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CULTURAL RESEARCH WITH PROCESSING TOMATOES 1986

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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. Metribuzin and chloramben were used for weed control according to standard recommendations. Other pesticides were applied according to recommended practice. No serious problems with weeds, insects or diseases occurred during the study. Further, unless a part of the study, ethephon was applied to all plots according to standard recommendations. Rainfall and temperature data are summarized in Table 1.

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-464/1-87/350

TABLE 1. Temperature and Rainfall Data

Month	Temperature (°)						Rainfall (in.)	
	1986 Means			Long Term Means				
	Min.	Max.	Ave.	Min.	Max.	Avg.	1986	Long Term Avg.
				Wooster				
April	38.6	64.9	51.7	36.9	59.5	48.1	2.10	3.14
May	50.3	73.0	61.7	46.5	70.4	58.4	3.08	3.88
June	55.0	79.2	67.1	55.5	79.2	67.4	5.45	3.88
July	60.7	84.5	72.6	59.5	83.3	71.4	3.99	3.97
August	55.1	81.0	68.0	57.7	81.9	69.6	1.33	3.55
Sept.	54.1	77.9	66.0	51.5	75.7	63.3	3.76	3.08
				VCB				
April	39.8	62.9	51.3	38.3	58.5	48.4	3.34	3.12
May	50.9	71.4	61.1	48.1	69.6	58.9	4.52	3.50
June	57.0	78.5	67.8	57.6	78.6	68.1	3.15	3.93
July	63.5	83.2	73.4	61.8	82.8	72.3	5.35	4.01
August	55.3	77.7	66.5	59.5	80.8	70.1	2.79	3.50
Sept.	55.5	76.8	66.1	53.0	74.9	64.0	2.83	2.93

A. Stand Establishment Studies - Transplant Quality:

1. Seed Priming for Direct Seeding

The seed priming study was initiated by the seed companies Royal Sluis and Asgrow, who are working on priming techniques. The primary purpose of seed priming is to improve seedling vigor and hasten emergence. Seed lots of seed were obtained from H.J. Heinz Co. and Campbell Soup Co. and sent to Royal Sluis and Asgrow where they checked seed vigor since they feel that only high quality seed should be primed and then they used their priming treatments and returned the seed to us. We seeded them in the sandy loam soil at the Vegetable Crops Branch on May 13, 1986, using a John Deere 33 vegetable seeder which clump-planted 3-5 seeds in 9-in. clusters. Vermiculite was used in the seed furrow as an anti-crustant. Stand counts were made on May 26 and June 2. A clump was counted if it included at least 1 plant. If no plant was present, the clump was missing. The complete 30-ft. row of each 4 replications was counted. Each row of primed seed was paired with a row of unprimed seed. On June 4, plant height was measured on each clump of plants in a 10-ft. section of each row. The fruit were machine harvested on Sept. 25, which was somewhat earlier than desirable based upon ripe fruit percentage but weather conditions and fruit rots precluded a later harvest.

Results (Table 3) suggest that the priming treatments generally did improve stand and emergence was hastened as indicated by plant height measured on June 4. Yields were not correspondingly increased and, indeed, the yields appears to be reduced. However, the primary reason the yields were lower was because the plants were so tall that they fell over into the furrows between the beds and could not be harvested by the mechanical harvester. The farm manager estimated that up to 15 tons/acre were lost from some plots. The plants from the primed seed were generally larger and had higher populations so they tended to fall over into the furrows more than plants from the non-primed seed. Therefore, these yield data are not a true picture of seed priming effects on yield.

Another interesting observation is that the two seed companies selected different seed lots and varieties as being the more desirable seed for priming treatments.

Results from this study suggest that seed priming may improve emergence of field seeded tomatoes. It may play a greater role in plant growing in Georgia or in improving stand in greenhouse production of transplants in the northern areas. This has yet to be proven because commercial seed treatment is still somewhat experimental. Work on seed priming does need to be continued.

2. Precooling Transplants in Georgia

Studies were conducted with Suhas Ghate, Larry Risse and Cas Jaworski on precooling transplants before loading on refrigerated trucks in Georgia for shipment to Ohio. This work was greatly assisted by personnel from H.J. Heinz who provided the trucks and coordinate the shipping.

TABLE 2. Influence of seed priming on emergence and stand establishment and subsequent yield of processing tomatoes, 1986.

Seed Co.	Priming Cultivar	Treatments Seed Lot No.	Seed Treat Code	Seed Treat	Ripe T/A	Ripe %	Green T/A	Green %	Rotten T/A	Rotten %	Total T/A-Rots	% Stand 1	% Stand 2	Plant height (in.)
Royal	O-832	54559-6821-31	BS2277	Yes	20.2	59.8	9.4	28.0	4.1	12.2	29.6	99.1	97.6	2.16
Sluis	O-832	54559-6821-31	4206	No	24.6	65.6	8.4	22.2	4.5	12.2	33.0	82.4	90.6	1.75
Royal	O-832	54559-6821-30	BS2276	Yes	21.1	61.1	9.5	27.4	4.0	11.5	30.6	98.3	97.4	2.29
Sluis	O-832	54559-6821-30	4205	No	24.4	67.3	8.4	23.1	3.5	9.6	32.8	90.5	96.7	1.87
Asgrow	H-7155	H-8602-47-0	XPE112	Yes	39.1	76.8	5.8	11.5	5.9	11.7	44.9	88.3	93.7	2.30
	H-7155	H-8602-47-0	4202	No	44.2	74.9	9.2	15.6	5.5	9.5	53.4	89.2	94.2	2.02
Asgrow	H-7155	H-8602-47	XPE112	Yes	39.5	75.3	7.0	13.5	5.7	11.2	46.5	89.5	96.1	1.86
	H-7155	H-8604-47	4201	No	38.4	76.8	7.1	14.9	4.1	8.3	45.4	67.0	81.5	1.71
Royal	Easywinner		BS2278	Yes	29.2	76.6	3.6	9.4	5.0	14.0	32.8	95.5	97.2	2.10
Sluis	Easywinner		4201	No	44.3	84.1	5.3	10.1	3.0	5.8	49.6	79.1	86.2	1.79
LSD 5%					9.3	7.2	2.4	6.3	1.4	3.8	9.1	11.9	7.8	.33

Seeded on 5-13-86 using John Deere 33 seeder, clumps of 3-5 seed, 9 inches apart, Sandy loam soil.

