THE EFFECTS OF PLANT GROWTH-REGULATING SUBSTANCES ON FRUIT-SET AND MATURITY OF TOMATOES GROWN IN MANITOBA

by

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INTRODUCTION

One of the main factors limiting the production of tomatoes in Manitoba is the short growing season and the difficulty in bringing fruit to maturity. Gardeners must grow early varieties, often of inferior quality, or give plants special care in order to harvest ripe fruit early enough in the season to command profitable prices.

The total value of Manitoba grown tomatoes sold to various Winnipeg marketing agencies during the period August 1, 1944 to July 31, 1945 was $74,936 (4). During this period tomatoes valued at over $400,000 were shipped into Winnipeg. If this period is taken as representative of the situation generally, it is readily seen that locally grown tomatoes constitute only a very small proportion of the tomatoes sold in Manitoba.

Considerable success in hastening the maturity of tomatoes, through the use of plant growth-regulating substances has been reported in several areas of the United States (26,33). A project was undertaken in 1949 and 1950 to test the value of these chemicals in hastening tomato fruit-set and maturity in Manitoba and a report of the work and results are herewith presented.

REVIEW OF LITERATURE

Luckwill (25) states that as long ago as 1880 Sachs postulated the existance of growth-regulating substances in plants. It was not until the early 1930's that Kogl, Haagen Smit, and Erxleben (23) isolated and determined the chemical structure of some naturally occurring growth-regulating substances or "hormones". Meanwhile several workers, Fitting(5), Morita (28), Laibach (24) and Yasuda (49) were working with pollen extracts and were having some success in producing seedless fruits. Laibach (24) and Thimann (43) showed that auxin is a constituent of pollen. Yasuda (50) showed that the pollen tubes bring into the ovary a substance which stimulates the growth of a young fruit. Gustafson (10) stated that this substance was undoubtedly auxin.

Yasuda (49), reporting in 1934, was probably the first to produce artificially induced parthenocarpic fruits of normal or nearly normal size. He did this by injecting pollen extract into the ovaries of eggplant and cucumber. It was Gustafson (9), however, who first induced fruit development by the use of laboratory synthesized growth-regulating chemicals. Since then many workers have published their findings on the use of these chemicals. Most of this work has dealt with the effect of various growth-regulating substances on the induction and development of parthenocarpic fruit.

Gardner and Marth (7), Gardner and Kraus (6), Schroeder (38), Gustafson (11), Howlett (16), Wong (48), Wittwer (45), Hamner, Schomer and Marth (14) and others have tested various chemicals. The results obtained have amply demonstrated that fruit-set can be induced in many horticultural crops, tomato included, by the application of certain growth-regulating chemicals.

The first chemicals used for this purpose were organic acids containing the indole radicle. Gustafson in 1936 (9), Schroeder in 1937 (38), Howlett in 1940 (16) and others used indoleacetic acid. Gardner and Marth in 1937 (7), Stier and DuBuy in 1939 (39) and Howlett in 1940, 1941 and 1942 (16,17,18) used indolebutyric acid. Many other chemicals were tested in work beginning about 1944. Some of these were beta-naphthoxyacetic acid, para-chlorophenoxyacetic acid, trichlorophenoxypropionic acid, 2,4-dichlorophenoxyacetic acid and naphthaleneacetic acid. There was a general change from the organic acids containing the indole radicle to those containing the naphthoxy and substituted phenoxy radicles. Of the chemicals tested since then, the ones most commonly used with success have been para-chlorphenoxyacetic acid and beta-naphthoxyacetic acid. (46,30,33,26,29,34,35).

The methods of applying these substances have varied, tending to become gradually simpler and less time consuming.

Gustafson (9), Strong (40) and Howlett (18) used both lanolin preparations applied to the pistil and water solutions or emulsions applied to open flowers with atomizers. The vapour method, used under greenhouse culture, and that of spraying the entire plant or cluster at one time were introduced by Zimmerman and Hitchcock (52,53). Sayre (36) tested the use of these chemicals in transplanting water as a starter solution. Stier and DuBuy (39) also tested this method of application as well as the application of auxin and talc to the seeds before planting. These soil and seed treatment methods gave unsatisfactory results, retarding rather than hastening maturity.

The application of plant growth-regulating substances to greenhouse grown tomatoes has generally given increased fruit-set and earlier maturity (46,17,18,33,22,34). However, Hemphill (15) stresses that in order to secure maximum benefit from plant "hormones", not only must the proper concentration be used but the chemical must be applied at the proper stage of development. Their effects on other factors such as quality, shape and taste have also been tested. Chemically, few, if any, consistent differences were found between fruit which developed normally and that which was induced by growth-substances. Howlett (16) found that the fruit induced by growth-substances was milder and contained a little less acid. Janes (21) found the acidity to be much the same in both types, although distributed differently. The differences he noted were attributed to the effect of the seeds on the developing fruit.

The findings in regard to relative size of natural and artificially induced fruits vary a great deal. Gustafson (12), Janes (21), Mitchell and Whitehead (27), Roberts and Struckmeir (35) and Schroeder (38) found the fruits of treated plants to differ little in size from those of untreated ones, but tending to be slightly smaller. A tendency for the fruits of treated plants to be slightly larger than those from untreated plants was noted by Gustafson (13), Howlett (17), Howlett and Marth (20), Murneek, Wittwer and Hemphill (31), Strong (41,42), Wittwer, Stallworth and Howell (46) and Mann and Minges (26). This variability in size of chemically induced fruits seems to depend on a number of factors such as age of flowers when treated (28), chemicals used (40,16), environment (12,17), number of seeds in the fruit (17), supply of food and auxin (12), and methods of application (14,41).

In general the fruits produced by treatment with growth-regulating substances seem to have compared favourably with those which set naturally (13,27). Some undesirable features of chemically induced fruits have been an inclination toward puffiness, undesirable shape, cracking, internal discoloration and green gelatinous pulp (14,17,20,21,35,42,34).

Mann and Minges (26) state that growth-substances will accentuate any naturally occurring roughness, explaining that this is partly because these substances will cause most of the first flowers which open to set. Since many of the early blooms are frequently malformed, mishappen fruits may result. A tendency toward pointedness in fruits from treated plants has been noted by Strong (42) and Murneek, Wittwer and Hemphill (31), and some pear-shaped fruit by Howlett (31). Sunburning because of vine damage has been reported by Mann and Minges (26). Howlett (19) reported a tendency in fruits from treated plants to become soft prematurely after picking. He attributed this partly to the change in inner constituents of the fruit and cell walls and also partly to an increased rate of transpiration.

Much of the data mentioned above was gathered from greenhouse grown tomatoes. The use of growth-substances on outdoor tomatoes has met with varied success (30,1,53). Went and Cosper (44) have stated that minimum night temperatures markedly influence fruit-set. Few fruits are set, according to these workers at temperatures below 55° F, and optimum set is obtained at temperatures between 59 and 68 degrees Fahrenheit. The results of Wittwer, Stallworth and Howell (46) led them to agree with Went and Cosper, that cool nights are a frequent cause of poor fruit-set. They obtained increased "earliness" as a result of spraying with plant growth-regulating substances. Murneek (30) after testing the results of plant growth-regulating substances for three summers reported negative results. He felt that these sprays for field grown tomatoes were of little value, "excepting possibly in regions or years of subnormal amounts of light". Howlett (16) questioned the practicability of the use of these substances. He stated that their use would depend upon the development of practical methods of application as well as on the number and nature of the fruits produced. Mann and Minges (26) when using plant growth-regulating substances obtained an improved set on field-grown tomatoes in California. Fruits were large, of normal quality and for the most part lacked seeds. They stated that growth-substances would likely accentuate roughness if this occurred naturally to any extent. They tested whole plant sprays and obtained severe plant injury, concluding that it was necessary to confine the spray to the flower clusters. Odland and Chan (33) obtained increased early yield, increased total yield, and larger fruit. Wittwer and Schmidt (47) tested flower-cluster and whole-plant sprays with the aim of devising methods of application practical under field conditions. They found flower-cluster sprays beneficial but whole-plant sprays of little value and detrimental to yields.

MATERIALS AND METHODS

PROCEDURE IN 1949

The plant growth-regulating substances tested were (1) Sure-Set (Dow Chemical Co.) with para-chlorophenoxyacetic acid as the active ingredient and (2) Beta-naphthoxyacetic acid. Throughout this paper they will be referred to as CIPA and NOA respectively. Both of these chemicals were applied as flower-cluster sprays. CIPA was applied at 25 p.p.m. and NOA at 60 p.p.m. Wittwer, Stallworth and Howell (46), Murneek (30) and others used approximately these rates and obtained favourable results.

The tests were conducted on plots located at the University of Manitoba, Fort Garry.

Four tomato varieties were used in the experiment. Two of these, Early Chatham and Bounty have a determinate habit of growth; the other two, Marglobe and Early Stokesdale No.4 have an indeterminate habit of growth. For the sake of brevity Early Stokesdale No.4 will be referred to as Stokesdale throughout this paper. The tomato plants were started in the greenhouse and transplanted to the field on June 7. Each transplant was given one and one-quarter pint of starter solution made up by dissolving one pound of ammonium phosphate (11-48-0) in forty gallons of water.

Several atomizers were tested in order to find a method of application suited to field conditions. The first application was made with a small Holmspray atomizer "No.600", which had a capacity of 25 cc. This proved inconveniently small and a larger DeVilbiss atomizer "No.261" connected to a pressure tank with a cut-off valve was tried next. This atomizer had a capacity of 100 cc., which was more satisfactory. It did not, however, give a sufficiently fine spray. In order to obtain this the small Holmspray atomizer connected to a pressure tank was used for the remaining treatments.

On June 16, when the flowers on the first trusses were beginning to open, the first spray was applied. The spray was directed at the open flowers, with no special precautions taken to keep it off the foliage. No damage to the plants was observed. The remaining treatments were given at four or five day intervals until July 25. It was hoped that spraying at this interval of time would affect most of the early blossoms and induce maximum fruit-set.

Counts of fruits set were made at the same intervals as the treatments and one day prior to each treatment. This was to obtain a record of the effects of the preceding treatment and weather on fruit-setting.

Harvesting of ripe fruit began on August 3 and continued until September 6. At this latter date all fruits of marketable size, both ripe and green, were stripped from the plants, in order to obtain total yield data.

As pointed out in the review of literature, extensive work by Went and Cosper (44) and later substantiated by Wittwer, Stallworth and Howell (46) indicated that fruit-set is dependent on minimum night temperatures. In order that continuous temperature and humidity readings could be recorded a "hygrothermograph" was kept in the plots. The weather data for 1949 which are considered relevant to this report are listed in Table 1 of the appendix.

The experiment was laid out in a split-plot design with four replicates. Ten plants constituted a treatment or plot. The results were analyzed by statistical methods as described by Goulden (8).

