on 6/25 and 7/14 in 1987 and 6/30 and 7/14 in 1988.

Plots were spring bedded on sandy loam soil. An application of 800 lbs/A of 0-26-26 was made prior to bedding. An application of 100 lbs/A N as ammonium nitrate was applied broadcast over the beds and lightly incorporated just prior to planting. The plots were irrigated on June 13, 1987 with 2 inches and 3 inches on July 6.

The plants were treated with Ethrel at the appropriate time and harvested with a mechanical harvester.

Table 9. Influence of foliar applied nutrients on content of the elements in mature leaves of processing tomatoes, Cv. H-1810. 1987.

	Content in Leaves - Dry Weight Basis*									
	%					ppm				
Treatments	N	P	K	Ca	Mg	Mn	Fe	B	Ca	Zn
Control	3.82	.34	2.96	3.52	.07	139	738	38	46	32
Na-Churs 3-18-18 2 gal/40 gal/A	3.94	.37	2.99	3.62	.07	139	727	40	55	32
Na-Churs 9-18-9 2 gal/40 gal/A	3.76	.33	2.73	3.32	.07	126	966	36	52	31
28% liquid N 1 gal/40 gal/A	4.07	.34	2.91	3.43	.07	149	701	36	75	32
3% N-amm. nit. 2 gal/40 gal/A	3.63	.32	2.67	3.47	.06	124	1010	36	59	29
9% N-amm. nit. 2 gal/40 gal/A	3.67	.31	2.93	3.40	.06	133	895	39	59	31
KNO_3 2 lbs/40 gal/A	3.59	.31	2.64	3.50	.06	138	1179	36	47	30
$Ca(NO_3)_2$ 2 lbs/40 gal/A	3.88	.34	3.01	3.48	.07	140	742	38	56	33
Urea 2 lbs/40 gal/A	3.87	.33	2.86	3.53	.07	128	662	38	55	30
Peters 20-20-20 0.8 lbs/40 gal/A	3.77	.33	2.90	3.48	.07	144	679	38	61	32
LSD 5%	NS	NS	NS	NS	NS	19	NS	NS	NS	NS

*Data are means of 4 sampling dates, 6/25, 7/14, 7/27 and 8/10/87.

B. Transplants and Stands of Tomatoes

1. Ethrel Applications to Plug Plants

Ethrel (ethephon) applications to tomato transplants grown in the field in Georgia has resulted, if conditions are optimum and timely applied, in plants that recover quickly following transplanting, develop rapidly and have higher, earlier yields than non-treated plants. The ethylene produced within the plants from ethephon application promotes root formation in tomatoes as well as other plants. This may be one reason the treated transplants recovered and grew better than non-treated plants.

A.A. Taha, one of our graduate students, treated some transplants he had grown in the greenhouse at OARDC in Wooster, but although he did obtain some root proliferation, he did not get good plant recovery after transplanting. The plants were slow to start regrowth and thus development and fruit maturity was delayed when plants were treated in the greenhouse.

With the increased use of northern-produced plug plants and a report that Ethrel-treated plug plants grew "better" than non-treated plants, it was decided to examine the effects of Ethrel on plug-plants at both Wooster and VCB locations. Plants were grown by Richard Hassell at the Muck Crops Branch and applications of Ethrel in deionized water were made 7 and 3 days prior to planting at the VCB. Rates used were 0, 300 ppm and 600 ppm.

Examination of the plants prior to planting and for several days after planting did not reveal any apparent differences between treated and non-treated plants. Root numbers and length appeared normal and all plants appeared to be growing satisfactorily.

Results, summarized in Table 10, revealed that stand, yield and fruit maturity as indicated by yield of ripe fruit were not influenced by ethephon treatment. However, plant height measured 3 or 4 weeks after planting was significantly less on treated plants than non-treated at both locations.

Because ethephon can favorably influence plant quality, this study needs to be expanded to determine if, indeed, parameters can be determined which will reliably provide favorable results on northern-produced tomato plug plants.

Table 10. Influence of use of Ethrel on plug-type transplants on subsequent plant stand and final yield of processing tomatoes, Wooster and Fremont locations, 1988.

Treatment Ethrel-ppm	Time	Wooster Stand*	Wooster Plant* height (in)	Wooster Yield (T/A) ripe	Wooster Yield (T/A) total	Fremont Stand*	Fremont Plant* height (in)	Fremont Yield (T/A) ripe	Fremont Yield (T/A) total
0	-----	32	7.9	31.0	37.6	30	11.3	19.6	24.1
300	3 days pre	31	6.9	28.2	36.0	30	9.0	19.3	25.1
600	3 days pre	30	6.5	27.2	35.8	32	9.7	17.9	21.9
0		30	7.7	25.9	34.0	31	11.4	20.1	24.4
300	7 days pre	31	7.3	30.7	40.0	32	10.5	18.4	23.1
600	7 days pre	31	6.7	28.0	36.4	30	8.9	19.8	25.8
	LSD 5%	NS	**	NS	NS	NS	**	NS	NS

*Stand counts are numbers of plants in 30 ft. rows. Plant heights were taken 3 weeks after planting at Wooster and 4 weeks after planting at Fremont. The plant heights are significantly different at the 1% level between the treated plants and checks for each time of treatment.