% Stand #1 = 5-26-86
% Stand #2 = 6-2-86
Plant height measured = 6-4-86
Harvested by machine on 9-25-86

The purpose of this study was to determine if the rapid removal of field heat from the plants (precooling) prior to shipment would improve plant survivability after planting in Ohio. Some of this was a repeat of similar experiments conducted in 1985, which was published in the 1985 report.

The results on plant survival are summarized in Table 3. These data indicate that precooling had no apparent favorable influence on plants planted immediately after arrival in Ohio. Precooling appeared to be harmful to plants which were stored in a cool shed for 5 days in Ohio prior to planting. This could be due to the temperature fluctuations of the plants which were precooled prior to loading in the truck and loaded with many plants which were warm. This probably resulted in moisture condensation on the precooled plants and subsequent plant decay during the storage period in Ohio.

Another obvious result is that tomato transplants should be planted as soon as possible after arrival in Ohio.

TABLE 3. Influence of precooling of tomato transplants in Georgia on plant survival in Ohio. 1985-1986.

Precooled	Stored (Days)	Stand (%) Expt. =1	2	3	4
Yes	0	94	100	96	93
No	0	95	97	95	78
Yes	5	15	8	54	3
No	5	25	59	39	27

3. Plant Quality and Storage

This was a continuation of studies started several years ago to attempt to provide an objective measurement of plant quality which would indicate survivability. Previous work has suggested that soluble solids in stem sap and/or plant dry matter accumulation could at times be used to predict plant survival. However, results have been so extremely variable that this has not been reliable.

Studies in 1986 were modified to try to eliminate the variability in soluble solids levels by re-hydrating the plants by soaking the roots in water for 4 hours before taking the readings. Nitrogen reserves may also play a role so they were estimated using the diphenylamine test.

Treatments and results are summarized in Table 4. The soluble solids after soaking the roots in water for 4 hours are not given because the uniformity in readings was not achieved, in fact, the readings appeared more variable. There is little doubt that the plants lost moisture in storage and plant survival generally declined the longer the plants were stored. This is in agreement with previous results. The nitrate levels were generally very high and certainly more than adequate for plant tissue regeneration requirements. Yields tended to be related to the plant stand.

TABLE 4. Influence of plant storage on plant quality characteristics, plant survival and yield, cv. H-1810, 1986.

Treatment	Plant Dry Wt.(%)	Soluble Solids (%)*	Nitrate nitrogen**	Pl.Survival (%)	Yield T/A Ripe
May 9 Planting					
0 Storage	11.6	4.4	4.0	95.1	34.2
1 day	12.1	4.4	3.7	89.7	33.5
2 days	13.2	3.9	2.3	85.2	32.4
3 days	11.5	3.7	3.7	96.4	37.1
4 days	16.4	5.5	5.0	90.8	36.8
5 days	15.7	5.0	4.7	74.8	32.3
May 31 Planting					
0 Storage	13.0	2.8	3.7	98.6	40.5
1 day	13.5	2.3	5.0	93.2	35.8
2 days	12.9	4.2	5.0	90.2	38.1
3 days	15.4	4.5	4.3	85.6	32.7
4 days	14.6	4.6	4.7	76.3	29.1
5 days	17.9	3.4	4.7	69.3	27.6
LSD 5%	2.8	1.3	---	9.4	7.4

* Soluble solids from juice express from the stems of 10-plant samples per replication.

**Nitrate nitrogen from section of the stem of 10-plant samples per replication using the diphenylamine test. The ratings suggest the following levels of nitrate nitrogen: 1 = 300-400 ppm, 2 = 800-1000 ppm; 3 = 1400-1800 ppm; 4 = 1800-2200 ppm; 5 = over 2500 ppm.

4. Relation of Small Fruits on Transplants To Establishment, Growth and Yield.

The objective of this study was to determine the influence of small fruits on transplants on stand establishments, growth and yield. This was the second year of this study.

In both seasons, Stan Gahn of H.J. Heinz arranged for plants that had a high percentage of plants with fruit present to be shipped to the Vegetable Crops Branch for planting. In the first season, we had only one planting and we could not find enough plants in 9 boxes of plants to plant 4 replications of the study. When the boxes were opened, it appeared that there were many plants with fruits present, but when we started sorting, there were actually less than 10% of the plants with fruits present. The situation was similar in 1986, but we received 2 shipments and thus, had 2 replications for each planting date. This is in no way to be critical of the source of plants and the cooperative effort of Stan Gahn. It is meant to point out the fact that fruits tend to stand-out in a crate of plants (as well as in the field) and one tends to think that the majority of the plants have fruits on them, when indeed, the actual numbers are low.

Results summarized in Tables 5 and 6 indicate very clearly that fruits on transplants do indeed reduce harvestable yields and/or delay plant development and fruit maturity. It is questionable however, if 10% of the plants or less have fruits present, that yields will be lowered significantly or maturity delayed noticeably. Another somewhat surprising result is the effect fruits on the plants have in reduced yields even though the fruits are picked-off prior to planting. This suggests that those small developing fruits on plants significantly reduce post-planting vigor.

This study needs to be continued with various percentages of plants with fruits present to determine the economic threshold of numbers of plants with fruits present influencing yields.

TABLE 5. Influence of fruit on transplants on maturity and yield of processing tomatoes*.

Treatment	Ripe T/A	Ripe %	Yld. Green T/A	Yld. Green %	Rots T/A	Rots %	Total T/A
Control-No fruits present	39.3	78.9	4.3	8.5	6.3	12.6	43.6
Fruits removed before planting	38.4	77.2	4.8	9.6	6.6	13.2	43.2
Fruits on all plants-none removed	31.0	70.3	7.5	17.0	5.5	12.7	38.5
Fruits removed 1 week after planting	32.7	73.8	6.5	14.5	5.1	11.7	39.2
Fruits remvd. 2 weeks after planting	34.0	72.7	7.4	15.9	5.4	11.4	41.4
Fruits remvd. 3 weeks after planting	33.0	73.9	7.4	16.6	4.2	9.5	40.4
Fruits remvd. 4 weeks after planting	29.7	67.5	8.9	20.4	5.3	12.1	38.6
Fruits remvd. 6 weeks after planting	36.4	76.3	7.8	16.3	3.5	7.4	44.2
Fruits removed from 25% of plants 2 weeks after planting	34.0	71.8	8.0	16.8	5.3	11.4	42.0
Fruits removed from 50% of plants 2 weeks after planting	33.6	72.0	9.4	20.3	3.5	7.7	43.0
Fruits removed from 75% of plants 2 weeks after planting	34.5	75.4	7.1	15.4	4.1	9.2	41.6
LSD 5%	NS	NS	2.2	4.3	NS	NS	NS

*Variety 6129; plants were sorted so that all plants other than control had fruits present at transplanting date on 5/31/85; control plants had not fruits on them at planting. Treated plots were duplicated in the field; 9 boxes of plants were sorted to provide the 600 plants with fruits present to plant this study.