PROCEDURE IN 1950

CIPA gave the most promising results in the 1949 tests. It was therefore used again in 1950 as a flower-cluster spray at 30 p.p.m. The rate of application was changed from 25 to 30 p.p.m. with the object of inducing a higher percentage of early fruit-setting. In the main experiment, along with CIPA, A900 (Dow Chemical Co.), with a-o-chlorophenoxypropionic acid as the active ingredient was used as a whole-plant spray at 50 p.p.m. A whole-plant spray was included since ease of application would make it popular, if it proved successful. A900 was used at 50 p.p.m., the rate recommended by Dow Chemical Co. Other chemicals tested were (1) NOA as a flower-cluster spray at 60 p.p.m. (2) A908 (Dow Chemical Co.), with a-2,4,5-trichlorophenoxypropionic acid as the active ingredient, as a whole-plant spray at 50 and 100 p.p.m. (3) N-1-naphthyl phthalamic acid (Naugatuck Chemical Co.) as a whole-plant spray at 0.5 and 1.0 p.p.m. and (4) maleic hydrazide (Naugatuck Chemical Co.), as a whole-plant spray at 1000 and 2000 p.p.m. The last two chemicals had been reported as having growth-promoting properties (32, 37) and so were included in these tests.

Owing to flooding of the University plot land the experiments were carried out at Headingly, Manitoba.

Two tomato varieties, Bounty (determinate) and

Stokesdale (indeterminate) were used in the tests. The plants were again started in the greenhouse, but at three different dates. This was to facilitate the transplanting to the field plots at three different dates, approximately one week apart. The plants were transplanted to the plots on May 27, June 5 and June 13. They were given the ammonium phosphate starter solution in the same manner as in 1949. Plant protectors were used twice on the first group transplanted on May 27 in order to protect them from low, near-freezing temperatures.

The first application of flower-cluster sprays was once again made with the small Holmspray atomizer connected to a pressure tank. A Hudson sprayer fitted with a fine nozzle tip No.400017 (Spraying Systems Co., Bellwood, Illinois) was used for the remaining applications. This tip gave a flat spray pattern with a spray angle of 40 degrees. It was considered very satisfactory. The whole-plant sprays were applied with a Hudson sprayer fitted with a nozzle tip No.650067 (Spraying Systems Co.).

Blossom opening began on June 14. The first treatments were applied on June 21, to some of the plants placed out on May 27. A plant was not sprayed until it had opened at least two blossoms. With flower-cluster sprays, each flower cluster was sprayed to "run-off". With whole-plant sprays the plant was given a uniform wetting, with about 25 cc. of solution being used per plant. The remaining treatments with CIPA were applied on June 27, July 4, July 11, July 18 and July 26. The remaining treatments with A900 were applied on June 27 and July 4. Two applications of each of the other chemicals were made on June 27 and July 4.

Open blossoms were examined and counted one week after the June 21 treatment, for evidence of any inhibitory effect of the chemicals on bud and flower development. Counts of fruit-set were made as in 1949, one day prior to each succeeding treatment.

Harvesting of ripe fruit began on August 3 and continued at intervals of approximately five days until Sept.15. On this date the plants were stripped of all fruits of marketable size to obtain total yield data.

Weather data were again obtained by placing a "hygrothermograph" in the plots. The weather data for 1950 which are considered relevant to this paper are listed in Table 11 of the appendix.

The experimental design used was a 3x3x2 factorial with four replicates. Ten plants again constituted a treatment or plot. This design enabled the confounding of some of the least valuable interactions in the analysis, resulting in a reduction of the experimental error. The results were analyzed by statistical methods as described by Yates (51) and Cockran and Cox (3).

RESULTS AND OBSERVATIONS

EXPERIMENTAL WORK IN 1949

The plants became established quickly following transplanting. This was attributed to the starter solution, since other plants nearby which had not received this treatment, developed less rapidly. Temperatures for the months of June, July and August were above normal. Growth and development of the plants was rapid until late July when lack of moisture began to limit growth.

The first evidence of fruit-set was noted on June 22 on an Early Chatham plant treated with CIPA. The first count of fruits set was made on June 27, and the averages are shown in Fig. 1. On the 160 determinate plants treated with CIPA, a total of 20 fruits had set, on the same number of plants treated with NOA 5 fruits had set, and on the same number of untreated plants only 1 fruit had set. Treatments appeared to be definitely affecting fruit-set. No fruits had set on the indeterminate plants. The lack of set on check plants can probably be explained by referring to the graph in Fig.4, which shows minimum night temperatures. Night temperatures had been favourable for fruit-setting (44) on only one night up to June 27; the average minimum night temperature up to this date being 48 degrees Fahrenheit. The average temperature for the period June 7 to June 27, on the other hand, had been 63 degrees or well within the optimal temperature range set forth as necessary for fruit setting (44,46). The results obtained substantiate the statements of Went and Cosper (44) and Wittwer, Stallworth and Howell (46) that minimum night temperatures below 59 degrees Fahrenheit may be responsible for the lack of fruit-setting in early spring and summer.

Unusual growth responses in the form of leaf distortions were noticed, on all plants during the latter part of June. These distortions appeared very severe at times and less severe at others, seeming to correspond with wet cloudy and clear dry periods respectively. These effects were found in all tomato fields examined in the area and were attributed to the use of 2,4-D in grain fields in surrounding districts. The symptoms were especially apparent on the indeterminate varieties, and possibly had some bearing on the setting and maturity of the fruits of these plants.

The second count of fruits set was made on July 4. Fig.4 shows that several nights with minimum temperatures favourable for fruit-setting had occurred after the first count on June 27. The results, which are given in Table 1 and Fig.2 show that fruit-setting had become general with all varieties except Marglobe. The comparative earliness of the four varieties, as judged by the number of fruits set on July 4, is seen in Fig.2. The analysis of variance for these data is given in Table 11 and shows varietal and treatment differences to be significant at the 1% level. The number of fruits set on the different varieties varied considerably, depending on the earliness of the variety. This earliness can be judged most easily by the number of fruits set on the check plots of each variety. Table 1 shows that the Early Chatham check plots had set an average of 23 fruits up to July 4 with Bounty, Marglobe and Stokesdale having set five, zero, and two fruits respectively. Also within each variety, the number of fruits set varied significantly because of the different treatments given the plants. Table 1 again shows that the CIPA and NOA treated plots of Early Chatham had set an average of 38 and 31 fruits respectively as compared with 23 for the untreated plots. On Bounty as on Early Chatham the CIPA treatments gave an increase in numbers of fruit-set significant beyond the 1% level and the NOA treatments an increase significant beyond the 5% level (Table 1). The small increases noted in Table 1 for Marglobe and Stokesdale were not significant.

Minimum night temperatures were favourable for fruit-setting from July 4 to July 9, the average minimum night temperature for this period being 62 degrees Fahrenheit. Counts made after this date showed setting to be general with all varieties, regardless of treatment.

TABLE 1

EFFECT OF TREATMENTS ON NUMBER OF FRUITS SET
ON FOUR TOMATO VARIETIES AT THREE DATES

Variety	Treatment	Dates		
		July 4	July 19#	July 26##
EARLY CHATHAM	CIPA	38**	260**	
	NOA	31*	241**	
	CHECK	23	210	
BOUNTY	CIPA	20**	184	
	NOA	13*	173	
	CHECK	5	176	
MARGLOBE	CIPA	2.5		93
	NOA	1		84
	CHECK	--		84
STOKESDALE	CIPA	7.7		112
	NOA	6		108
	CHECK	2		111
L.S.D. at 5% level		7.02	17.57	17.57
1% level		9.55	23.88	23.88

**Significantly different from the corresponding check at the 1% level of significance.
*Significantly different from the corresponding check at the 5% level of significance.
#No counts made on this date on Marglobe and Stokesdale.
##No counts made on this date on Early Chatham and Bounty.

TABLE 11

ANALYSIS OF VARIANCE FOR NUMBER OF FRUITS SET ON JULY 4

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	1.73	.58	---		
Varieties	3	6331.90	2110.63	404.33**	3.86	6.99
Error (a)	9	47.01	5.22			
Treatments	2	685.54	342.77	14.76**	3.40	5.61
Varieties x Treatments	6	252.29	42.05	1.81	2.51	3.67
Error (b)	24	557.51	23.23			
Total	47	7875.98				

**Significant at the 1% level.

The final count of fruits set was made on July 19 for the determinate varieties and on July 26 for the indeterminate varieties. Since the indeterminate varieties used are of later inherent maturity than the determinate ones, these two dates were considered comparable and analyzed together. The results of these last counts are shown in Fig.3. The histogram shows the average number of fruits set, but does not show the size differences between the fruits of treated and untreated plots. The difference in number of fruits set between treated and untreated plots was not great, but many of the fruits

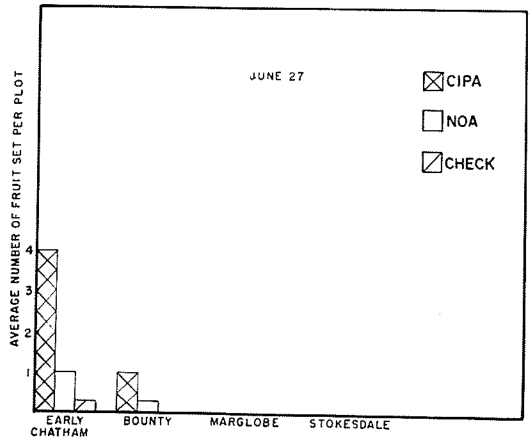


FIG. I

Histogram representing the effect of treatments on the number of fruits set per plot of four tomato varieties on June 27, 1949.

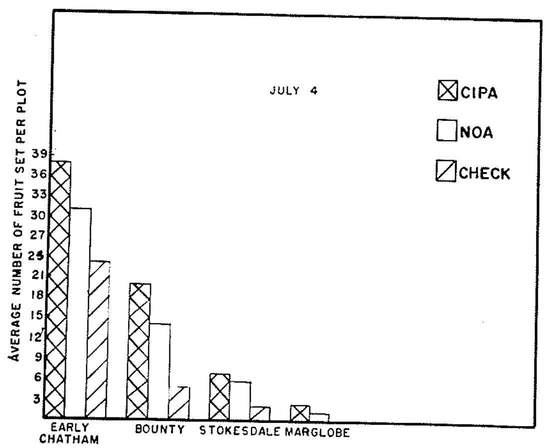


FIG. 2

Histogram representing the effect of treatments on the number of fruits set per plot of four tomato varieties on July 4, 1949.

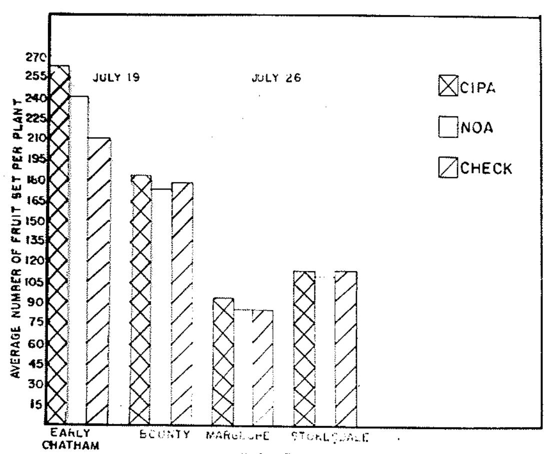


FIG. 3

Histogram representing the effect of treatments on the number of fruits set per plot of four tomato varieties on July 19 and July 26, 1949.

