

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

Historical Research Bulletins of the Nebraska
Agricultural Experiment Station (1913-1993)

Agricultural Research Division of IANR

2-1968

Differential Plant Injury and Yield Responses of Tomato Varieties to 2,4-D

D. P. Coyne

O. C. Burnside

Follow this and additional works at: <http://digitalcommons.unl.edu/ardhistrb>



Part of the [Agriculture Commons](#), and the [Horticulture Commons](#)

Coyne, D. P. and Burnside, O. C., "Differential Plant Injury and Yield Responses of Tomato Varieties to 2,4-D" (1968). *Historical Research Bulletins of the Nebraska Agricultural Experiment Station (1913-1993)*. 92.

<http://digitalcommons.unl.edu/ardhistrb/92>

This Article is brought to you for free and open access by the Agricultural Research Division of IANR at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Historical Research Bulletins of the Nebraska Agricultural Experiment Station (1913-1993) by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Research Bulletin

226

February 1968

Differential Plant Injury
and Yield Responses
of Tomato Varieties
to 2,4-D

RECEIVED
JUN 5 1968

COLLEGE OF AGRICULTURE
LIBRARY

by

D. P. Coyne

O. C. Burnside

University of Nebraska College of Agriculture
and Home Economics

The Agricultural Experiment Station

E. F. Frolik, Dean; H. W. Ottoson, Director

CONTENTS

Summary	1
Introduction	2
Materials and Methods	3
Experimental Design	3
Spray Applications	5
General Culture	6
Injury Ratings and Plant Measurements	7
Harvesting Procedure	7
Statistical Analysis	8
Results and Discussion	8
1966 Observation Experiment	8
1966 Replicated Experiment	9
1967 Experiments	10

Issued February 1968, 3,000

ACKNOWLEDGMENTS

The authors wish to thank Dr. Willis H. Skrdla, Coordinator Regional Project NC-7, USDA, ARS, Crops Research Division, North Central Regional Plant Introduction Station, Ames, Iowa 50010, for providing the tomato PI lines used in this investigation.

Appreciation is expressed for seed of a large number of tomato varieties provided by Asgrow Seed Co. and Joseph Harris Co.

The authors are also grateful to Mr. Robert Fast and Mr. Kenneth Hill, Department of Horticulture and Forestry, University of Nebraska, for their assistance in these experiments.

We are also appreciative for the advice of Dr. K. E. Alban, Department of Horticulture and Forestry, Ohio State University, Columbus, Ohio, for advice on response of tomatoes to 2,4-D.

The observations of Mr. Wayne Whitney, Extension Horticulturist, Department of Horticulture and Forestry, University of Nebraska, Lincoln, Nebraska, on the response of tomato varieties to 2,4-D drift in home gardens in Nebraska are also appreciated.

SUMMARY

Experiments were conducted in 1966 and 1967 to determine the effect of 2,4-D sprays on degree of plant injury and yield of a wide range of home garden, processing tomato varieties, and plant introductions (PI).

The 2,4-D diethylamine formulation was used in all experiments and applied in 14.4 and 20.1 gallons of water per acre in 1966 and 1967, respectively.

In 1966, 448 tomato PI lines and 60 commercial varieties and/or breeding lines were planted in an observation trial and sprayed with 2,4-D at nine ounces/acre at time of first bloom.

Three hundred and ninety-four varieties were killed completely.

Five PI lines showed excellent recovery, and these were evaluated again in a replicated trial in 1967.

Three of these PI lines, 129,131 (Panama), 190,858 (Argentina), and 203,229 (Australia) again showed excellent ability to recover from repeated application of high rates of 2,4-D sprays. It may be desirable to select for tolerance to 2,4-D injury in a breeding program if any of these PI lines are used as sources of other particular traits.

In 1966, fifty commercial tomato varieties were planted in a replicated experiment and sprayed with one ounce of 2,4-D per acre. The first flower cluster was in bloom in the majority of the varieties at the time of spraying. The varieties showed a marked differential plant injury response to the 2,4-D spray. Some, like Morton Hybrid, showed only slight leaf curling while others like Starfire showed severe stem distortion and severe leaf curling.