TABLE 6. Influence of fruits on transplants and their removal on maturity and yield of processing tomatoes, 1986*.

Treatment	Yield: Ripe T/A	Ripe %	Green T/A	Green %	Rots T/A	Rots %	Total T/A
5-12-86 (H-2653)							
Control-no fruit present	23.4	82.2	2.0	7.1	3.0	10.7	25.4
Fruits removed before planting	21.2	80.2	3.0	11.5	2.2	8.3	24.2
Fruits on all plants-none removed	13.1	59.2	7.5	33.7	1.6	7.1	20.6
Fruits removed 1 wk after planting	18.6	75.7	3.7	15.2	2.2	9.0	22.3
Fruits removed 2 wks after planting	22.1	80.2	3.8	13.8	1.6	5.9	25.9
Fruits removed 3 wks after planting	19.8	76.5	4.7	18.1	1.4	5.3	24.5
Fruits removed 4 wks after planting	15.9	70.0	5.6	25.4	1.0	4.6	21.5
Fruits removed 6 wks after planting	18.7	75.3	4.4	17.6	1.7	7.1	23.1
Remove fruit from 25% of plants 2 wks after planting	19.3	72.7	5.4	20.5	1.8	6.9	24.7
Remove fruit from 50% of plants 2 wks after planting	20.1	78.6	3.3	13.0	2.1	8.4	23.4
Remove fruit from 75% of plants 2 wks after planting	20.5	74.4	5.1	19.4	1.7	6.2	25.6
5-31-86 (Var.Unknown-may be H-7151)							
Control-no fruit present	37.8	85.1	5.1	11.5	1.5	3.4	42.9
Fruits removed before planting	34.6	83.8	5.5	12.9	1.4	3.3	40.1
Fruits on all plants-none removed	30.6	81.1	6.2	15.7	1.2	3.1	36.8
Fruits removed 1 wk after planting	29.7	81.7	5.3	14.5	1.4	3.8	35.0
Fruits removed 2 wks after planting	32.1	84.9	4.1	10.8	1.6	4.3	36.2
Fruits removed 3 wks after planting	33.6	81.6	6.2	14.9	1.4	3.4	39.8
Fruits removed 4 wks after planting	32.7	81.0	6.2	15.2	1.5	3.8	38.9
Fruits removed 6 wks after planting	29.0	79.4	6.0	16.4	1.5	4.2	35.0
Remove fruit from 25% of plants 2 wks after planting	26.3	77.6	6.5	19.4	1.0	2.9	32.8
Remove fruit from 50% of plants 2 wks after planting	28.9	81.3	5.1	14.3	1.5	4.3	34.0
Removed fruit from 75% of plants 2 wks after planting	29.3	80.6	5.8	15.8	1.4	3.6	35.1
LSD 5%	4.95	9.61	2.56	.968	---	---	3.97

*Boxes of plants sorted to provide plants with fruits present at transplanting. The variety for the second planting date was not given on the boxes, but it was a main season variety. Planting 1 was harvested on Aug. 5 and the second planting on Sept. 22, 1986.

B. Plant Nutrition Studies

1. K and Fruiting Effects on Plant Shoot and Root Growth

A study was conducted in sand culture in the departmental greenhouse at Wooster to determine the influence of fruiting and K fertilization rate on shoot and root growth and on blossom-end rot and blotchy ripening.

Tomatoes of H-1810 were transplanted into acid washed sand and after regrowth had started, were treated with a modified Hoaglund's solution with 100% K or 50% K each time the plants required water. The flower removal treatments are given in Table 6 with 4-single plant replications per treatment. When the majority of the fruits were ripe, the fruits were harvested and evaluated for blossom-end rot (BER) and blotchy ripening. The plants were then carefully removed from the pots, sand washed off and fresh and dry weights measured.

Results (Table 7) indicate that low potassium results in increased amount of fruits with blotchy ripening; generally reduced dry matter accumulation, especially in the roots as it is very pronounced when plants are also fruiting. There does not seem to be any correlation between degree of fruiting and low K effects. Fruiting greatly reduces root growth and dry matter accumulation because plants with all flowers removed had over half of total plant dry matter in the roots.

TABLE 7. Relation of K nutrition and fruiting on shoot and root growth and on the fruit disorders, blossom-end rot and blotchy ripening; cv. H-1810.

K Level	All Flowers Removed From:	Dry Matter Accumulation* Shoot (gm/plant)	Root (gm/plant)	% Roots of Total	Fruit Disorders BER (%)	Blotch (%)
100%	0	44.0	18.3	29.4	16.0	1.8
	1 shoot	52.5	37.1	41.4	7.9	1.0
	2 shoots	60.7	45.0	42.6	15.9	0
	50% shoots	67.2	38.8	36.6	19.0	1.4
	all	145.6	220.0	60.2	----	---
50%	0	48.7	14.8	23.3	18.7	19.3
	1 shoot	49.8	20.7	29.3	5.3	37.5
	2 shoots	47.6	18.8	28.4	10.4	26.6
	50% shoots	54.9	29.6	35.1	15.0	31.6
	all	146.2	253.3	63.4	----	----

*Fruits not included

2. K and N Rate on K Levels in Plant Foliage and Subsequent Yield

This is the first year of a long-term study on the influence of K fertilization in the field on fruit quality and yield. Nitrogen rate is also included since greenhouse studies indicated a relationship of N and K to ripening disorders.

The basic study in 1986 consisted of K rates of 0, 200, 400, and 600 lbs/acre of K_2O applied pre-plant in the spring and worked into 60-inch beds with a power bedder. N rates were 70 (standard), 100 and 150 lbs of N/acre applied pre-plant broadcast within all K treatments in a split plot design. Plot rows were 30 ft. long and treatments were replicated 4 times.