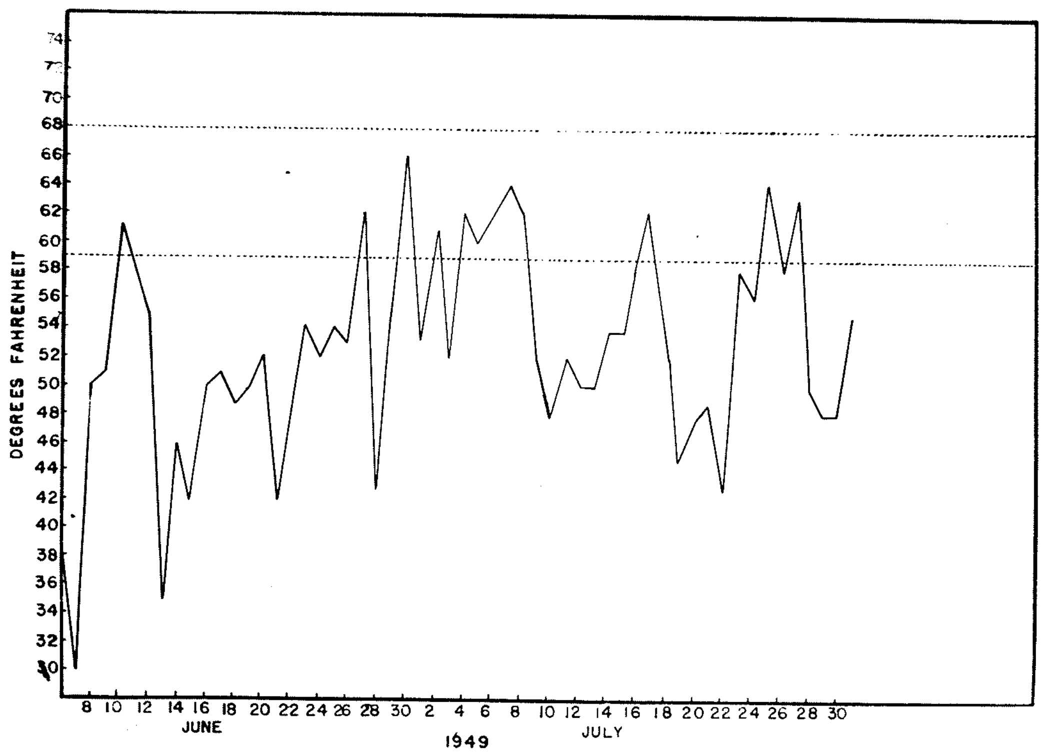


FIG. 4

Minimum night temperatures during June and July 1949 recorded in the plots at Winnipeg, Manitoba.

The area bounded by the dotted lines, 59°- 68°F, represents the optimal temperature range for tomato fruit-setting (44).

on the treated plots had set early and were much larger than those on the untreated plots. Statistical analysis of these data shows varietal differences, treatment differences and variety by treatment interaction to be significant at the 1% level (Table 111). The number of fruits set on the check plots of the four varieties varies a great deal as seen in Table 1. Thus the Early Chatham check plots had set an average of 210 fruits, with Bounty, Marglobe and Stokesdale having set 176, 84 and 111 fruits respectively. Table 1 shows that the significant differences between treatments applies only to the Early Chatham plots, the CIPA, NOA and check plots having set 260, 241 and 210 fruits respectively. Differences in number of fruits set due to treatments on other varieties were not large. However, the differences in the Early Chatham plots were large enough to make treatments significant in the analysis. The interaction of treatments by varieties is significant as may be seen in Table 111. This may be explained by the fact that varieties having a natural tendency to produce early flowers would likely respond to the treatments more readily than those of later flowering habits.

TABLE 111

ANALYSIS OF VARIANCE FOR NUMBER OF FRUITS SET ON JULY 19 AND 26

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	1290.09	430.03	.92	3.86	6.99
Varieties	3	166546.09	55515.36	119.12**	3.86	6.99
Error (a)	9	4194.41	466.05			
Treatments	2	2295.55	1147.77	7.89**	3.40	5.61
Varieties x Treatments	6	3254.78	542.46	3.73**	2.51	3.67
Error (b)	24	3491.00	145.46			

**Significant at the 1% level.

Figures 1, 2 and 3 show that CIPA treatments increased fruit-set more than NOA treatments for all varieties. Thus while CIPA treatments generally resulted in large increases in early fruit-set over the checks, NOA treatments generally resulted in only small increases. Fruit-set counts were not made beyond July 19 and 26. It appeared, however, that the untreated plots, which had begun to set more fruit than the treated plots during late July, continued to do so. However, such late fruits frequently fail to mature or mature very late and so would be of little value.

The first ripe fruits were picked on August 3, 42 days after the first evidence of fruit-set. Other pickings of ripe fruit were made on August 8,11,15,18,23,29 and September 6. The yield data for each picking date are given in Table 111 of the appendix. The yields from the first four pickings have been grouped together as early ripe fruit. The averages of these for each treatment and variety are shown in Fig.5 and Table 1V. The results are very similar to those for fruit-set, with CIPA treated plants yielding highest and check plants lowest. Statistical analysis of these early yield data shows varietal and treatment differences to be significant at the 1% level and the variety by treatment interaction to be significant at the 5% level (Table V). The different rates of development and ripening of the fruits of the four varieties probably explain the significant differences between varieties. Thus Table 1V shows that Marglobe check plots had yielded an average of 6.37 pounds of ripe fruit, the Early Chatham plots 4.49 pounds, the Stokesdale plots 3.11 pounds, and the Bounty plots 1.46 pounds. Table 1V shows that in all but the Early Chatham plots the significant differences due to treatments exist only between the CIPA treated and check plots. The differences between the CIPA treated and the check plots were significant at the 1% level for all varieties. The differences between the NOA treated and the check plots were significant at the 5% level for only Early Chatham.

TABLE 1V

EFFECT OF TREATMENTS ON YIELD IN POUNDS PER PLOT OF FOUR TOMATO VARIETIES

Variety	Treatment	Early Ripe Fruit (Up to Aug.15)	Total Ripe Fruit	Total Fruit Yield Ripe and Green
EARLY CHATHAM	CIPA	6.59**	61.02	80.89*
	NOA	6.07*	54.84*	72.21**
	CHECK	4.49	67.35	86.98
BOUNTY	CIPA	4.88**	65.26	83.51*
	NOA	2.67	62.68	81.68
	CHECK	1.46	66.58	88.20
MARGLOBE	CIPA	9.94**	30.55	42.18
	NOA	7.06	28.47	41.59
	CHECK	6.37	29.14	45.20
STOKESDALE	CIPA	8.91**	32.34*	45.03**
	NOA	7.06	24.46	38.15
	CHECK	6.37	22.81	36.93
L.S.D. at 5% level		1.54	9.35	3.79
at 1% level		2.09	12.71	5.15

**Significantly different from the corresponding check at the 1% level of significance.
*Significantly different from the corresponding check at the 5% level of significance.

TABLE V

ANALYSIS OF VARIANCE FOR YIELD OF EARLY RIPE FRUIT

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	19.01	6.33	2.18	3.86	6.99
Varieties	3	139.10	46.36	15.93**	3.86	6.99
Error (a)	9	26.22	2.91			
Treatments	2	115.79	57.89	51.92**	3.40	5.61
Varieties x Treatments	6	22.57	3.76	3.37*	2.51	3.67
Error (b)	24	26.76	1.12			
Total	47	349.45				

**Significant at the 1% level.
*Significant at the 5% level.

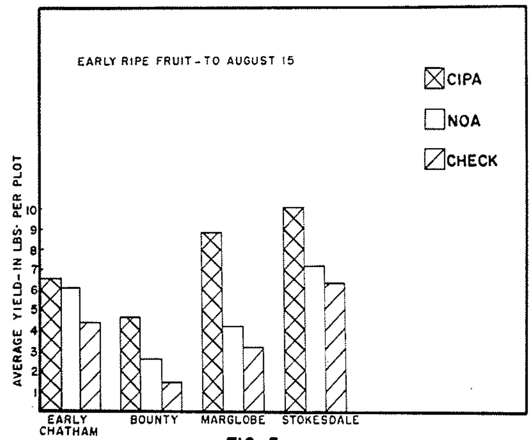


FIG. 5

Histogram representing the effect of treatments on the yield of early ripe fruit in pounds per plot of four tomato varieties in 1949.

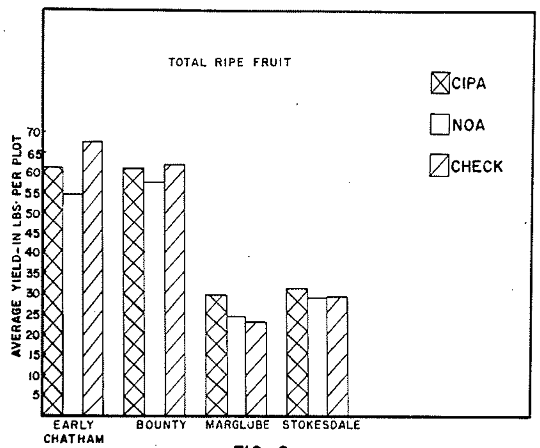


FIG. 6

Histogram representing the effect of treatments on the yield of total ripe fruit in pounds per plot of four tomato varieties in 1949.

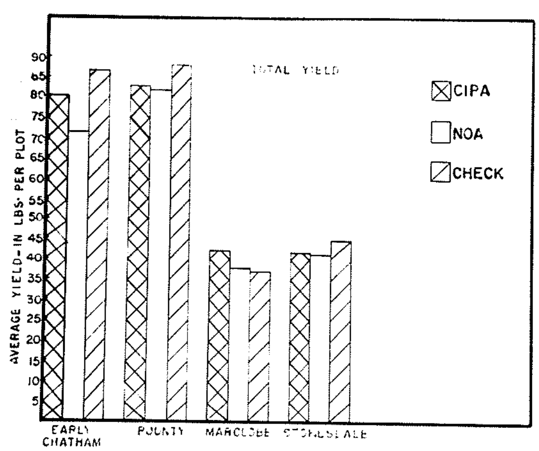


FIG. 7

Histogram representing the effect of treatments on total yield in pounds per plot of four tomato varieties in 1949.

The average yield per plot of total ripe fruit for each variety and treatment is shown in Fig. 6. In most cases the total ripe fruit picked from the treated plots was slightly less than that picked from the check plots. Statistical analysis of these data shows replicate differences to be significant at the 5% level and variety differences to be significant at the 1% level of significance (Table V.). Diseased plants were more prevalent in some replicates than others and may have caused the significant variation between replicates. The determinate varieties produced more fruits than the indeterminate varieties and, no doubt, caused varietal differences to be significant. Table lV shows that check plots of Early Chatham and Bounty yielded 67.35 and 66.58 pounds of ripe fruit respectively and those of Marglobe and Stokesdale 29.14 and 22.81 pounds respectively. Only in the case of the Early Chatham plots treated with NOA was the yield of ripe fruit significantly lower, being 54.84 pounds from NOA plots and 67.35 pounds from check plots (Table lV). The yield of ripe fruit was significantly higher from only the CIPA treated Stokesdale plots. The increased early yield from the treated plots was balanced by a larger yield from the untreated plants later in the season.