In general, the majority of the varieties tended to show a reduction in yield. Varieties Roma, Heinz 1439, Heinz 1350, Moreton Hybrid, Glamour and Galaxy, which had the highest resistance to 2,4-D spray injury in 1966, were again evaluated in 1967.

In 1967, one ounce and $\frac{1}{5}$ ounce 2,4-D per acre was applied at the time of first bloom. Four additional applications of $\frac{1}{5}$ ounce 2,4-D per acre were made at about weekly intervals on the plots which received the first $\frac{1}{5}$ ounce/acre application.

There was a trend for reduction in yield of all varieties under both spray treatments but the largest yield reduction occurred under the repeated spray treatment.

The variety Roma had a slight yield reduction under the single one ounce 2,4-D per acre spray treatment, and this variety is regarded as having the best tolerance of the commercial varieties tested.

Probably 2,4-D drift on this variety under ordinary conditions would cause only slight plant injury and yield reduction. Roma is an excellent processing tomato variety and is suggested for planting in Nebraska where 2,4-D drift is a frequent problem.

Differential Plant Injury and Yield Responses of Tomato Varieties to 2,4-D

Dermot P. Coyne and Orvin C. Burnside¹

INTRODUCTION

The common herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) is widely used to control weeds in lawns, roadsides, pastures and many important agronomic crops.

Drift and/or volatilization from these 2,4-D applications often cause damage to sensitive crops such as tomatoes grown in commercial fields or in home-vegetable gardens. In some cases injury may be severe, resulting in curling of leaves, stem distortion, stunting of plant growth, failure of fruit set, and/or development of malformed fruit.

In town gardens where 2,4-D is commonly used on lawns, many tomato plants show 2,4-D symptoms. If the injury is slight, plants generally recover and apparently produce a satisfactory tomato crop.

However, Robbins and Taylor² reported that tomatoes treated with 5 to 75 ppm 2,4-D showed reduced yield, delayed maturity, changed fruit size, and acidity in amounts that affected quality. Fruit color was not materially influenced.

They observed greatest reduction in yield when a high rate of 2,4-D was applied at the time of full bloom. Tomato yield loss was much less when a high rate of 2,4-D was applied when a good portion of the fruit was already set.

Improved Garden State was the only variety used in these tests. Differences in degree of varietal resistance to 2,4-D have been observed by Alban³ and Whitney.⁴ Some varieties made a satisfactory recovery from mild injury due to drift, while other varieties failed to produce a satisfactory crop.

Alban³ indicated that "based on his research and observation, early sparse foliage varieties tend to show greater economic damage as contrasted with later maturing varieties with heavier foliage." He

¹ Associate Professor, Department of Horticulture and Forestry, and Professor, Department of Agronomy, University of Nebraska, Lincoln, Nebraska.

² Robbins, Wayne A. and Taylor, William S. 1957. Injury to canning tomatoes caused by 2,4-D. Proc. Amer. Soc. Hort. Sci. 70:373-378.

³ Personal communication in 1966 from K. E. Alban, Department of Horticulture and Forestry, Ohio State University, Columbus, Ohio.

⁴ Personal communication in 1966 from W. C. Whitney, Department of Horticulture and Forestry, University of Nebraska, Lincoln, Nebraska.

also mentioned that the responses of tomato plants to 2,4-D sprays are related to two factors: namely, the physiological age and physiological conditions of the plants, and the time of exposure to the various concentrations and formulations of 2,4-D.

Experiments reported in this bulletin were conducted to determine the extent of plant injury and yield loss due to high and low rates of 2,4-D sprays on a wide range of home garden and processing tomato varieties. Results of this study could be used as a basis for suggesting tomato varieties suitable for growing in areas where 2,4-D drift is a common problem.

An experiment was also conducted to determine if there was resistance to or good recovery from 2,4-D injury in other tomato species and in a wide collection of tomato plant introductions (PI).