For the first time in several studies on K nutrition on tomatoes at the Vegetable Crops Branch where K levels in the soil average over 200 lbs/acre, a yield increase resulted from the K treatment (Table 8). The yield increase was only from the 200 lbs/acre K_2O treatment and it occurred at all N levels. The trend was for higher yields as N increased, but the yields are not statistically different. Green fruit yields also tended to be increased by increasing N, but not all differences are significant.

Blotchy ripening was not generally found in any of the plots and fruit color was not apparently influenced by either N or K treatment when mascerated fruit tissues were examined by the Hunter Color meter using USDA standard tomato color for comparison.

TABLE 8. Influence of K and N fertilization on yield of H-1810 processing tomatoes, 1986.

K_2O (lbs/ acre	N(lbs/A)=	Ripe (tons/acre)			Green (tons/acre)		
		70	100	150	70	100	150
0		29.1	29.4	32.2	1.9	2.0	2.6
200		36.0	39.6	40.2	2.0	2.6	2.8
400		32.4	33.1	34.5	1.8	1.7	3.3
600		33.1	33.8	37.0	2.1	2.0	2.7
LSD 5%			4.6			0.8	

K levels in leaf samples are given in Table 9 as well as sample dates.

TABLE 9. Influence of K fertilization on levels of K in mature leaves sampled at 7 sampling dates.

K_2O	K in Leaves - %-Dry Wt.					
lbs/A	Date=6/17	7/1	7/15	7/30	8/6	8/14
0	0.77	2.23	1.34	0.99	0.93	0.97
200	1.07	2.34	1.67	1.30	1.59	1.35
400	1.45	2.37	1.63	1.57	1.59	1.59
600	1.27	2.61	2.21	1.54	1.46	1.93
LSD 5%	0.58	----	0.50	0.43	0.43	0.47

C. Growth Regulator Trials

1. Growth Inhibitors

Objectives of this trial were to attempt to improve uniformity of fruit set and ripening by concentrating flowering. Plants of O-832 were planted at the Wooster campus on May 23, 1986. Treatments given in Table 9 were applied with a CO_2 sprayer with rate of water spray at 60 gpa. Rows were 30 ft. long and treatments were replicated 4 times. Treatments 1, 2 and 3 were applied at 1:00-2:00 p.m. on July 15, temp. 83°F; 5, 6, and 7 were applied on July 31, 10:30-11:00 a.m., temp. 74°F.

As with previous years, these treatments had no apparent effect on concentration of flowering as indicated by yield and percentages of ripe or green fruits. Although some of these treatments were effective on cultivars used in the early 1970's, none was effective in trials with present cultivars. This is likely due to the very highly concentrated flowering and ripening character of present cultivars.

TABLE 10. Influence of growth inhibitors on yield and maturity of O-832 tomatoes.

Chemical Rate	Flower Stage	Yield-Ripe Tons/acre	Yield-Ripe %	Yield-Green Tons/acre	Yield-Green %
Alar 2500 ppm	Full bloom	31.6	84.1	3.6	9.7
FL 500 50 ppm	Full bloom	30.0	81.7	4.2	11.2
RSW0411 1000ppm	Full bloom	33.8	86.2	3.9	10.0
Alar 2500 ppm	2 wks.after full bloom	31.1	81.8	4.4	11.6
FL 500 50 ppm	2 wks. after full bloom	30.1	82.9	3.5	9.6
RSW0411 1000ppm	2 wks. after full bloom	31.7	84.7	3.8	10.3
Unsprayed Check		30.0	82.7	3.5	9.5

2. Influence of Gibberellic Acid on Tomatoes

A previous study suggested that treatment of tomatoes with GA3 may extend the post-harvest life of the fruit or with processing tomatoes, help hold fruit quality during vine storage.

Plant of O-832 were planted at Wooster on May 23, 1986, in 30-ft. rows and given normally recommended cultural care. Ten days prior to harvest 2 GA3 treatments were applied (Table 11). Fruit were harvested by hand as a once-over harvest on Sept. 3, 1986. Twenty-five pound samples of ripe fruit from each of 4 replications were placed in a controlled temperature room at 70°F. The next day analyses for soluble solids, pH and titratable acidity were determined from juice expressed from 20-fruit sub-samples. This was also done for 6 and 9 days after harvest.

Results (Table 11) indicate that the GA3 treatments had no apparent influence on soluble solids or titratable acids, but the pH was higher in treated fruit than the untreated fruit on the first day of storage and on the average for 9 days of storage. There appeared to be no effect on firmness (indicated by feel), color, or any other appearance factor from the GA treatments.

TABLE 11. Influence of GA3 applied pre-harvest and as post-harvest fruit dips on fruit quality of tomatoes.

Treatment	Soluble Solids(%)				pH				Titratable Acids (%)			
(ppm)	Time*1	2	3	Avg.	1	2	3	Avg.	1	2	3	Avg.
Untrt.CK	5.30	5.42	5.05	5.25	3.86	4.16	4.13	4.05	.531	.430	.425	.464
GA3, 100 10 days pre-harv.	5.65	5.50	5.25	5.46	4.02	4.23	4.13	4.13	.542	.425	.433	.467
GA3, 200 10 days pre-harv	5.42	5.67	5.15	5.41	4.11	4.25	4.19	4.18	.497	.432	.399	.442
GA3, 100 30 sec. dip	5.35	5.30	4.92	5.19	4.00	4.33	4.22	4.18	.534	.406	.385	.442
GA3, 200 30 sec. dip	5.70	5.32	5.40	5.47	3.34	4.26	4.15	4.11	.547	.423	.435	.468
LSD 5%		NS				0.14		0.08		NS		NS

*Time 1 = 1 day after harvest (9-4-86); 2 = 6 days after harvest (9-9-86); 3 = 9 days after harvest (9-12-86).

D. Fruit Quality

1. Undercutting of Plants Prior to Harvest

This study was a repeat of the 1985 experiment to determine if undercutting of tomato plants improves harvester efficiency or affects fruit quality factors. The primary difference in 1986 was that each undercut treatment had a non-treated control row adjacent to it so that maturity changes could be accounted for.