2. Relation of Stand and Single or Twin Rows to Yield

This study was done in conjunction with a hail research study. The results apply not only to hail injury, but to other aspects of stand establishment. The plants were transplanted in single or twin rows of 9,000 plants and 12,000 plants per acre, respectively, in mid-May. Following plant recovery, but prior to much re-growth, plants were removed to give 85 and 70% of the original stand which was above 95%.

Results revealed that, 1) reduced stands result in reduced yields; 2) because yields are higher from twin rows, yield reductions from the same percentage of reduced stand were less than from single rows.

Table 11. Influence of stand on yield of single and twin rows of processing tomatoes, Cv. H-1810, 1987 and 1988.

		Yield - Tons/Acre					
		1987		1988		Average	
Rows	% Stand	Ripe	Total	Ripe	Total	Ripe	Total
Single	95+	24.7	41.0	17.4	24.7	21.0	32.9
	85	22.3	38.6	16.0	22.5	19.2	30.6
	70	20.0	35.7	12.7	19.0	16.3	27.4
Twin	95+	30.6	46.3	26.3	33.9	28.4	40.1
	85	26.9	41.5	24.6	32.1	25.8	36.8
	70	27.4	41.6	20.1	26.6	23.8	34.1
	LSD 5%	3.2	4.4	3.2	3.7	2.8	3.6

C. Drainage and Rotation Effects on Tomatoes

This study has been in progress since 1983 and the importance of rotations for the production of tomatoes has become highly evident. Although yields were extremely low in 1988 due to the severe drought and heat stresses, the relationships were still evident (Tables 12 and 13). Because of the need to irrigate much of the acreage at the VCB and limited equipment (plus some electrical problems), it was not possible to irrigate this experimental area sufficiently to provide an acceptable crop. Nevertheless, continuous tomatoes for 5 seasons has resulted in significant yield losses.

A new project will start in 1989 to attempt to determine the causal factors for this yield decline.

The influence of drainage systems on yield is less clear and this will be another part of the new study to examine these effects more thoroughly.

Table 12. Influence of drainage and rotation on yield of processing tomatoes, 1983-1987.

		Yield-Tons/Acre Ripe			
Drainage	Rotation*	1983	1985	1986	1987
Surface only	No	14.9	23.2	20.4	14.5
	Yes	14.3	24.5	22.5	20.6
Surface + tile 50′	No	18.7	23.7	24.2	15.1
	Yes	17.4	25.5	23.1	19.2
Surface + tile 25′	No	20.7	20.5	22.9	16.2
	Yes	20.2	22.5	23.8	20.7
Rainfall for Tomato season (ins)		13.00	14.09	13.06	16.17

*No rotation - continuous tomatoes
Rotation - 3 year rotation with sugar beets and cucumbers.

Table 13. Influence of drainage and rotation on yield of processing tomatoes under severe drought and heat stress of 1988.

Drainage	Rotation	Yield-Tons/Acre Ripe	Green	Rots	Total
Surface only	No	4.1	4.2	1.5	8.3
	Yes	6.3	8.8	2.0	15.1
Surface + tile 50′	No	5.1	4.6	1.6	9.7
	Yes	6.9	8.0	2.4	14.9
Surface + tile 25′	No	5.4	4.0	2.0	9.4
	Yes	6.3	6.5	2.6	12.8
	LSD 5%	2.0	2.5	0.9	3.1

Plots were irrigated on June 29 with 2 1/4 inches.
Total rainfall for tomato season = 4.79 inches.

D. Drainage Effects on Pickling Cucumbers

This study has been in progress for 6 years and is a part of the tomato rotation study. Cucumbers appear to respond more to the drainage parameters because in 3 of the 6 years of the study, higher yields occurred where the plots has tile drainage in addition to good surface drainage (Table 14).

This study is continuing with efforts to obtain the reasons for the observed differences in drainage responses.

Table 14. Influence of drainage on yield of pickling cucumbers.

Drainage	Yield-Tons/Acre Ripe 1983	1984	1985	1986	1987	1988
Surface only	12.3	9.8	13.7	11.2	7.6	7.6
Surface + tile 50′	13.6	10.8	13.6	11.5	8.5	6.8
Surface + tile 25′	14.4	10.3	15.3	11.1	9.5	7.5
Rainfall for Tomato season (in.)	8.24	6.02	7.32	8.35	7.90	7.04*

*Includes 2 1/4 inches of irrigation on June 29.