MATERIALS AND METHODS

Experimental Design

A study was initiated at Lincoln, Nebraska to test 448 tomato PI lines and 60 tomato variety and/or breeding lines for degree of tolerance to injury from a spray application of 2,4-D at the rate of nine ounces per acre. The complete list of the PI lines is published elsewhere.⁵ The majority of the PI lines were *Lycopersicon esculentum* mill.

An eight-foot-long observation row of each entry was direct seeded at Lincoln, Nebraska, on May 5, 1966. The seed was planted in Sharpsburg silty clay loam soil about one inch deep in rows 4 feet 6 inches apart. The entries were planted in tiers and there were three-foot alleyways between tiers. A 158-foot-long control row of the variety Ace was planted 13.5 feet to the west of the treated area.

In a second experiment conducted in 1966 at Lincoln, a duplicated split-plot experimental design was used with 0 and one ounce 2,4-D/acre rates as main plots and 50 commercial varieties as sub-plots. The varietal names and sources of seed are listed in Table 1.

Each variety was planted in single row plots six feet long and four to five feet apart. Five tiers of rows separated by three-foot alleyways were included in each block. Ten rows of each variety, along with two guard rows, were planted in each tier. The varieties were direct seeded about one inch deep in a well-prepared, moist seedbed on May 6, 1966.

In 1967, two replicated experiments were conducted at Lincoln. In one test, three processing and three home garden varieties which showed a high degree of tolerance to 2,4-D in 1966 were again evalu-

⁵ Coyne, Dermot P., Orvin C. Burnside, and Whitney, Wayne C. 1966. Evaluation of *Lycopersicon* species, plant introductions and varieties for resistance to 2,4-D injury. Prog. Rpt. 54, Dept. of Hort. and Forestry, Univ. of Nebr., Lincoln, Nebr.

Table 1. Effect of 2,4-D amine at one ounce per acre on degree of plant injury and weight of total fruit of 50 tomato varieties in 1966 at Lincoln, Nebraska.

Variety and source	Injury rating ^a 7/11/66	Total wt. of fruit in tons/acre	
		Check	2,4-D
Beefsteak (Asgrow)	4	53.9	42.9
Garden State (Asgrow)	4	62.2	38.8
VF 145-21-4 (Asgrow)	4	61.1	25.9X ^b
Supermarket (Asgrow)	3	33.5	39.2
Pink Ponderosa (Asgrow)	4	34.3	30.4
Oxheart (Asgrow)	3	75.1	51.8
Urbana (Asgrow)	3	47.8	46.6
VF 14 (Asgrow)	3	51.0	38.5
VF Moscow (Asgrow)	2	57.9	37.9
Cardinal Hybrid (Harris)	3	44.9	45.0
Earlypak 7 (Asgrow)	2	74.2	49.2
ES 24 (Asgrow)	3	62.0	43.7
Marion (Asgrow)	2	37.7	40.2
Earliana (Asgrow)	3	50.4	67.1
Marglobe (Asgrow)	3	39.9	35.3
Red Top (Asgrow)	3	57.7	37.7
CPC-2 (Asgrow)	2	55.6	37.4
Grandpak (Asgrow)	3	71.3	40.6X
Earlypak (Asgrow)	3	51.1	29.5
Ace 55VF (Asgrow)	2	36.9	34.9
Heinz 1370 (Asgrow)	3	47.3	29.9
Heinz 1409 (Asgrow)	3	52.3	27.7
Heinz 1350 (Asgrow)	2	41.6	30.7
Fireball (Asgrow)	3	21.1	29.9
Sioux (Asgrow)	3	58.6	30.7
Roma (Asgrow)	2	67.7	54.9
Campbell No. 146 ((Asgrow)	3	44.6	42.5
Glamour (Asgrow)	3	40.7	51.9
Pearson Improved (Asgrow)	3	57.1	30.1
Valiant (Asgrow)	3	50.9	27.5
Tecumseh (Asgrow)	2	48.1	61.3
Rutgers (Asgrow)	1	42.2	37.8
Early Bird (Stokes)	3	29.0	28.6
Cavalier (Stokes)	3	39.4	22.9
Scotia (Stokes)	3	34.3	34.7
Viscount (Stokes)	3	54.4	39.0
Red Cloud (Stokes)	3	29.8	36.4
Galaxy (Harris)	3	29.0	23.8
Starfire (Stokes)	3	44.0	11.0X
Marion (Northrup King)	3	37.7	24.7
Campbell 1327 (Harris)	3	49.9	41.2
Heinz 1439 (Harris)	2	54.8	50.3
September Dawn (Harris)	3	52.3	31.2
Moreton Hybrid (Harris)	2	63.0	61.1
Trellis 22 (Harris)	3	42.9	46.7
Tom-Tom (Harris)	3	67.1	72.7
Gardener (Harris)	3	59.0	34.2
Wonder Boy (Harris)	3	54.1	49.3
Superman (Harris)	2	27.1	42.2
Indian River (Asgrow)	3	40.4	39.0