Plots were established with transplants of H-722 and FM 6203 on May 14. The soil was a sandy loam and bedded in the spring prior to planting. Single-row plots were used. The plants were undercut with a flat blade attached to a 3-point hitch and run about 1-inch deep. It was quite effective in cutting off the plants without significantly moving the plant. The undercutting was done August 18 to 22. The plots were then harvested by machine 1, 2, 3, 4 and 5 days after undercutting and these data were compared to plots where plants were not undercut. In addition to the fruits harvested by the harvester, fruits were also picked-up by hand to determine the amount of fruits left by the harvester.

Results in 1985 indicated that undercutting had no significant effect on yield of ripe fruits. The longer the delay between undercutting and harvest appeared to reduce the amount of green fruits, but also increased the amount of rots. The undercutting had no apparent influence on recovery with the 2 cultivars. Fruit quality data in 1985 did not give a clear picture of the influence of undercutting on fruit quality. Results of the 1985 study (Table 12) indicate that there was no influence on yield of ripe or green fruit, but rots appeared to be increased by undercutting. The amount of fruit lost was reduced by undercutting, but since ripe-fruit yields were not increased, there appears to be no advantage to undercutting.

Fruit quality data do not give a clear picture, as in 1985.

TABLE 12. Influence of undercutting on yield and fruit quality of tomatoes, cv. FM 6203 and H-722, 1986.

		Yield								Fruit Quality		
	#	Ripe		Green		Rots		Drops		SS		Acids
Undercut	days	T/A	%	T/A	%	T/A	%	T/A	%	(%)	pH	(%)
FM 6203												
Yes	1	28.2	85	1.6	5	2.4	7	0.9	3	5.0	4.1	.445
No		27.4	84	1.4	5	1.7	6	1.7	5	5.4	3.9	.435
Yes	2	24.0	79	1.4	5	4.0	14	0.9	3	4.8	3.9	.465
No		23.8	80	1.0	4	3.3	11	1.4	5	5.0	3.9	.450
Yes	3	24.1	77	0.7	2	4.8	16	1.7	5	4.6	3.9	.415
No		25.9	77	1.3	4	3.8	12	2.5	8	4.8	3.8	.440
Yes	4	25.7	77	1.5	5	3.8	12	1.9	6	4.5	4.0	.385
No		23.5	77	1.0	3	3.7	13	2.0	7	4.9	3.9	.430
Yes	5	23.0	77	0.7	3	4.4	16	1.3	5	4.4	3.8	.390
No		23.1	80	0.7	3	3.5	12	2.1	7	4.6	3.7	.415
H-722												
Yes	1	26.7	76	6.5	18	1.0	3	1.2	3	4.7	4.0	.535
No		27.2	78	4.5	13	1.0	3	2.3	7	4.8	4.0	.530
Yes	2	26.9	74	5.7	16	2.4	7	1.1	3	4.7	3.9	.510
No		28.5	79	4.2	11	1.9	5	1.7	5	4.6	3.9	.525
Yes	3	28.2	76	3.6	10	4.5	11	1.5	4	4.7	3.8	.520
No		26.8	76	3.5	10	2.5	7	2.7	8	4.7	3.8	.530
Yes	4	28.0	78	3.0	9	3.0	9	1.6	5	4.5	4.0	.480
No		28.3	78	3.2	9	2.4	7	2.4	7	4.6	3.9	.515
Yes	5	30.1	83	2.0	6	2.5	7	1.8	5	4.3	3.7	.530
No		30.4	80	3.1	8	1.5	4	2.9	8	4.5	3.7	.465
LSD 5%		3.8	6	1.9	5	1.6	4	0.6	2	0.4	0.1	.040

E. Tomato Plant Development

As part of another study, data were recorded on several parameters of plant development of 5 cultivars of processing tomatoes (O-832, H-1810, H-7135, Easy Winner and Early Harvest). Plants were sampled weekly starting 2 weeks after harvest until near fruit maturity.

The five cultivars of processing tomatoes had similar growth patterns although they were different in fruit maturation (Fig. 1-3). Some cultivars were more vegetatively vigorous than others and some were more upright in growth during the vegetative period. However, growth of the primary stem was similar in all cultivars and generally developed 4 fruiting clusters. Secondary shoot growth was also similar with side shoots developing 4 to 6 flowering clusters. The terminal flower clusters on the primary and secondary shoots developed at about the same time, although the first and second clusters on the primary shoot developed considerably earlier; up to 2-3 weeks earlier. Generally the major fruit set for harvest comes from the second through fourth clusters on the primary shoot and the first 3 or 4 clusters on the secondary shoots. Fruits on the first cluster of the primary shoot usually become over-ripe and rot before harvest. Many flowers on the terminal clusters do not set fruit. Thus, the so-called "full bloom" when the plants are at maximum flowering of the terminal clusters and the plants appear yellow with fruits from a distance, does not provide the majority of fruit for harvest. It is likely however, that many of these flowers will set if the set is minimal on the earlier clusters.

Transplants appear to go thru an early period of vegetative growth that lasts from 6 to 8 weeks followed by a period of dramatic fruit growth (yield accumulation), then by fruit ripening or ripe fruit accumulation. The heavy bloom for harvest period usually occurs 5 to 6 weeks after planting, but is affected by cultivar, earlier cultivars bloom earlier and later ones as much as 2 weeks later. However, the length of fruit growth and development also varies for early and late cultivars and the primary bloom period may not be greatly different between early and main season cultivars. The bloom period generally lasts for about 3 weeks, depending upon growing conditions, especially temperature and rainfall. Fruit ripening for once-over mechanical harvest usually occurs over about a 3-week period, although it will vary, depending upon concentration of fruit setting, temperature, and use of Ethrel.