TABLE Vl

ANALYSIS OF VARIANCE FOR TOTAL YIELD OF RIPE FRUIT

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	3490.14	1163.38	5.48*	3.86	6.99
Varieties	3	15330.16	5110.05	24.09**	3.86	6.99
Error (a)	9	1909.40	212.15			
Treatments	2	154.68	77.34	1.87*	3.40	5.61
Varieties x Treatments	6	292.19	48.69	1.18	2.51	3.67
Error (b)	24	990.35	41.26			
Total	47	22166.92				

**Significant at the 1% level.
*Significant at the 5% level.

Average yields per plot of total fruits picked for each variety and treatment are graphically shown in Fig.7. As may be seen the check plots outyielded the treated ones by a small amount with the exception of the Marglobe variety. Statistical analysis of these data shows replicate, variety and treatment differences to be significant at the 1% level of significance. The variety by treatment interaction is significant at the 1% level (Table V111). Diseased plants may have been responsible for the replicate difference.

Varietal differences are again striking between determinate and indeterminate types. Table lV shows that while the check plots of Early Chatham and Bounty had yielded a total of 86.98 and 88.20 pounds of fruit respectively, these of Marglobe and Stokesdale had yielded only 36.93 and 45.20 pounds respectively. Table lV shows that only with the determinate plants did the check plots outyield the treated plots. Stokesdale plants treated with CIPA, on the other hand, yielded significantly higher than the checks. This inconsistent response of varieties to treatments was undoubtedly responsible for the significant variety by treatment interaction.

TABLE Vll

ANALYSIS OF VARIANCE FOR TOTAL YIELD

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	5431.18	1810.39	7.69**	3.86	6.99
Varieties	3	20659.28	6886.42	29.25**	3.86	6.99
Error (a)	9	2118.64	235.40			
Treatments	2	274.65	137.32	20.25**	3.40	5.61
Varieties x Treatments	6	337.56	56.26	8.30**	2.51	3.67
Error (b)	24	1627.30	6.78			
Total	47	30448.61				

** Significant at the 1% level.

Fruits picked at each date were classified as marketable or unmarketable. Scars and shape irregularities caused some fruits to be classified as unmarketable, but the majority were unmarketable because of blossom-end rot and rot caused by contact with the ground. Rotting due to ground contact was a problem with only the determinate varieties which bear their fruit near the ground. This, however, was balanced by a larger percentage of fruits on the indeterminate plants being affected with blossom-end rot. Table V111 gives the average percentages of marketable fruits picked from each variety and treatment. Statistical analysis of these data

TABLE V111

PERCENTAGE OF MARKETABLE FRUIT PICKED FROM FOUR TOMATO VARIETIES WITH THREE TREATMENTS

	EARLY CHATHAM	BOUNTY	MARGLOBE	STOKESDALE	AVERAGE
CIPA TREATED	77	68	86	78	77
NOA TREATED	70	73	84	73	75
CHECK	77	73	80	74	76
Average	75	71	83	75	76

shows replicate and variety differences to be significant at the 1% level of significance (Table 1X). Differences between replicates were probably due to varying amounts of disease in the different replicates. The averages for varieties given in Table V111 range from 83% for Marglobe to 75% for Stokesdale and Early Chatham and 71% for Bounty. As stated above these differences are largely due to varying amounts of blossom-end rot and ground soft-rot. The small amount of scarred, irregular fruit, produced was of little importance and not objectionable. Differences in marketable yield shown between the three treatments were not significant, indicating that the treatments did not affect marketable yield.

TABLE 1X

ANALYSIS OF VARIANCE FOR MARKETABLE FRUIT

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	926.75	308.92	8.36**	3.86	6.99
Varieties	3	1149.75	383.25	10.37**	3.86	6.99
Error (a)	9	332.75	36.97			
Treatments	2	17.38	8.69	.36	3.40	5.61
Varieties x Treatments	6	254.12	42.35	1.78	2.51	3.67
Error (b)	24	572.50	23.85			
Total	47	3253.25				

** Significant at the 1% level.

Fruits were weighed at each picking and the average individual fruit weight recorded. The data were separated into "first two pickings" and "later pickings", since it appeared that the first fruits to mature from the treated plants were larger than those from the check plants. Table X gives the average individual fruit weight of the first two and the remaining pickings.

TABLE X

EFFECT OF TREATMENTS ON AVERAGE WEIGHT OF INDIVIDUAL RIPE FRUIT OF FOUR TOMATO VARIETIES (IN OUNCES)

Varieties	Treatments	Fruit from first two pickings	Fruit from later pickings
EARLY CHATHAM	CIPA	2.48	2.36
	NOA	2.20	2.60
	CHECK	2.64	2.56
BOUNTY	CIPA	4.24	3.32
	NOA	3.88	2.64**
	CHECK	3.88	3.80
MARGLOBE	CIPA	4.28	3.64
	NOA	3.96	3.68
	CHECK	4.28	3.88
STOKESDALE	CIPA	4.88	4.32
	NOA	4.28	4.80
	CHECK	4.28	4.44
L.S.D. at 5% level		.616	.808
at 1% level		.838	1.097

**Significantly different from the corresponding check, at the 1% level of significance.

Statistical analysis of the data for the first two pickings shows only variety differences to be significant, Table Xl. Size differences due to treatments as shown in Table X, were not large enough to be significant, thus indicating no appreciable effect of the treatments on fruit size.

TABLE Xl

ANALYSIS OF VARIANCE OF FRUIT SIZE OF FIRST TWO PICKINGS

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	.0061	.0020	2.22	3.86	6.99
Varieties	3	.1004	.0335	37.22**	3.86	6.99
Error (a)	9	.0085	.0009			
Treatments	2	.0026	.0013	1.08	3.40	5.61
Varieties x Treatments	6	.0110	.0018	1.50	2.51	3.67
Error (b)	24	.0292	.0012			
Total	47	.1578				

**Significant at the 1% level.

Statistical analysis of the data for the later pickings shows replicate and variety differences to be significant at the 1% level, (Table Xll). As in the early pickings, the fruits from the indeterminate varieties were larger than those from the determinate varieties. While the analysis shows treatment differences to be significant at the 5% level, Table X shows that a reduction in fruit size was obtained only in the case of Bounty plants treated with NOA.

TABLE X11

ANALYSIS OF VARIANCE OF FRUIT SIZE OF LATER PICKINGS

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	.0284	.0095	11.87**	3.86	6.99
Varieties	3	.1167	.0389	48.62**	3.86	6.99
Error (a)	9	.0074	.0008			
Treatments	2	.0048	.0024	3.43*	3.40	5.61
Varieties x Treatments	6	.0029	.0005	.71	2.51	3.67
Error (b)	24	.0168	.0007			
Total	47	.1770				

** Significant at the 1% level.
 * Significant at the 5% level.

EXPERIMENTAL WORK IN 1950

The plants were transplanted to the plots on May 27, June 5 and June 13. One-third of the Bounty and Stokesdale plants were placed out at each of these dates. Low temperatures after the first transplanting date resulted in the transplants making slow progress, while those remaining in the frames made rapid progress. Although the plants were transplanted to the plots at approximately one week intervals, several weeks later there was little difference in their size or stage of development. Cool, below-normal temperatures and above-normal precipitation continued throughout the spring and summer, resulting in slow growth and development of the plants. Fig.8 shows that minimum night temperatures were favourable for fruit-setting on only one night up to July 7 (44); the average minimum temperature for this period being 47 degrees Fahrenheit.

One week after the first treatment flower clusters were checked for evidence of inhibitory effects of the early treatment on immature flowers and buds. No injurious or retarding effect could be detected at this time. This agrees with the 1949 results, when the flowers were treated at an early stage and no inhibition of flower development noted.

The first count of fruits set was made on July 3. The results of this count are shown in Fig.9 and in Table X111.

Very few fruits, an average of only 1 fruit per 7 plants, had set on the check plants. The CIPA treated plants, on the other hand, had to a large degree overcome the weather barrier, having set an average of just under 1 fruit per plant. The combination of early transplanting plus CIPA treatment gave a striking increase in numbers of fruits set. Plots with this combination had set an average of just under 2 fruits per plant as compared with the corresponding checks which had set an average of just over 1 fruit per 4 plants. The CIPA treated plots had set the most fruit, followed by the A900 treated and check plots, with averages of 1 fruit per plant, 1 fruit per 4 plants and 1 fruit per 7 plants respectively. Statistical analysis of these data shows transplanting dates and treatment effects to be significant at the 1% level. The date by treatment interactions are also shown to be significantly different at the 1% level, and the treatment by variety interactions to be significantly different at the 5% level, (Table XlV). The plants transplanted on the first date had become better established than those transplanted on the second and third dates and set fruit despite the unfavourable temperatures, (Table X111). The check plots of Bounty and Stokesdale transplanted on the first date had set an average of 2.5 and 4.75 fruits respectively while those planted on the second

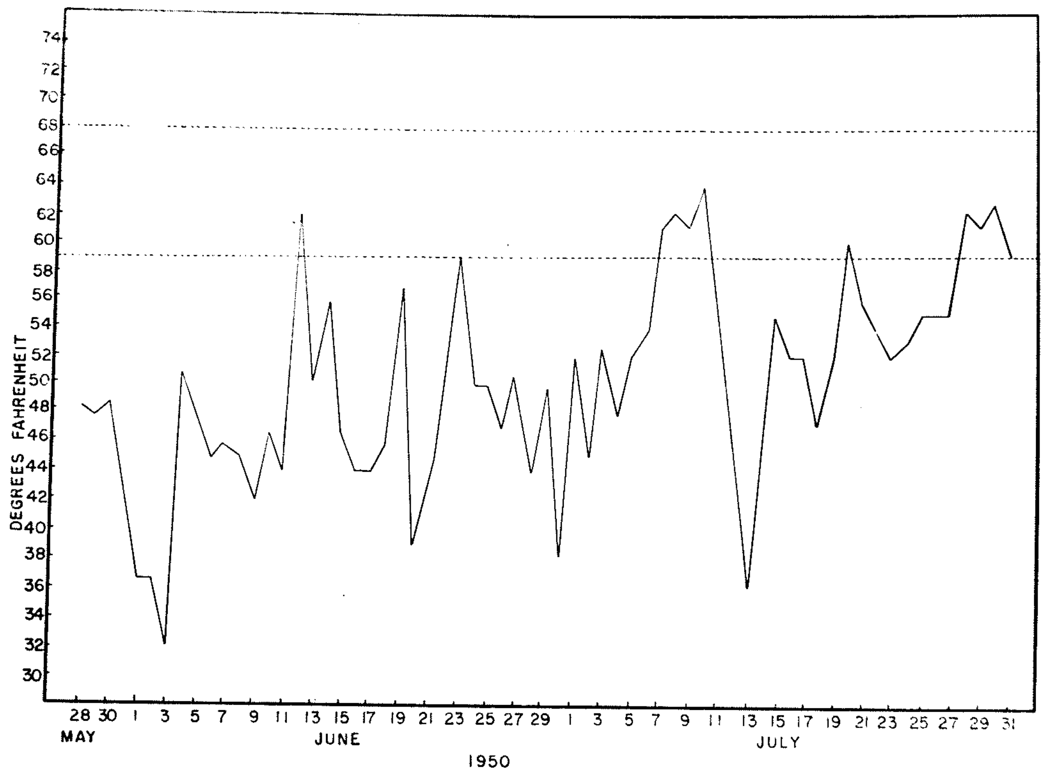
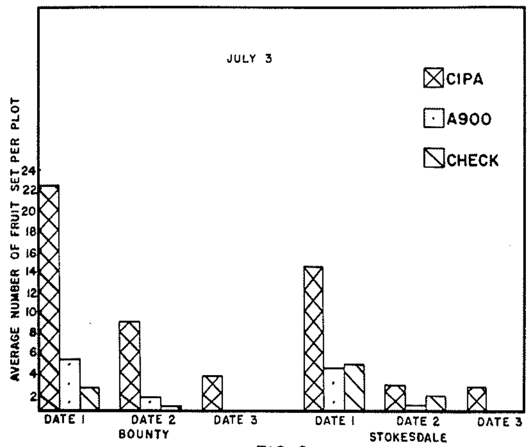


FIG. 8

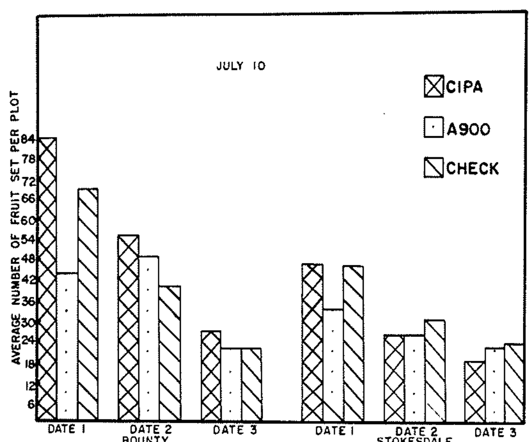
Minimum night temperatures during June and July 1950 recorded in the plots at Headingly, Manitoba.