^a A rating of 1 to 5 was used to describe the degree of plant injury; 1 indicates no symptoms and 5 indicates death of plant. For description of ratings see section on material and methods.

^b Duncan's Multiple Range test was used to test significance of mean differences between check and 2,4-D treatments within each variety (P. 0.05); X indicates significance at the P. 0.05 level. The remainder of the comparisons are non-significant.

ated. A susceptible variety of VF145-21-4 was also included. A split-plot experimental design consisting of three replicates, three treatments and seven varieties was used.

The three treatments were as follows: control, 2,4-D at one ounce/acre applied at time of first bloom, and five applications of 2,4-D at 1/5 ounce/acre applied at weekly intervals, the first application taking place at the time of first bloom. Single-row plots, ten feet long, spaced six feet apart, were planted for each variety. There were nine rows in each tier and six-foot alleyways between tiers. The variety Heinz 1548 was planted in the guard rows.

In the second experiment conducted in 1967, 18 tomato varieties and/or PI lines were evaluated for degree of resistance to 2,4-D injury. Six of these entries were PI lines which showed the highest degree of resistance to 2,4-D injury in the 1966 observation tests. The other varieties in the test were well-known home garden or processing tomato varieties.

A split-plot experimental design consisting of two replicates, two treatments and 18 varieties was used. The two treatments were control and two applications of 2,4-D spray (2 and 3 ounces/acre).

Each replicate consisted of two tiers, each containing nine varieties. Single-row plots were ten feet long and spaced six feet apart. The variety Fireball was planted in the guard rows. The varieties were direct seeded on April 28, 1967.

Spray Applications

The 2,4-D diethylamine salt formulation was used in all experiments and applied in 14.4 and 20.1 gallons of water per acre in 1966 and 1967, respectively. In 1966, the spray was applied by means of a hand carried Hudson Simplex sprayer at 20 p.s.i. pressure.

In the 1966 replicated experiment, 2,4-D amine at the rate of one ounce per acre was sprayed on the plants just before sundown when the air was calm on July 1 (temperature about 70°F). At this time, the first flower cluster was open in 28 varieties, the flower cluster was in the bud stage in 20 varieties, and small green fruit were observed on the first cluster of Early Bird and Red Cloud.

High daytime temperatures prevailed for two weeks following spraying, the highest daytime temperatures ranging from 90 to 105°F. The high day temperature was above 100°F for six days. Minimum night temperatures ranged from a low of 64°F to a high of 84°F in this period.

In the 1966 observation experiment, 2,4-D amine at the rate of nine ounces per acre was applied when the first flower cluster was open in most of the entries on June 25. The temperature was about 80°F at time of spraying. In the week following spraying, the high

day temperatures ranged from 83 to 93°F. Minimum night temperatures ranged from 63 to 72°F in that period.

In 1967, a small plot sprayer having a shielded spray boom was used to apply 2,4-D sprays to the plots. In the first experiment, 2,4-D at 1/5 ounce and one ounce/acre was applied on July 18. The first cluster was set on most varieties at this date. The plants were about 12 inches tall.

In the two weeks following spraying, the high day temperatures ranged from 83 to 99°F. The temperature was over 90°F for seven days. The minimum night temperatures ranged from 63 to 78°F in that period. Subsequent sprays of 1/5 ounce actual 2,4-D were applied to the plots which received the first 1/5 ounce application on July 24, July 31, Aug. 7 and Aug. 11.