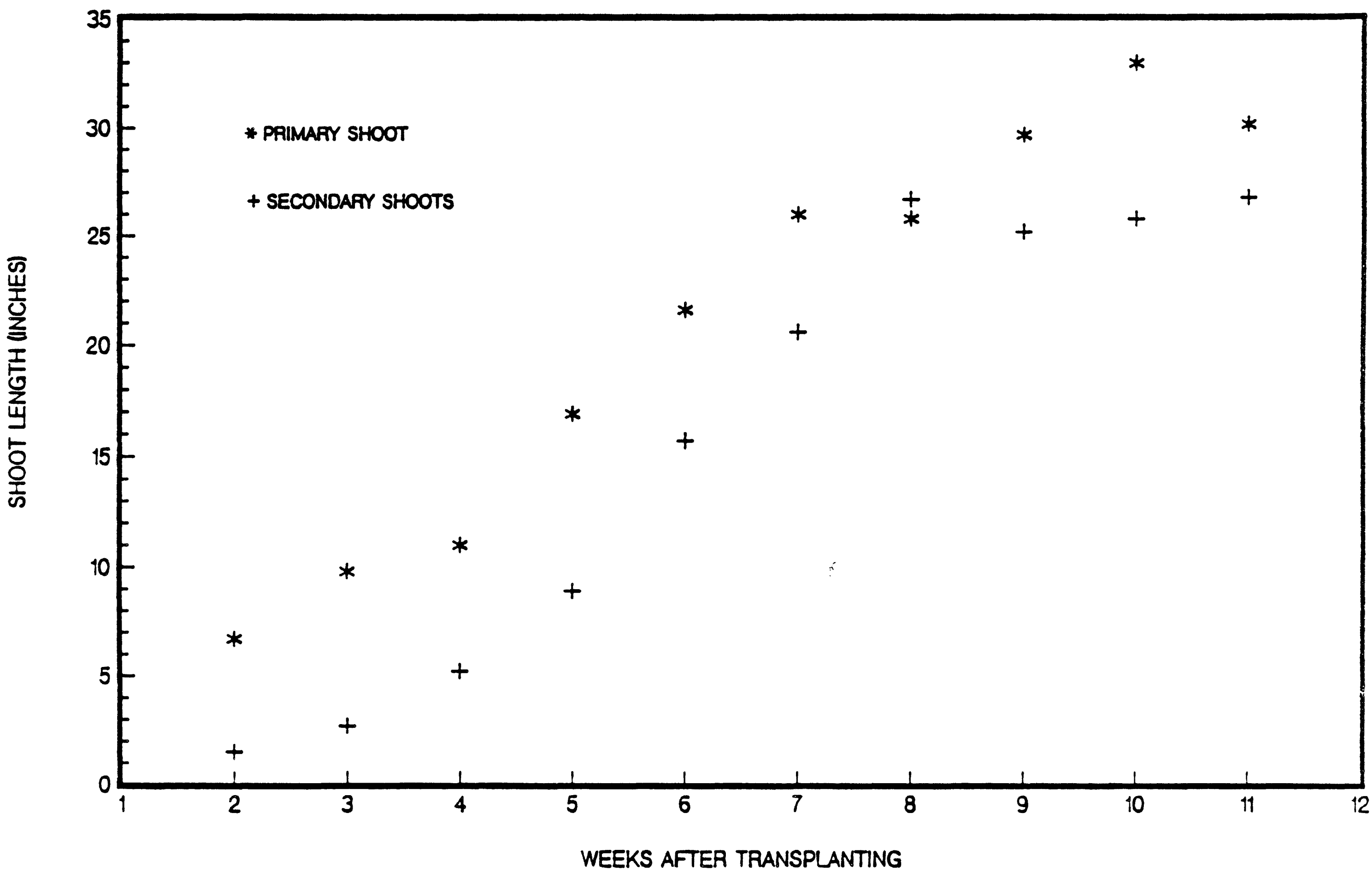

Fig. 1 – Plant growth and development of processing tomatoes – means of five cultivars