The area bounded by the dotted lines, 59°- 68°F, represents the optimal temperature range for tomato fruit-setting (44).



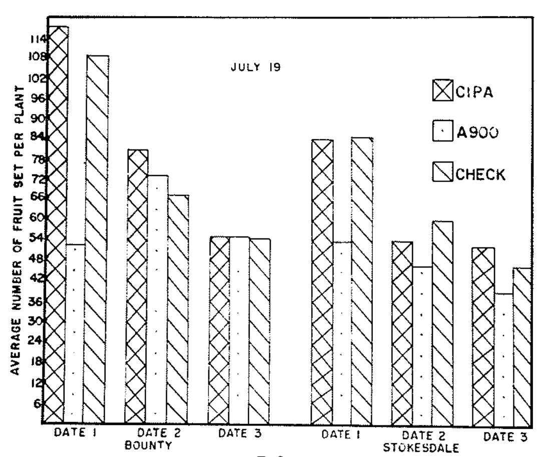
FIG· 9

Histogram representing the effect of treatments on the number of fruits set per plot of two tomato varieties on July 3, 1950.



FIG· 10

Histogram representing the effect of treatments on the number of fruits set per plot of two tomato varieties on July 10, 1950.



FIG· 11

Histogram representing the effect of treatments on the number of fruits set per plot of two tomato varieties on July 19, 1950.

TABLE XIII

EFFECT OF TWO TREATMENTS ON NUMBER OF FRUITS SET ON TWO TOMATO VARIETIES AT 3 DATES

	BOUNTY			STOKESDALE		
	JULY 3	JULY 10	JULY 19	JULY 3	JULY 10	JULY 19
PLANTED MAY 27						
CIPA TREATED	22.5**	84	117	15.25**	46	84
A900 TREATED	5.5	44**	52	4.50	33	54**
CHECK	2.5	69	108	4.75	46	85
PLANTED JUNE 5						
CIPA TREATED	9.0**	55	84	2.75	26	54
A900 TREATED	1.5	49	74	.50	22	46
CHECK	.5	40	68	1.50	30	60
PLANTED JUNE 13						
CIPA TREATED	3.5	27	56	.25	18	52
A900 TREATED	---	22	56	--	22	39
CHECK	---	22	55	--	23	47
L.S.D. at 5% level	5.74	16.73	18.58	5.74	16.73	18.58
at 1% level	7.64	22.27	24.75	7.64	22.27	24.75

** Significantly different from the corresponding check at the 1% level of significance.
* Significantly different from the corresponding check at the 5% level of significance.

date had set only an average of 0.5 and 1.5 fruits and those planted on the third date had set no fruit. The plant protectors used on the earliest group of transplants, and left on for several nights may have kept night temperatures favourable for fruit-setting. The differences due to treatments as shown in Table XIII are very striking on the plots transplanted on May 27, less striking on the plots transplanted on June 5 and too small to be significant on the plots transplanted on June 13. The treatments gave differential responses with the different dates of planting thus causing the interactions of treatments by dates to be significant. The significant treatment by variety interaction may be explained by the greater effect of the chemicals on the earlier varieties.

TABLE XIV

ANALYSIS OF VARIANCE FOR NUMBER OF FRUIT SET ON JULY 3

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	52.61	17.53	1.24	2.88	4.27
Blocks within Replicates	8	188.61	23.58	1.67	2.17	2.97
Dates	2	958.03	479.02	33.92**	3.22	5.17
Treatments	2	810.03	410.02	29.04**	3.22	5.17
Varieties	1	53.39	53.39	3.78	4.06	7.25
Dates x Treatments	4	465.96	116.49	8.25**	2.60	3.82
Dates x Varieties	2	3.69	1.85	--	3.22	5.17
Treatments x Varieties	2	143.36	71.68	5.08*	3.22	5.17
Dates x Treatments x Varieties	4	21.73	5.43	--		
Error	43	607.20	14.12			
Total	71	3304.61				

** Significant at the 1% level.
* Significant at the 5% level.

The second count of fruits set was made on July 10. By this time the setting of fruit had become general on all plants. Prior to this date, the temperatures on several consecutive nights had been high enough for normal fruit-setting (44,46), as shown in Fig.8. The poorest set had occurred on plants treated with A900 as shown in Fig.10 and Table XIII. All the check plants were setting heavily by this date and had, in many cases, surpassed the treated plants in total numbers of fruits set. Statistical analysis of these data shows the difference between dates, between treatments and between varieties to be significant at the 1% level. The date by treatment interaction is significant at the 1% level and the treatment by variety interaction is significant at the 5% level of significance. At this date, the differences between planting dates were larger than those between varieties or treatments. Comparisons may easily be made from Table XIII. The CIPA treated plots of Bounty planted on May 27 had set significantly more fruits than the corresponding check plants, while the A900 treated plots had set significantly less fruits. The CIPA treatments generally resulted in increases in numbers of fruits set, while the A900 treatments resulted in decreases in comparison with the checks. The combination of first planting date and CIPA treatment again, as in the previous count gave the most striking result, see Figs.9 and 10.

TABLE XV

ANALYSIS OF VARIANCE FOR NUMBER OF FRUITS SET ON JULY 10, 1950

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	546.56	182.18	1.52	2.82	4.27
Blocks within Replicates	8	2293.11	286.64	2.39*	2.17	2.97
Dates	2	12160.78	6080.39	50.69**	3.22	5.17
Treatments	2	1289.36	644.68	5.37**	3.22	5.17
Varieties	1	4278.12	4278.12	35.67**	4.06	7.25
Dates x Treatments	4	1088.80	272.20	2.27	2.60	3.82
Dates x Varieties	2	1603.09	801.55	6.68**	3.22	5.17
Treatments x Varieties	2	900.76	450.38	3.75*	3.22	5.17
Dates x Treatments x Varieties	4	289.17	72.29			
Error	43	5158.03	119.95			
Total	71	29607.78				

** Significant at the 1% level.
* Significant at the 5% level.

The last count of fruits set was made on July 19, by which time minimum night temperatures were no longer a limiting factor as seen in Fig.8. By this date, the numbers of fruits set on the check plants of both varieties was equal or almost equal to that on the CIPA treated plants and greater than that on the A900 treated plants as seen in Table XIII. Statistical analysis of these data shows significant variations to exist within all the main factors studied and some of the interactions. Table XIII shows that there are large differences between treatments, especially between A900 treated and check plots planted on May 27. Thus the A900 treated Bounty plots had set only 52 fruits as compared with 108 for the check plots. The differences between varieties and between dates are also evident, hence we could expect that differences would exist for the interactions.

TABLE XVI

ANALYSIS OF VARIANCE FOR NUMBER OF FRUITS SET ON JULY 19

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	1770.09	590.03	3.98*	2.82	4.27
Blocks within Replicates	8	5633.72	704.21	4.75**	2.17	2.97
Dates	2	12876.19	6438.09	43.44**	3.22	5.17
Treatments	2	5440.36	2720.18	18.36**	3.22	5.17
Varieties	1	4576.06	4576.06	30.88**	4.06	7.25
Dates x Treatments	4	3942.59	985.65	6.66**	2.60	3.82
Dates x Varieties	2	360.52	180.26	1.22	3.22	5.17
Treatments x Varieties	2	270.02	135.01	--	3.22	5.17
Dates x Treatments x Varieties	4	1720.95	430.24	2.90*	2.60	3.82
Error	43	6372.11	148.19			
Total	72	42962.61				

** Significant at the 1% level.
* Significant at the 5% level.

The foregoing data have shown that fruit on CIPA treated plants set earlier than on untreated plants. Observations of fruit development showed another effect of this chemical, a more rapid ripening of the fruits from treated plants. Photographs taken on July 21 (Plates 1 and 2) show the size and developement of fruit on CIPA treated and check plants at that date. Plates 3 and 4 show the same comparison between fruit on CIPA treated and check plants on August 10. The fruits on the CIPA treated plants, as well as having set earlier, were maturing more rapidly than those on the check plants.

The data presented in Table XVII enable us to compare the number of days to bloom, fruit-set and ripe fruit, required by treated and untreated plants. The plants treated with A900, the whole-plant spray, ripened fruit in less time than either check or CIPA treated plants, although this again was at the expense of a loss in total fruits ripened. In many cases plants treated with A900 produced one or two ripe fruits very early in the season, and then failed to ripen any more fruit for several weeks. This may have been due to the fact that these plants were retarded considerably by the first spray. The reduction in vigour of the plants treated with A900 may be seen by comparing a row of these plants as seen in Plate 7 with a row of plants treated with CIPA, as seen in

Plate 8. Columns 6, 7 and 8 of Table XVII show the reduction in the number of days required to mature fruits on the treated plants. It is evident from Table XVII that the increase in earliness was not entirely due to earlier fruit-setting, but also to a reduction in the time between setting and maturing required by fruits of the treated plants. This may be shown by comparing the treated and untreated Bounty plants transplanted on May 27. Column 5 shows that the check plants had set an average of 1 fruit per plant only 3 days later than the CIPA treated plants. Column 7, however, shows that the check plots had not yielded an average of 1 pound of ripe fruit per plant until 20 days after the CIPA plots. The difference of 17 days was gained by the fruits of the CIPA treated plants because they matured faster. The lack of any gain in maturity of fruits of both Bounty and Stokesdale planted on June 13 is evident from Column 7. By the time these plants had reached the fruit-setting stage minimum night temperatures were favourable for fruit-setting and so the chemicals were of little or no value.