The approximate range of plant height in the entire experiment on the successive spray dates was as follows: 12"-18", 12"-24", 14"-26" and 18"-30", respectively.

In the second experiment conducted in 1967, the first spray of 2,4-D at two ounces/acre was applied on July 24. The second spray of three ounces/acre was applied on Aug. 11.

The green fruit of the first cluster had reached about the size of an egg on the majority of the commercial varieties at the time of first spraying on July 24. Plant height at this time ranged from 18-24 inches.

General Culture

All experiments were direct seeded using a cone seeder. The seed was placed one inch deep in a moist, firm seedbed. Plants were thinned to one plant per foot using a hand hoe.

A good plant stand was obtained in all experiments except the second replicated trial in 1967, where the stand of some varieties was low and variable. A broadcast application of nitrogen at the rate of 30 pounds/acre was applied to all experimental areas before planting.

In 1967, plots also received an additional application of nitrogen at 30 pounds/acre applied as a band along the rows on July 25. The plots were not irrigated in 1966 but rainfall was sufficient to ensure vigorous growth during the season.

The experiment which received the lowest rates of 2,4-D in 1967 was irrigated once using a sprinkler system about the time the second fruit cluster was setting on most tomato varieties. Growth of the plants was retarded in this experiment due to lower soil fertility and greater soil compaction as the area was cut and leveled to form a bench during the previous fall.

Plant growth was vigorous during the entire season in the second tomato experiment which received the highest rates of 2,4-D. Good

control of weeds in both experiments was obtained by surface cultivation and hand weeding as needed. The plants were sprayed at about weekly intervals with a maneb-diazinon spray combination and good control of insects and diseases was obtained in both years.

Injury Ratings and Plant Measurements

In 1966 the plants were rated on a row basis for degree of plant injury on a scale of 1 to 5 as follows: 1 indicated no symptoms; 2 indicated slight leaf curling and/or some stem distortion; 3 indicated moderate leaf curling, moderate stem distortion and stunted growth; 4 indicated severe leaf curling, severe stem distortion and severely-stunted growth; and 5 indicated a dead plant.

In 1967, a modified rating scale was adopted. A rating of 2 indicated slight leaf curling but no stem distortion. Ratings of 3 and 4 apply to progressively severe stem distortion and 5 means death of the plant.

In the 1966 observation trial, plants were rated for degree of plant injury on July 1, seven days after spraying. Notes on degree of plant recovery from injury were recorded on Aug. 8. In the 1966 replicated experiment, injury ratings were recorded on July 11, eleven days after spraying. In 1967, ratings for plant injury on a row basis were recorded on July 24 and Aug. 9 in the first experiment and on Aug. 9 in the second experiment.

In 1967, tomato plant height and width were measured on a row basis to the nearest inch. The data were recorded in both experiments on Aug. 9.

Harvesting Procedure

A "one shot harvest" as is commonly used in machine harvesting of tomatoes was practiced in all experiments. In 1966, a few varieties were harvested before Oct. 3-4 at about the stage when the number of fruit turning a red color equaled the number of fruit starting to rot.

It was necessary to harvest the remainder of the varieties on Oct. 3-4 because a frost was expected. A killing frost occurred on the night of Oct. 4. Some varieties still had all green or only a small number of red fruit on Oct. 3-4.

Similarly, in 1967 only a small number of varieties were harvested at an optimum stage of maturity. It was necessary to harvest the majority of the plots in the first experiment on Sept. 16 because of the threat of cold weather.

Some varieties had only a small amount of ripe fruit at this date. However, data on total weight of fruit are still useful in making varietal comparisons between treated and control plots. Many varieties in the second experiment, particularly in the treated plots, were har-

vested before the Sept. 16-18 period. Fruit was harvested from all plants in the row except the first and last plant. The number of harvested plants in each row was recorded.

Statistical Analysis

An analysis of covariance was conducted to adjust row mean yields on the basis of plant stand. Duncan's Multiple Range test was used to test for significant differences between means of control and 2,4-D treatments within each variety at the P. 0.05 level.