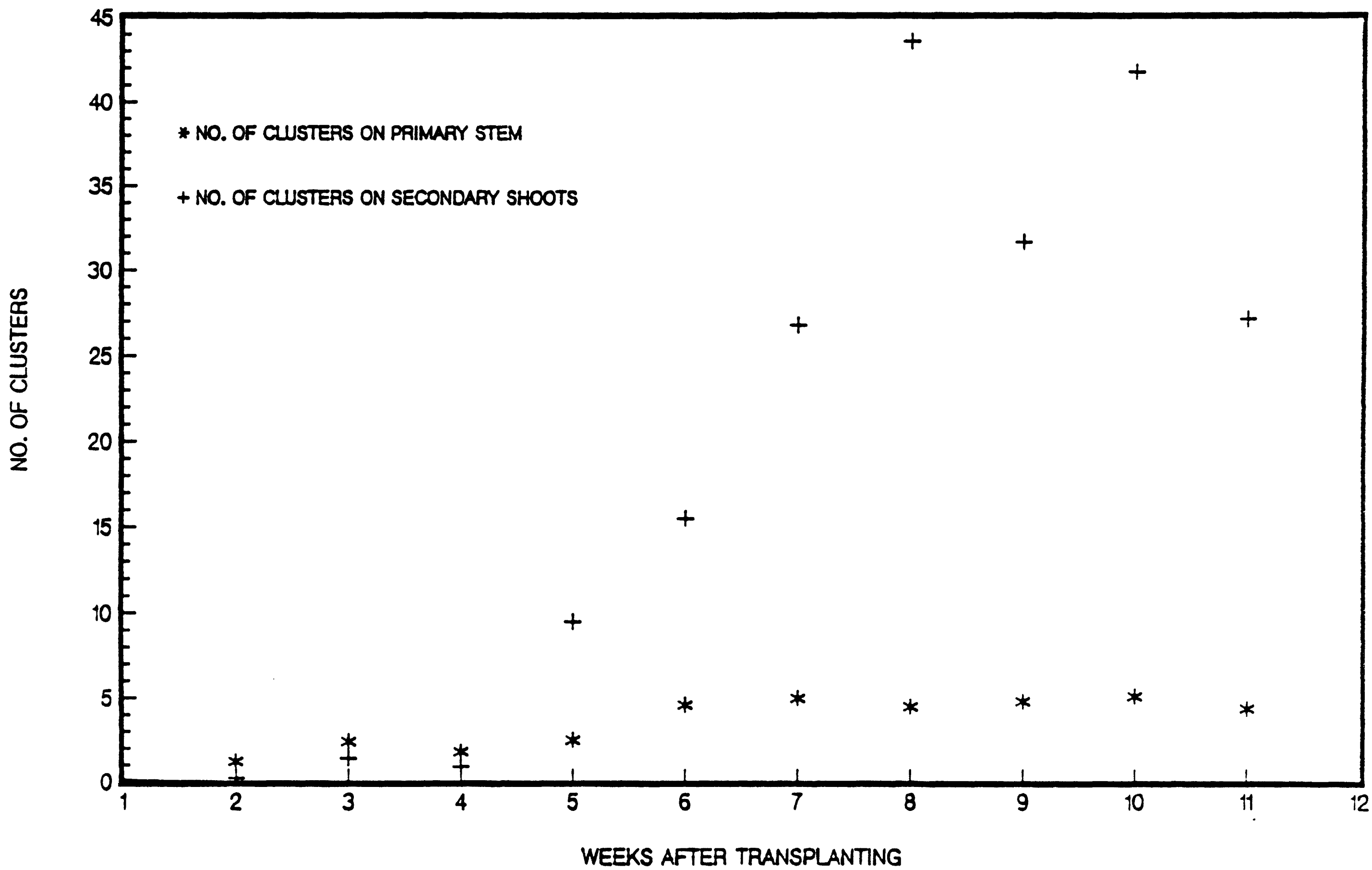

Fig. 2 – Development of flowering/fruiting clusters on primary stem and secondary shoots of processing tomatoes – means of 5 cultivars

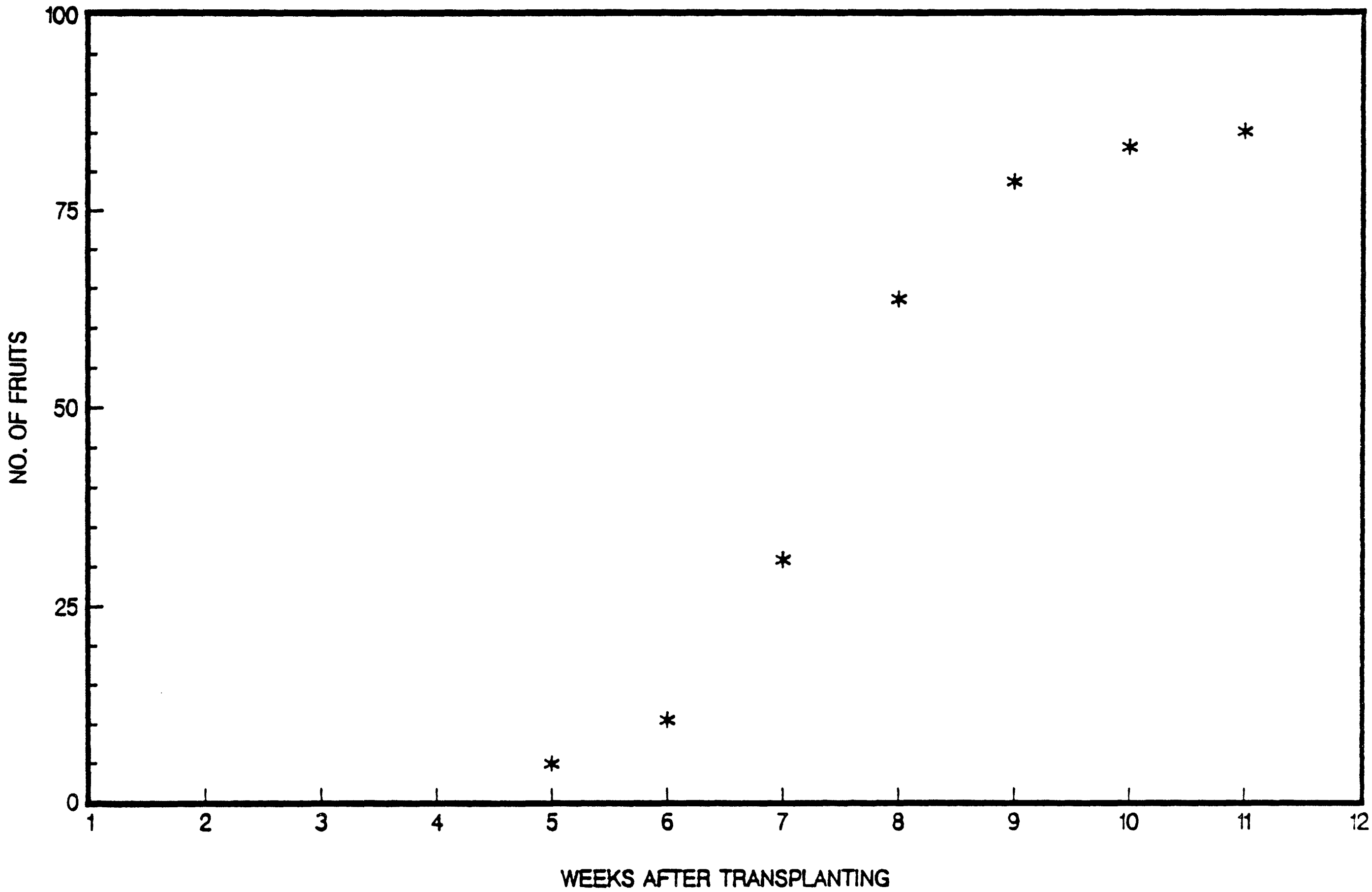

Fig. 3 – Development of fruits on processing tomatoes – means of 5 cultivars

F. Hail Injury

1. Simulated Hail-Transplants

Transplants of H-1810 were planted on spring beds (sandy-loam soil) in 30 ft. x 5 ft. single rows with 11 in. plant spacing on May 9, May 26, and June 4, 1986. This planting sequence provided for plants of 3 different ages for the two simulated hail treatments dates. The hail machine and a gasoline-powered "weed wacker" were used to simulate hail injury. The weed wacker effectively removed leaves, stems and fruits (or flowers) but the plant injury did not resemble hail. The hail machine was very effective and the several experienced hail adjusters classed the injury as closely resembling actual hail. The hail treatments were made on June 24 and July 21. The weed wacker treatments were applied the following day in each case.

Yield data are presented in Table 13. Some responses to injury appear obvious: 1-any injury resulted in reduced yields of ripe fruits and the greater the injury the greater the yield reduction; 2-injury resulted in a delay in maturity, and generally, the earlier the injury in plant development the greater the delay and the greater the injury the greater the delay; 3-the loss in yield was real because the total yields of ripes plus greens and rots from treated plants was less than total yields from check plants, especially the severely injury plants; 4-the amount of rotted fruits was greatly increased on plants that had many fruits present at time of injury (treatment).