The first ripe fruits were picked on July 29. These were few in number and most were very irregular in shape with large stem or blossom-end scars. The fruits picked on this date were grouped along with those on August 3 for recording purposes. Other pickings of ripe fruit were made on August

TABLE XVII

DATES WHEN VARIOUS STAGES OF PLANT DEVELOPMENT WERE FIRST ATTAINED AND NUMBER OF DAYS FROM TRANSPLANTING TO 1 LB. OF RIPE FRUIT PER PLANT

(1)	(2)	DATE					(8)
		(3)	(4)	(5)	(6)	(7)	
Variety	Treatment	Planting	Bloom (Average 1 per plant)	Fruit-set (Average 1 per plant)	First Ripe Fruit	Ripe Fruit (Average 1 lb. per plant)	Number of days From 3-7
BOUNTY	CIPA	May 27	June 20	June 30	Aug.3	Aug.16	81
	A900	"	"	July 5	July 29	Aug.30	95
	CHECK	"	"	July 2	Aug.16	Sept.5	101
	CIPA	June 5	June 24	July 4	Aug.10	Aug.21	77
	A900	"	"	July 5	Aug. 9	Aug.30	86
	CHECK	"	"	July 6	Aug.18	Sept.5	92
	CIPA	June13	June 28	July 8	Aug.16	Sept.5	84
	A900	"	"	"	Aug.15	"	84
	CHECK	"	"	"	Aug.20	"	84
STOKESDALE	CIPA	May 27	June 23	July 2	Aug. 3	Aug.21	86
	A900	"	"	July 5	July 29	Sept.5	101
	CHECK	"	"	July 2	Aug.16	Sept.5	101
	CIPA	June 5	June 29	July 4	Aug. 9	Aug.30	86
	A900	"	"	July 6	Aug. 3	Sept.5	92
	CHECK	"	"	"	Aug.18	"	92
	CIPA	June 13	June 29	July 8	Aug.10	Sept.5	84
	A900	"	"	July 7	Aug.12	"	84
	CHECK	"	"	"	Aug.18	"	84

TABLE XVIII

EFFECT OF TREATMENTS ON YIELD IN POUNDS PER PLOT OF TWO TOMATO VARIETIES

	BOUNTY				STOKESDALE			
	Early Ripe Fruit (To Aug.25)	Total Ripe Fruit	Total	% of Green Fruit of Total Yield	Early Ripe Fruit (To Aug.25)	Total Ripe Fruit	Total	% of Green Fruit of Total Yield
PLANTED MAY 27								
CIPA TREATED	30.07**	93.53**	132.09	30	15.14	52.03	87.97	41
A900 TREATED	6.11	26.56**	59.02**	55	4.78	38.29*	169.29**	45
CHECK	2.78	53.01	136.70	61	4.84	52.86	96.98	46
PLANTED JUNE 5								
CIPA TREATED	13.32	58.91*	112.16	47	6.80	35.86	72.17	51
A900 TREATED	4.74	36.25	68.75*	47	2.74	32.89	73.14	55
CHECK	1.81	43.94	126.88	65	2.48	34.46	82.06	58
PLANTED JUNE 13								
CIPA TREATED	6.08	42.84	117.13	63	3.59	33.39	68.14	51
A900 TREATED	2.46	26.92	72.79	63	1.69	27.83	64.74	57
CHECK	1.87	37.43	113.18	67	1.63	29.16	71.21	59
L.S.D. at 5% level	13.15	13.61	15.27		13.15	13.61	15.27	
at 1% level	17.60	18.13	20.34		17.60	18.13	20.34	

** Significantly different from the corresponding check at the 1% level of Significance.
 * Significantly different from the corresponding check at the 5% level of Significance.

TABLE XIX

ANALYSIS OF VARIANCE FOR YIELD OF EARLY RIPE FRUIT

Variation due to	D.F.	S.S.	M.S.	Calculated F. value	F value at 5% level	F value at 1% level
Replicates	3	5.86	1.95	---	2.82	4.27
Blocks with Replicates	8	282.11	35.26	---	2.17	2.97
Dates	2	750.19	375.09	5.01*	3.22	5.17
Treatments	2	1412.22	706.11	9.44**	3.22	5.17
Varieties	1	144.98	144.98	1.94	4.06	7.25
Dates x Treatments	4	546.20	136.55	1.82	2.60	3.82
Dates x Varieties	2	38.65	19.32	---	3.22	5.17
Treatments x Varieties	2	252.53	126.26	1.69	3.22	5.17
Dates x Treatments x Varieties	4	88.52	22.13	---		
Error	43	3217.67	74.83			
Total	71	6738.93				

** Significant at the 1% level.
 * Significant at the 5% level.

10,16,21,25,30, September 5,10 and 15. The yield data for each picking date are given in Table IV of the appendix. By August 10 the yield of ripe fruit from plants transplanted on May 27 and treated with CIPA had averaged one-third pound per plant, while that from untreated plants of the same date was nil.

All the fruits picked up to August 10 were seedless and of good eating quality, although quite rough and scarred. This fruit roughness continued throughout the season on both treated and untreated plants and was from 15 to 20% more prevalent with the fruit from the treated plants. This roughness can be seen clearly in Plates 5 and 6, on fruits of both treated and untreated plants. These data agree with the findings of Mann and Minges (37), that growth-regulating substances tend to accentuate any natural occurring fruit roughness. It was definitely objectionable and reduced the market value of the fruits considerably.

The amount of ripe fruit picked from CIPA, A900 and check plants respectively on August 16 is shown from left to right in Plate 5 for Bounty and Plate 6 for Stokesdale. The increased yield from the CIPA treatments was very striking. All ripe fruit picked prior to August 25 was considered as early ripe fruit and grouped together as such for analysis. The differences in yield of early ripe fruit between treated and check plots can be seen in Fig.12 and Table XVIII. Statistical analysis of the early ripe yield data shows treatment differences to be significant at the 1% level of significance and differences due to dates of transplanting significant at the 5% level of significance (Table XIX). Table XVIII shows that the only significant differences due to

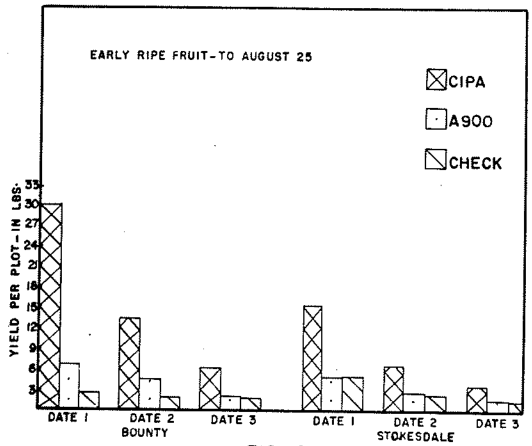


FIG. 12

Histogram representing the effect of treatments on the yield of early ripe fruit in pounds per plot of two tomato varieties planted at three dates in 1950.

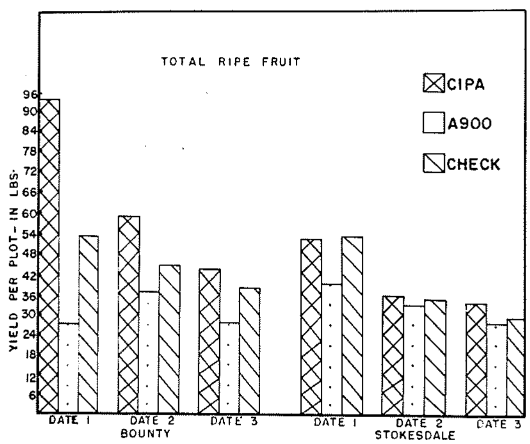


FIG. 13

Histogram representing the effect of treatments on the yield of total ripe fruit in pounds per plot of two tomato varieties planted at three dates in 1950.

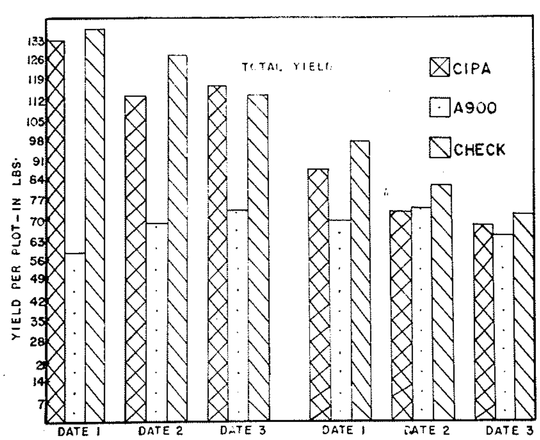


FIG. 14

Histogram representing the effect of treatments on the total yield in pounds per plot of two tomato varieties planted at three dates in 1950.

treatments were between CIPA anc check plants of Bounty transplanted on May 27. These CIPA treated Bounty plots yielded 30.07 pounds as compared to only 2.78 pounds for the checks. The plants which were transplanted on May 27 had set fruit earlier which resulted in earlier maturity as shown by the figures in Table XVIII.

The average yields of total ripe fruit from treated and untreated plots are shown in Fig.13 and Table XVIII. Statistical analysis of these data shows yield differences between dates of planting, treatments and varieties to be significant at the 1% level of significance (Table XX). Table XVIII shows that the check plots of Bounty planted on the first date had yielded 53.01 pounds of ripe fruit, those planted on the second date had yielded 43.94 pounds and those planted on the third date 37.43 pounds. Similar large differences may be seen from Table XVIII when comparing varieties and treatments. Bounty plants transplanted on May 27 and June 5 and treated with CIPA had yielded significantly more ripe fruit than their corresponding checks. Bounty and Stokesdale plants, planted on May 27 and treated with A900 had yielded significantly less fruit than their checks. None of the other differences were significant.

TABLE XX

ANALYSIS OF VARIANCE OF YIELD OF TOTAL RIPE FRUIT

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	182.47	60.82	--	--	--
Blocks	8	2591.91	323.99	4.05**	2.17	2.97
Dates	2	4793.47	2396.73	30.00**	3.22	5.15
Treatments	2	5447.62	2723.81	34.09**	3.22	5.15
Varieties	1	1517.18	1517.18	18.99**	4.07	7.27
Dates x Treatments	4	1365.31	341.33	4.27**	2.59	3.80
Dates x Varieties	2	127.12	63.56			
Treatments x Varieties	2	2404.40	1202.20	15.05**	3.22	5.15
Dates x Treatments x Varieties	4	801.59	200.39	2.51	2.59	3.79
Error	43	3435.07	79.89			
Total	71	22666.14				

** Significant at the 1% level.

Total yield averages are also given in Table XVIII and shown diagramatically in Fig.14. These yields are very high, largely due to the favourable moisture conditions which prevailed all summer. When we consider the percentages of these yields which is made up of green fruit as shown in Table XVIII, we see that this proportion was very large. It is desirable that this percentage be as low as possible since the green fruit is of little value. The percentages were lowest for the CIPA treated plots, intermediate for the A900 treated plots and highest for the check plots. Thus, although in most cases the check plots outyielded the treated plots as seen in Table XVIII and Fig. 14, this was not a serious objection to the treatments. Statistical analysis of the total yield data shows significant differences for dates of planting, treatments and varieties (Table XXI). Plants placed out early in the season became established earlier and would therefore be expected to yield higher as a result of the longer season. Table XVIII shows that the significant differences between treatments when compared to the checks applied only to the A900 treated plots. In most cases the use of this chemical resulted in greatly reduced yields. Thus the Bounty planted on May 27 and treated with A900 yielded only 59.02 pounds of fruit as compared with 136.70 pounds for the check plots. Varietal differences would be expected because of the inherent earliness and yielding ability of Bounty when compared with Stokesdale under Manitoba conditions.

A record of fruit size was again kept. As in 1949 there was little difference in size between the fruit from treated and from check plants. These data were so similar that an analysis of variance was not run on them.