RESULTS AND DISCUSSION

1966 Observation Experiment

On July 7, seven days after 2,4-D spraying, three entries showed slight injury and 104 entries showed moderate injury while the remainder of the entries had either severe or very severe injury ratings.

Some entries had plants varying in injury ratings as follows: six entries had plants with ratings of 2 and 3, and nineteen entries with ratings of 3 and 4. Most of the entries which had severe or very severe injury on July 1 died by Aug. 8 (Figure 1).

All plants in 394 entries were dead on Aug. 8, 1966. However, severely-injured entries such as PI 203,229 (Australia) and PI 129,131 (Panama) made a good recovery. They were as vigorous and as productive as the non-treated variety Ace, although their maturity was comparatively delayed.

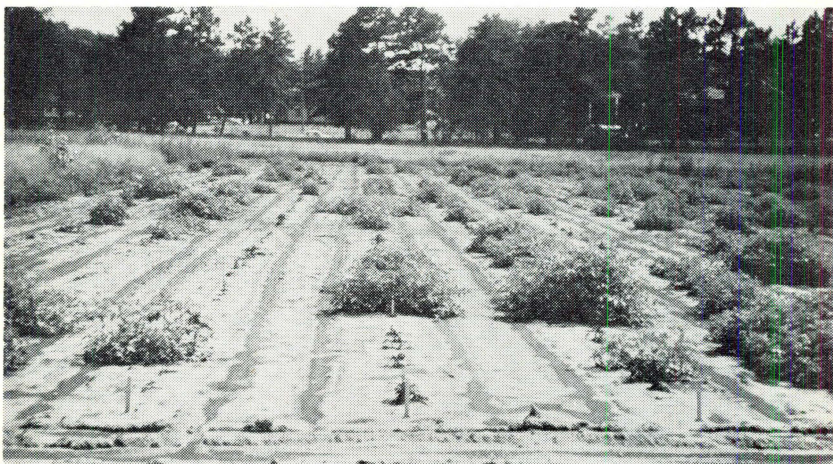


Figure 1. Photograph of observation trial of tomato plant introductions (PI) sprayed with 2,4-D amine at nine ounces per acre. Numerous lines were killed, while some showed good recovery. Photograph taken 45 days after spraying.

Recovery, as used here, means the ability of the injured plant to produce new, apparently normal and vigorous shoots capable of yielding a good load of fruit.

However, most of the entries which showed a good plant growth recovery had only moderate early plant injury. The PI lines which showed the best resistance to 2,4-D injury were: PI 118,778 (Brazil), PI 190,858 (Argentina), PI 124,036 (Argentina), and PI 272,636 (Costa Rica). These four lines along with lines PI 203,229 (Australia) and lines PI 129,131 (Panama) were tested again the following year.

1966 Replicated Experiment

Ratings for degree of plant injury were made eleven days after spraying with 2,4-D at one ounce/acre. There was no difference between replicates for each variety in degree of plant injury. The injury ratings for each variety are shown in Table 1. No variety was completely free of injury symptoms.

The following varieties showed slight leaf curling and some stem distortion: Moreton Hybrid, Tom-Tom, VR Moscow, Earlypak 7, Marion, CPC-2, Ace 55 VF, Heinz 1350, Roma, Tecumseh, Rutgers, Heinz 1439 and Superman.

An example of slight injury is shown in Figure 2, in which sprayed and unsprayed plants of Moreton Hybrid (Harris) are compared. Thirty-three varieties showed moderate leaf curling, moderate stem distortion and moderately stunted growth.

Varieties Beefsteak, Garden State, Starfire, VF 145-21-4 and Pink Ponderosa were severely affected by the spray. Severe leaf curling, stem distortion and stunted growth were observed.

Figures 3 and 4 illustrate severe injury in sprayed plants of VF 145-21-4 and Pink Ponderosa.

The adjusted means of total weight of fruit in tons/acre for sprayed and non-treated plants of each of the 50 varieties are presented in Table 1. It was possible to harvest only a small number of varieties at the stage when the number of fruit beginning to turn red about equaled the number of fruit starting to rot.