There was no doubt that the hail treatments made before and during fruit set caused a delay in maturity. Efforts were made to determine the precise delay, but these data were lost due to heavy rains late in the season and an excessive workload of the field crew at the Vegetable Crops Branch to get as many other research efforts harvested as possible. It appears, however, that the harvest maturity was delayed for several weeks and the severe hail treatment had the greatest effect on maturity.

Table 13. Influence of Plant Injury From Simulated Hail or Weed Wacker (w/w/) on Yield of Processing Tomatoes: cv. Heinz 1810, Fremont

Yield - Tons/Acre Ripe

	Treated 6-24			Treated 7-21		
Treatment Planted=	5-9	5-26	6-4	5-9	5-26	6-4
Check	29.2	35.5	39.7	24.8	38.2	45.1
Slight hail	19.5	29.1	32.0	23.1	23.8	31.5
Moderate hail	17.0	26.3	34.9	23.1	15.7	22.7
Severe hail	4.9	11.8	14.0	11.9	5.8	9.1
Slight w/w	27.3	34.8	36.5	27.3	29.1	31.8
Moderate w/w	22.2	31.5	39.3	28.3	16.2	19.4
Severe w/w	8.9	22.8	29.1	12.0	6.5	2.3
LSD - 5%			6.3			

Yield - Ton/Acre Green

	Treated 6-24			Treated 7-21		
Treatment Planted	5-9	5-26	6-4	5-9	5-26	6-4
Check	3.1	2.9	6.9	3.0	2.2	6.8
Slight hail	3.6	4.8	11.6	2.1	1.7	6.6
Moderate hail	5.7	10.1	13.3	2.0	1.0	6.7
Severe hail	5.9	17.4	17.7	0.5	1.1	9.6
Slight w/w	3.9	3.8	7.9	1.8	1.6	5.8
Moderate w/w	2.9	6.3	8.7	4.0	1.3	10.3
Severe w/w	6.9	12.2	15.6	0.5	1.4	8.4
LSD - 5%			2.9			

Yield - Ton/Acre Rots

	Treated 6-24			Treated 7-21		
Treatment Planted =	5-9	5-26	6-4	5-9	5-26	6-4
Check	1.5	6.1	4.1	1.9	5.4	3.5
Slight hail	1.8	4.8	1.5	6.1	9.7	3.8
Moderate hail	2.1	2.7	1.3	4.3	10.9	4.0
Severe hail	1.0	0.7	0.2	8.4	9.0	2.9
Slight w/w	1.7	5.1	2.7	3.5	7.1	4.4
Moderate w/w	2.3	4.5	1.8	3.5	7.7	3.9
Severe w/w	1.8	2.0	0.9	5.9	6.6	1.0
LSD - 5%			1.7			

2. Simulated Hail-Field Seeded

Seed of H-1810 were planted on May 8, 1986, using a John Deere vegetable seeder which seeded 3-5 seeds spaced 9 in. apart. Rows were 30 ft. x 5 ft.

The direct seeded plants were much more difficult to defoliate with the hail machine because the plants were much taller and more whippy and tended to give and flatten out when the air stream with the crushed ice hit them as opposed to the transplants which were shorter and stockier plants. Also, the seeded plants were very large and difficult to walk through on the July 28 treatment data and it would have required an excessive amount of crushed ice to cause high levels of injury.

Yield results (Table 14) indicate that the earliest treatments, June 26, did not significantly affect ripe fruit yields from a once-over mechanical harvest. There was certainly a trend towards lower ripe fruit yields and higher green fruit yields. This suggests a delay in development and fruit maturity from the more severe hail injury on plants that are just starting to flower (10-25% of first clusters with one or more open flowers). The later treatment (July 28) resulted in reduced yields which also increased as severity of injury increased. Plants on this date had the majority of fruits set and fruits were from "pea size" to 3/4 of final fruit size. Fruit rots were also increased from the hail treatments at this stage.

TABLE 14. Influence of simulated hail on yield of direct seeded processing tomatoes, cv. H-1810, Fremont.

	Treated 6-26						Treated 7-28					
	Ripe		Green		Rots		Ripe		Green		Rots	
Treatment	T/A	%	T/A	%	T/A	%	T/A	%	T/A	%	T/A	%
Check	37.3	77	6.4	13	4.9	10	6.1	79	6.1	13	3.9	8
Sl.Hail	40.7	77	8.1	15	4.1	8	4.8	66	4.8	13	7.6	21
Mod.Hail	35.3	74	9.9	21	2.5	5	7.4	62	7.4	21	5.3	17
Sev.Hail	34.2	73	10.7	23	1.8	4	4.5	60	4.5	15	7.2	25
LSD 5%	NS	NS	4.0	9	2.1	NS	NS	8	NS	NS	2.1	7

3. Leaf Removal by Hand

The primary reason from doing this study was to obtain more definitive data on defoliation affects on yield and to compare these results with simulated hail which causes additional injury to fruits and shoots. Yield results are summarized in Table 15. These data indicated that generally 30% defoliation had no apparent influence on yield or maturation. Further, even 60% defoliation did not always result in yield reduction nor influence maturity; 90% defoliation did reduce yield and delay maturity and the greatest effects occurred when the defoliation was done during bloom (fruit set) and during early fruit growth. Twin row culture tended to reduce the severity of yield reduction from 90% defoliation.

TABLE 15. Influence of hard leaf removal on yield of single and twin rows of tomatoes, cv. H-1810 and H-7151, Fremont.

Treatment %-defol	Defol. Date	Single Rows 6/2	6/16	7/2	7/21	Twin Rows 6/2	6/16	7/2	7/21
		Yield-Tons/Acre of H-1810							
0		34.3	29.5	26.2	35.8	40.8	33.7	30.5	28.0
30		36.5	26.6	24.3	33.6	38.4	32.4	36.3	33.2
60		36.2	23.7	28.7	27.3	37.7	35.3	29.3	32.9
90		31.9	18.5	17.8	16.7	38.5	27.6	22.6	21.6
LSD 5%						8.1			
		Yield-Tons/Acre of H-7151							
0		31.2	28.0	22.9	28.7	33.0	30.5	25.7	34.2
30		30.9	26.0	26.4	22.8	33.6	31.0	27.0	26.2
60		31.9	18.8	19.6	24.4	33.1	25.3	25.2	23.3
90		29.2	15.8	10.9	12.5	31.2	19.3	13.7	16.4
LSD 5%						6.2			

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