E. Growth Regulator Effects on Tomatoes and Cucumbers

Growth regulators are always interesting to work with because the potential is great and the results unpredictable. A series of products from Abbott Laboratories has the potential for significantly affecting growth and development of many plants provided the treatment parameters can be determined. An initial effort was conducted on tomatoes and pickling cucumbers in 1980.

Another product, MB86, has been reported to improve tomato fruit size and thus, yields of tomatoes in Florida. OPG-7 is another extract of plant materials that also has increased tomato yields in Florida.

These materials were obtained and applied to processing tomatoes at Wooster. The results (Table 15) indicate that there was no treatment effect on either ripe fruit or total yield of this processing tomato hybrid.

The ABG materials were applied to pickling cucumbers (cv. Carolina) because the potential for a favorable response with these chemicals was great. Applications were made according to supplier's directions. Plots were 10 ft. long with 8 replications.

Results (Table 16) indicate that the treatments had no apparent influence on early plant development, early and total yields.

Table 15. Influence of growth regulator treatments on yield of processing tomatoes, Ohio, 1988.

Treatment	Ripe T/A	Ripe %	Total T/A
Check	29.1	60.7	41.7
ABG-3092 + ABG-3091, 3 appl.	25.6	57.5	38.1
ABG-3095 + ABG-3091, 3 appl.	32.6	64.6	45.5
ABG-3092 + ABG-3093, 3 appl.	30.8	59.9	45.3
ABG-3095 + ABG-3093, 3 appl.	24.9	56.8	37.6
ABG-3091, 3 appl.	28.8	55.2	44.4
ABG-3093, 3 appl.	26.4	56.8	38.2
BM86, 3 appl.	28.1	56.8	42.6
OPG-7, 4 appl.	27.2	55.9	42.2
LSD 5%	5.94	7.10	7.66

Plots planted 6/7/88, cv. H-6004; treatment applied in 40 gpa distilled water + 20 drops Tween 20/2000 ml. Treatments replicated 3 times - 30 ft. rows. Treatments applied according to supplier's recommendation. ABG materials from Abbott Laboratories, BM-86 from Agrimer Corp., OPG-7 from OPG Associates.

Table 16. Influence of ABG treatments on yield of pickling cucumbers, Ohio 1988.

Treatment	Yield - Tons/Acre 7/28	8/1	Total
Check	1.14	2.48	23.66
ABG-3092 @ 50 mls/A + ABG-3091 @ 10 gms/A	1.27	2.74	27.26
ABG-3095 @ 50 mls/A + ABG-3091 @ 10 gms/A	1.04	3.08	24.31
ABG-3092 @ 50 mls/A + ABG-3093 @ 50 mls/A	1.18	2.26	25.32
ABG-3095 @ 50 mls/A + ABG-3093 @ 50 mls/A	1.21	2.30	24.06
ABG-3091 @ 10 gms/A	1.10	2.56	23.27
ABG-3093 @ 50 mls/A	.86	2.59	21.55
LSD 5%	.42	.83	3.46

*Total yield from the first two harvest dates plus 4 more harvests.

F. Nitrogen Fertilization of Processing Cabbage

Cabbage has a rather limited root system and responds to N fertilizer and water applications. It is also sensitive to excess water and N fertilization. Excess N can result in internal tip-burn and other undesirable internal quality disorders. Excess water can result in severe growth restrictions and plant death.

This study was established in 1986 to attempt to determine a more optimum placement and timing of N fertilizer on cabbage than just a pre-plant broadcast of the nutrient. Results (Table 17) from 3 years of study indicate that it probably doesn't make much different when or how the N fertilizer is applied. It does appear that treating a 12-inch band over the row is just as effective as broadcast over the entire field. This could reduce the total amount of nitrogen applied by up to 60 percent if rows are spaced on 30-inch centers and only a 12-inch band is treated. However, growers should only try this on a small scale for several seasons under their own conditions before treating large acreages.

Table 17. Influence of rate, timing and method of application of nitrogen fertilizer on yield of cabbage for processing. 1986-88.

		Yield-tons/acre		
N rate-lbs/acre	Applied	1986	1987	1988
0		38.9	37.0	32.5
100	Pre-plant broadcast	41.9	41.3	34.8
50+50	pre-plant broadcast + side-dress at thinning	42.1	42.0	34.5
50	12-inch strip pre-plant	51.1	36.2	34.5
100	12-inch strip pre-plant	37.1	40.8	33.7
50	Side-dress at thinning	46.5	45.9	32.3
	LSD 5%	10.7	6.2	NS

G. Simulated Hail Injury Effects on Tomatoes and Cucumbers.

The report from this study will be reported in a separate publication.

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