Early-maturing varieties Supermarket, Fireball, Scotia, Starfire and Moreton Hybrid were harvested at about this stage of maturity. However, it was necessary to harvest all the other varieties on Oct. 3 and 4 because of a threat of a frost.

The following varieties produced abundant green fruit at that date: Pink Ponderosa, Cardinal Hybrid, Ace 55 VF, Pearson Improved, Rutgers, Wonder Boy and Indian River. However, total yield data are useful to make comparisons between control and 2,4-D treated plants within each variety (Table 1). Total yield of control plants of Grandpak, VF 145-21-4 and Starfire was significantly greater than that of the corresponding 2,4-D treated plants.

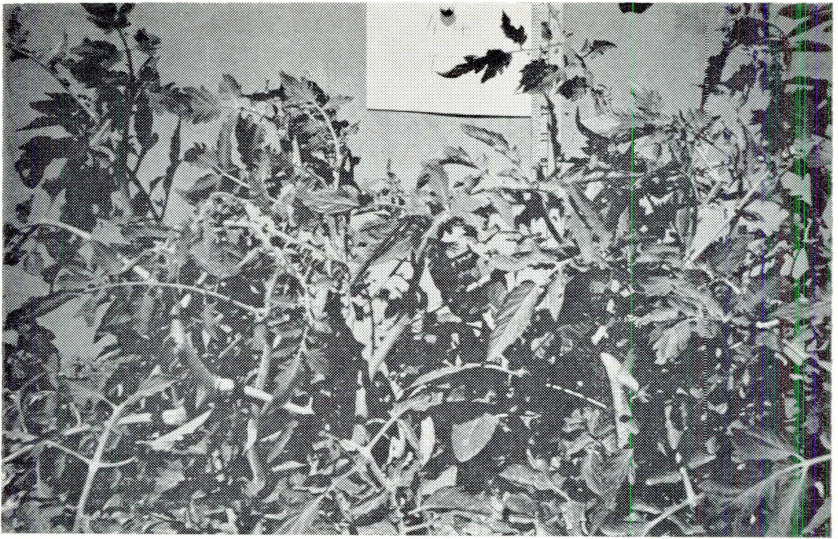


Figure 2. Top row: Plants of Moreton Hybrid showing slight symptoms due to 2,4-D amine spray at one ounce per acre. Bottom row: Control plants of Moreton Hybrid. Photographs taken seven days after spraying.

1967 Experiments

Results of experiment one, in which was studied the effect of 2,4-D spray at one ounce/acre (T_1) and $\frac{1}{5}$ ounce/acre repeated at five intervals (T_2) on time of tomato harvest and yield of fruit in seven tomato varieties, are presented in Table 2.

All of the control varieties and four varieties in each of the T_1 and T_2 treatments were harvested on Sept. 16. None of the varieties in these treatments were at an optimum stage of maturity for machine harvesting at that date. Four varieties in each of the T_1 and T_2 2,4-D treated plots were harvested prior to Sept. 16. A differential varietal yield response to the 2,4-D spray applications was observed (Table 2).

No statistically significant difference was observed between treatment means of total fruit weight within the varieties Heinz 1439 and Galaxy (Table 2). The total weight of fruit in the control plots was significantly higher than that in the T_2 treated plots for the varieties VF 145-21-4, Roma, Heinz 1350, Moreton Hybrid and Glamour.

In general, there was a trend for all the 2,4-D treatments to produce a reduction in yield; the greater yield reduction occurring in plots which received the repeated low rate of 2,4-D. The varieties



Figure 3. Top row: Plants of VF 145-21-4 showing severe symptoms due to 2,4-D amine spray at one ounce per acre. Bottom row: Control plants of VF 145-21-4. Leaves of this variety have a characteristic curling or cupping not due to 2,4-D. Photographs taken seven days after spraying.