TABLE XXI

ANALYSIS OF VARIANCE OF TOTAL YIELD DATA

Variation due to	D.F.	S.S.	M.S.	Calculated F value	F value at 5% level	F value at 1% level
Replicates	3	513.25	171.08	1.71	2.82	4.27
Blocks	8	1117.82	139.73	1.39	2.17	2.97
Dates	2	1911.25	955.62	9.54**	3.22	5.15
Treatments	2	18337.16	9168.58	91.57**	3.22	5.15
Varieties	1	14231.81	14231.81	142.13**	4.07	7.27
Dates x Treatments	4	2488.37	622.09	6.21**	2.59	3.80
Dates x Varieties	2	230.18	115.09	1.15	3.22	5.15
Treatments x Varieties	2	8276.50	4138.25	41.33	3.22	5.15
Dates x Treatments x Varieties	4	74.09	18.52			
Error	43	4305.58	100.13			
Total	71	51486.01				

** Significant at the 1% level

There was little disease in the plots and very few fruits were affected by blossom-end rot. The only factor affecting marketability was roughness of the fruit. This was so general that classifying the fruits was very difficult and indefinite. Taken as a whole, neither the fruit from the treated or check plants would have been of a high quality grade. However, data on fruit roughness did indicate that the percentage of rough fruit from CIPA and A900 treated plants was about 20% and 10% higher than from the check plants, respectively. This fruit roughness which was likely due to the cool spring and summer temperatures was thus accentuated by the treatments. Internal examination of these rough fruits showed many to be puffy with large cavities where the gelatinous pulp had separated from the locule walls, and to be seedless. The photograph in Plate 10 shows this condition. Such fruits were most common during the latter part of the season from treated plants which had produced a high yield of ripe fruits earlier in the season. Some fruits had stem and blossom-end scars.

OTHER CHEMICALS TESTED IN 1950

The other chemicals tested were A908 containing a-o-trichlorophenoxypropionic acid, N-1-naphthylphthalamic acid and NOA. These were all applied as whole-plant sprays with the exception of NOA. The treatments were not replicated and the results are largely observations. Only NOA, used as a flower-cluster spray, substantially hastened fruit maturity (Table XXII). All the whole-plant sprays proved injurious to the plants at the rates used. Yield data given in Table

XXII show the general reduction in yield which resulted from the treatments. It was apparent from the results obtained that the chemicals were applied at concentrations which were excessive under the conditions of the experiment.

TABLE XXII

YIELD PER PLOT (IN LBS.) OF PLANTS TREATED WITH OTHER CHEMICALS

	Early Ripe Fruit (To Aug.25)	Total Ripe	Green Fruit	Total Yield
BOUNTY				
A900 - 100 p.p.m.	.50	6.26	9.00	15.26
A908 - 100 p.p.m.	.80	7.95	.50	8.45
NOA - 60 p.p.m.	6.21	30.47	47.75	78.22
Maleic Hydrazide - 1000 p.p.m.	1.42	15.20	8.00	23.20
N-1-Naphthyl-phthalamic acid 0.5 p.p.m.	2.31	17.45	31.50	48.95
N-1-Naphthyl-phthalamic acid 1.0 p.p.m.	.50	13.11	10.00	23.11
CHECK	1.57	32.38	71.75	104.13
STOKESDALE				
A900 - 100 p.p.m.	1.95	4.38	13.25	17.63
A908 - 100 p.p.m.	--	7.45	3.00	10.45
NOA - 60 p.p.m.	3.06	17.45	18.00	35.45
Maleic Hydrazide - 2000 p.p.m.	--	1.15	.50	1.65
N-1-Naphthyl-phthalamic acid 0.5 p.p.m.	1.63	25.33	13.25	38.58
N-1-Naphthyl-phthalamic acid 1.0 p.p.m.	--	3.94	27.75	31.69
CHECK	1.24	24.75	36.84	61.59

All the whole-plant sprays except maleic hydrazide at 1000 p.p.m. damaged the plants severely. The plants became badly twisted and deformed with the terminal shoot often being killed. Some of the most seriously injured plants were similar to the one shown in Plate 9. However, even the most seriously injured plants matured some small fruits early in the season. Maleic hydrazide at 1000 p.p.m. applied to Bounty, caused the plants which had begun to set fruit to revert to further vegetative growth. These later produced many small fruits. At 2000 p.p.m. on Stokesdale the plants were severely injured and little fruit was produced. Of these treatments only NOA, as a flower-cluster spray, compared favourably with the checks (Table XXII).

DISCUSSION AND CONCLUSIONS

The CIPA treatments in 1949 resulted in an increased yield of early ripe fruit for all varieties. In 1950 they gave an increased yield of early ripe fruit with only the Bounty plants which were transplanted on May 27. This increase was very striking. In both years the results indicate that the CIPA treatments gave the best results on the varieties having the greatest inherent earliness. These were Early Chatham and Bounty in 1949 and Bounty in 1950. These varieties reached the fruit-setting stage early in the season when temperatures were generally unfavourable for fruit-setting. It was at this time that the action of this chemical was most beneficial in aiding fruit-setting.

The CIPA treatments in both years resulted in no changes in yield of total ripe fruit. Whereas the early flowers were stimulated to set fruits and thus increase early yields,there was no inhibition of later flowers nor any serious reduction of plant vigour. The total yield (ripe plus green fruit) of the two earlier varieties was reduced by the CIPA treatments,whereas with the later varieties it was increased with Stokesdale and unchanged with Marglobe. The early varieties,because they were stimulated to set more fruit early in the season,appeared to have less plant food available for later plant development and fruit-setting and, therefore, bore less fruit. The later maturing varieties on the other hand were affected less because they did not reach the flowering stage till temperatures were favourable for fruit-setting. The chemical for this reason had little or no effect and fruit-setting and plant development proceeded in the normal manner.

The NOA treatments in 1949 gave an increase of early ripe fruit with only Early Chatham, the earliest variety. Early Chatham began setting fruit while temperatures were still unfavourable for normal fruit-setting. This early stimulation and increased early yield had the effect of lowering the total yield of ripe fruit and total yield. The results indicated that under the conditions of the experiment NOA was not as effective a fruit-setting chemical as CIPA.

The A900 treatments in 1950 resulted in no significant increases in yield of early ripe fruit, although they did cause a few fruits to mature very early. The reduced plant size which resulted from the treatments with A900 was very marked. The yield of total ripe fruit and total fruit were greatly reduced, probably because of the retarded development of these plants. All of the other whole-plant sprays tested caused plant distortion and inhibited plant development, resulting in little or no gain in fruit maturity, unsatisfactory fruit size and reduced yields. Whole-plant sprays appeared to be unsatisfactory from the standpoint of increasing early yields. Although they stimulated a few of the flowers to set fruits early, they inhibited the growth of less developed flowers and buds and reduced yields.

The results obtained in 1950 were generally more favourable than those of 1949, from the standpoint of hastening maturity. The critical factor in tomato fruit-setting seems to be minimum night temperatures. Table I of the appendix gives the average minimum temperatures for the fruit-setting months of 1949, namely June and July. In June, the average minimum night temperature was 49.6 as compared with a normal of 50.4 and in July it was 54.6 as compared with a normal of 55.3. The normal temperatures represent 76 year averages as supplied by the Meteorological Division of Air Services, Department of Transport, Winnipeg. These monthly means as well as the daily temperatures for June and July were very close to normal. Temperatures were favourable for fruit-setting on 3 nights in June and on 9 nights in July as shown in Fig.4. On 5 consecutive nights, from July 4 to 8 inclusive, temperatures were favourable for fruit-setting. We could, therefore, expect that fruit-setting would proceed more or less normally. The 1949 results bear this out showing only small increases in fruit-setting as a result of the chemical treatments. Table II of the appendix gives the average minimum temperatures for the fruit-setting months of 1950. In June the average was 46.9 as compared with a normal of 50.4 and in July it was 54.0 as compared with a normal of 55.3. These averages were considerably below normal, particularly the June average, as were also the mean daily temperatures. Temperatures were favourable for fruit-setting on only 1 night in June and on 7 in July. Two or more consecutive nights with temperatures favourable for fruit-setting did not occur until July 7 and 8. These temperatures were not favourable for fruit-setting, especially during June, as proven by the early counts of fruits set on the check plants. Increases in early fruit-set due to the chemical treatments in 1950 were large as seen in Table XIII. The poor response in 1949 and the very favourable response in 1950 appear, therefore, to correspond directly with the normal and favourable fruit-setting temperatures of 1949 and the below normal temperatures of 1950, respectively.

The market quality of the fruit was not affected by either chemical in 1949 although plants treated with both chemicals produced some fruits with stem and blossom-end scars. Most of these developed from the first flowers. Such early flowers are often fasciated and tend to produce scarred, irregular fruits (26). In 1950 considerable rough fruit was produced on both check and treated plants. This abnormal amount of rough fruit was probably associated with the abnormally cool, wet growing conditions of early summer. The numbers of such rough fruits were significantly greater with the treated plants. As the earliest flowers are those most likely to be abnormal, and as the fruit-setting treatments caused a higher proportion of these to develop into fruits, the results obtained were quite logical. Some "puffy" fruits were produced from both treated and untreated plants. Similar "puffy" fruits were found in most tomato fields and may be attributed to the unusual growing conditions which prevailed in 1950. Fruit size was not affected by the treatments, except for the later pickings of NOA treated Bounty plants which were reduced in size.

Of the chemicals tested, only CIPA gave consistent increases in yield of early ripe fruit in both 1949 and 1950. This chemical may be satisfactorily applied with a common knapsack sprayer fitted with a fine nozzle tip. A concentration of 30 p.p.m. in water gave the most favourable results.

Plate 1

Bounty plant treated with CIPA.

Transplanted May 27, photographed July 21, 1950.

Plate 2

Bounty plant which received no treatment.

Transplanted May 27, photographed July 21, 1950.

Plate 3

Stage of development of fruit on Bounty plant treated with CIPA. Photographed on Aug.10, 1950.

Plate 4

Stage of development of fruit on untreated Bounty plant. Photographed on Aug.10, 1950.

Plate 5

Amount of ripe fruit picked on Aug.16 from one replicate of each of three treatments with the variety Stokesdale. Left to right the groups are from CIPA, A900 and check plots respectively.

Plate 6

Amount of ripe fruit picked on Aug.16 from one replicate of each of three treatments with the variety Bounty. Left to right the groups are from CIPA, A900 and check plots respectively.

Plate 7 Plate 8

Plate 7 A row of Bounty plants treated with A900 whole-plant spray. Transplanted May 27.

Plate 8 A row of Bounty plants treated with CIPA flower-cluster spray. Transplanted May 27.

Note reduction in height and vigor of plants in Plate 7 treated with A900.

Plate 9

A Bounty plant treated with A908 whole-plant spray at 100 p.p.m.
Note the severe plant distortion.

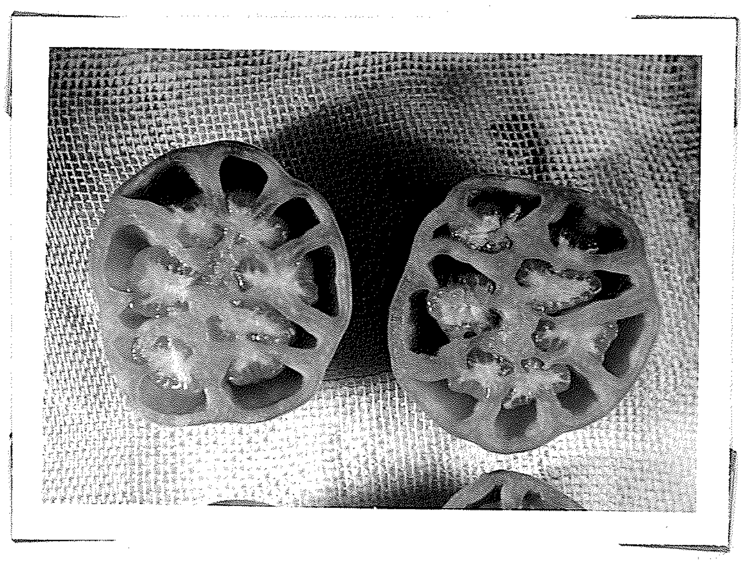


Plate 10

Cross-section of a large "puffy" fruit of Bounty. Many such fruits were picked from both treated and untreated plots.

SUMMARY

The effect of plant growth-regulating substances on tomato plants was studied with special reference to fruit-setting, fruit maturity and yield.

The chemicals tested in 1949 were Sure-Set (CIPA) with para-chlorophenoxyacetic acid as the active ingredient at 25 p.p.m. and beta-naphthoxyacetic acid (NOA) at 60 p.p.m. applied as flower-cluster sprays. The tests were made on four tomato varieties. The main chemicals tested in 1950 were CIPA applied as a flower-cluster spray at 30 p.p.m. and A900 containing a-o-chlorophenoxypropionic acid as a whole-plant spray at 50 p.p.m. Other chemicals tested in 1950 were NOA as a flower-cluster spray at 60 p.p.m., A908 containing a-2,4,5 trichlorophenoxypropionic acid at 50 and 100 p.p.m., N-l-naphthyl-phthalamic acid at 0.5 and 1.0 p.p.m. and maleic hydrazide at 1000 and 2000 p.p.m. The last three chemicals were applied as whole-plant sprays. The tests in 1950 were made on two tomato varieties.

Various methods of applying the chemicals were tested. The use of a common knapsack sprayer fitted with a fine nozzle tip was found the most practical method of applying these chemicals to field-grown tomatoes.

Early summer temperatures in 1949 were close to normal. In 1950 early summer temperatures were considerably

below normal accompanied by much wet, cloudy weather.

Of the chemicals tested only CIPA gave consistently good results in both 1949 and 1950. The results were more favourable in 1950 when a gain in maturity of 10 days to two weeks was obtained. NOA used as a flower-cluster spray gave small and generally insignificant increases in fruit maturity. All the whole-plant sprays tested in 1950 retarded plant development, reduced yields and were unfavourable at the concentrations used.

None of the chemicals affected fruit size in 1949 or 1950. A large percentage of the first fruits produced were seedless or partially so, the percentage being larger in 1950. In 1949 the marketability of the fruit was not affected by the treatments, although some fruits with stem and blossom-end scars were produced. In 1950 the percentage of rough fruit was accentuated considerably by the treatments.

The results indicate that CIPA may be of considerable value in supplementing normal fruit-setting in Manitoba. This is likely to be most pronounced when early summer weather is wet and cloudy with temperatures generally below normal.

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APPENDIX

TABLE 1

WEATHER DATA FOR 1949

	Min. Temperature	Max. Temperature	Precipitation	
June 6	38	62		
7	30	70		
8	50	72		
9	51	80		
10	61	97	Tr.	
11	50	96	.11	
12	55	74	Tr.	
13	35	72		
14	46	77	.07	
15	42	70	Tr.	
16	50	69	.69	
17	51	60	.05	
18	49	70	.03	
19	50	64	.12	2.71
20	52	70		
21	42	78	Tr.	
22	48	78		
23	44	82	Tr.	
24	52	85	.53	
25	54	72	.42	
26	53	82	.04	
27	62	78	Tr.	
28	43	78	.23	
29	55	86	.41	
30	66	75		
Average	49.6	76		
Normal	50.4	73.6		

Temperatures were slightly above normal for the month. Precipitation was only 87% of normal.

July 1	53	82	Tr.
2	61	95	
3	52	77	
4	62	78	.01
5	60	84	Tr.
6	62	66	.21
7	64	90	Tr.

WEATHER DATA 1949 (CONCLUDED)

	Min. Temperature	Max. Temperature	Precipitation	
July 8	62	85		
9	52	74	Tr.	
10	48	84		
11	52	86		
12	50	80		
13	50	84		
14	54	82		
15	54	88	.21	
16	58	94	Tr.	
17	62	86	Tr.	
18	52	70	.02	
19	45	66		
20	48	61	.57	
21	49	60	.07	
22	43	78	.25	2.29
23	58	89		
24	56	90	.05	
25	64	88	Tr.	
26	58	90	.60	
27	63	84		
28	50	62	.25	
29	48	73		
30	48	82	.02	
31	55	75	.03	
Average	54.6	80		
Normal	55.3	78.8		

Temperatures were again slightly above normal for the month. Precipitation was only 78% of normal.

TABLE 11

WEATHER DATA FOR 1950

	Min. Temperature	Max. Temperature	Precipitation	
June 1	37	65	.01	
2	37	49	.05	
3	32	67		
4	51	83		
5	48	60	Tr.	
6	45	80		
7	46	64	.08	
8	45	77	.03	
9	42	52	.16	
10	47	74		
11	44	76	.42	
12	62	84		
13	50	82		
14	56	90	Tr.	
15	47	68	.53	3.26
16	44	68		
17	44	71		
18	46	78	.01	
19	57	76		
20	39	62		
21	45	70	.04	
22	53	87	Tr.	
23	59	72		
24	50	74	Tr.	
25	50	57	1.53	
26	47	72		
27	51	77	.23	
28	44	68		
29	50	67	Tr.	
30	38	76	.17	
Average	46.9	71.5		
Normal	50.4	73.6		

Temperatures were below normal.
Rainfall was slightly above normal.

WEATHER DATA FOR 1950 (CONCLUDED)

		Min. Temperature	Max. Temperature	Precipitation	
July	1	52	70	Tr.	
	2	45	73	.04	
	3	53	73	.01	
	4	48	74	.01	
	5	52	78		
	6	54	88		
	7	61	85		
	8	62	75	.16	
	9	61	85		
	10	64	83		
	11	57	75	.08	
	12	46	57	Tr.	
	13	36	62	Tr.	
	14	43	68	.02	
	15	55	66	.74	2.05
	16	52	71		
	17	52	75		
	18	47	73		
	19	52	80		
	20	60	78	.03	
	21	56	71	.18	
	22	54	66	.31	
	23	52	77		
	24	53	78		
	25	55	79		
	26	55	80		
	27	55	87		
	28	62	90		
	29	61	93		
	30	63	80	.27	
	31	59	72	.02	
Average		54	76.2		
Normal		55.3	78.8		

Temperatures were again below normal for the month. Precipitation was 30% below normal.

TABLE 111

YIELD PER PLOT (IN LBS.) ON EACH PICKING DATE OF 1949.

	Aug.3	Aug.8	Aug.11	Aug.15	Aug.18	Aug.23	Aug.29	Sept.6 Ripe	Sept.6 Green	Total Ripe	Total Yield
EARLY CHATHAM											
CIPA TREATED	.76	1.06	4.77	11.94	7.24	12.37	13.25	9.62	19.87	61.02	80.89
NOA TREATED	.20	.70	5.17	11.39	6.20	10.81	13.11	7.25	17.37	54.84	72.21
CHECK	.10	.34	4.05	10.38	7.48	15.67	18.14	11.19	19.62	67.35	86.98
BOUNTY											
CIPA TREATED	.50	1.17	3.16	14.63	12.85	14.25	10.81	7.90	18.25	65.26	83.51
NOA TREATED	--	.79	1.88	12.15	10.75	14.29	14.18	8.62	19.00	62.68	81.68
CHECK	.06	.21	1.18	9.44	11.44	15.90	16.72	11.62	21.62	66.58	88.20
MARGLOBE											
CIPA TREATED	.02	.05	1.74	8.02	4.37	5.17	7.15	5.81	12.69	32.34	45.03
NOA TREATED	--	.07	.22	3.82	2.95	5.08	7.01	5.31	13.69	24.46	38.15
CHECK	--	--	.07	3.04	3.37	4.55	5.82	5.94	14.12	22.81	36.93
STOKESDALE											
CIPA TREATED	.08	.76	2.08	7.09	5.36	4.96	6.73	3.50	11.62	30.55	42.18
NOA TREATED	--	.30	.97	5.75	3.84	5.26	7.54	4.81	13.12	28.47	41.59
CHECK	.18	--	.18	6.01	4.00	7.81	5.95	5.00	16.06	29.14	45.20

TABLE IV

YIELD PER PLOT (IN LBS.) ON EACH PICKING DATE OF 1950

	Aug.3	Aug.10	Aug.16	Aug.21	Aug.25	Aug.30	Sept.5	Sept.10	Sept.15 Ripe	Sept.15 Green	Total Ripe	Total Yield
BOUNTY												
Planted May 27												
CIPA Treated	.52	3.82	9.67	11.62	4.42	6.99	20.14	22.67	13.55	39.06	93.53	132.09
A900 Treated	.81	1.21	.59	2.06	1.16	3.84	7.29	3.88	4.25	30.87	26.56	59.02
Check	--	----	.46	.83	1.43	3.99	16.84	12.41	15.54	81.94	53.01	136.70
Planted June 5												
CIPA Treated	--	1.00	4.75	5.45	2.13	5.08	14.95	15.46	10.09	53.25	58.91	112.16
A900 Treated	--	.34	.63	1.72	2.05	5.31	12.74	6.94	6.52	42.50	36.25	68.75
Check	--	----	.19	.79	1.01	4.50	13.76	14.44	9.42	82.94	43.94	126.88
Planted June 13												
CIPA Treated	--	.08	1.38	2.70	1.82	3.04	7.00	13.52	7.56	77.50	42.84	117.13
A900 Treated	--	--	.13	.69	1.60	3.16	7.41	7.41	5.68	43.22	26.92	72.79
Check	--	--	----	.94	.93	2.21	11.97	12.25	9.12	75.75	37.43	113.18
STOKESDALE												
Planted May 27												
CIPA Treated	.50	2.71	3.99	4.37	4.42	4.16	8.41	14.81	9.51	35.94	52.03	87.97
A900 Treated	.43	1.53	1.08	1.15	.59	2.60	7.42	8.90	13.20	31.00	38.29	69.29
Check	--	----	.92	2.00	1.17	3.00	11.27	18.75	14.64	44.12	52.86	96.98
Planted June 5												
CIPA Treated	--	.43	2.47	2.00	1.79	2.49	8.40	10.12	8.04	36.31	35.86	72.17
A900 Treated	.06	.28	.20	1.28	.84	2.61	8.90	10.81	7.82	40.25	32.89	73.14
Check	--	----	.28	1.07	1.13	2.23	8.62	10.51	10.85	50.10	34.46	82.06
Planted June 13												
CIPA Treated	.18	.19	.96	1.24	1.02	2.23	9.31	10.99	7.26	44.15	33.39	68.14
A900	--	.19	----	1.17	.34	3.14	5.86	9.59	7.53	36.91	27.83	64.74
Check	--	----	.10	.58	.95	2.77	7.82	8.97	8.86	42.92	29.16	71.21