Figure 4. Top row: Plants of Pink Ponderosa showing severe symptoms due to 2,4-D amine spray at one ounce per acre. The foliage shows a fern-like effect, while plants of VF 145-21-4 assumed a squat rolled effect (Fig. 3). Bottom row: Control plants of Pink Ponderosa. Photographs taken seven days after spraying.

Roma and Galaxy tended to show the least reduction in yield due to the single application of 2,4-D at one ounce/acre.

The effect of 2,4-D spray at one ounce/acre (T_1) and $1/3$ ounce/acre repeated at five intervals (T_2) on ratings for degree of plant injury at two dates and height and width of plants at one date is presented in Table 3.

On the first date of observation, July 24, VF 145-21-4, Glamour and Heinz 1350 showed severe plant injury and all other varieties showed moderate plant injury due to the T_1 treatment.

At the same date under the T_2 treatment, VF 145-21-4 showed moderate injury and all the other varieties showed slight plant injury.

Table 2. Effect of 2,4-D amine at one ounce per acre (T₁) and 1/5 ounce per acre repeated at five intervals (T₂) on time of harvest and mean weight of total fruit of seven tomato varieties in 1967 at Lincoln, Nebraska.

Variety and source	Total wt. of fruit in tons/acre			Mean diff. sign ^a	Date of harvest		
	Check	T ₁	T ₂		Check	T ₁	T ₂
VF 145-21-4 (Asgrow)	7.9	2.9	3.0	Check > T ₁ and T ₂	9/16	9/5	9/16
Roma (Asgrow)	11.9	11.1	5.8	Check > T ₂	9/16	9/16	9/16
Heinz 1439 (Asgrow)	7.7	3.9	1.9	NS	9/16	9/16	9/16
Heinz 1350 (Asgrow)	11.8	6.9	4.2	Check > T ₂	9/16	9/16	9/16
Moreton Hybrid (Harris)	11.9	6.8	1.8	Check and T ₁ > T ₂	9/16	9/5	8/24
Glamour (Asgrow)	12.2	7.2	1.7	Check and T ₁ > T ₂	9/16	9/16	9/5
Galaxy (Harris)	5.9	5.2	3.0	NS	9/16	9/5	8/24

^a Duncan's Multiple Range test was used to test significance of mean differences between check and 2,4-D treatments within each variety (P. 0.05); NS indicates no significant differences between means.

Table 3. Comparison of control (c) with effect of 2,4-D amine at the rates of one ounce per acre (T₁) and 1/5 ounce per acre repeated at five intervals (T₂) on degree of plant injury (at two dates) and height and width of plants of seven tomato varieties. 1967.

Variety and source	Injury ratings ^a				Plant height ins.			Mean diff. sign	Plant width ins.			Mean diff. sign
	7/24/67		8/9/67		(8/9/67)				(8/9/67)			
	T ₁	T ₂	T ₁	T ₂	C	T ₁	T ₂		C	T ₁	T ₂	
VF 145-21-4 (Asgrow)	4.0	3.0 X ^b	4.3	3.7 NS	14.0	12.0	12.5	NS	15.7	13.2	13.0	NS
Roma (Asgrow)	3.4	2.1 X	2.9	2.3 X	15.5	16.0	17.8	NS	17.0	15.2	20.0	NS
Heinz 1439 (Asgrow)	3.4	2.3 X	4.0	3.1 X	16.0	12.5	13.7	C > T ₁	16.8	12.3	13.7	NS
Heinz 1350 (Asgrow)	3.5	2.1 X	4.0	2.9 X	17.8	12.5	15.5	C & T ₂ > T ₁	20.3	10.7	17.5	C & T ₂ > T ₁
Moreton Hybrid (Harris)	3.3	2.5 X	3.8	3.0 X	17.5	14.0	17.2	C & T ₂ > T ₁	21.0	13.2	18.5	C & T ₂ > T ₁
Glamour (Asgrow)	3.9	2.5 X	3.5	2.9 X	17.2	13.7	17.8	C & T ₂ > T ₁	18.3	14.0	19.7	T ₂ > T ₁
Galaxy (Harris)	3.1	2.3 X	4.0	3.3 X	12.3	11.0	12.5	NS	15.0	12.3	14.5	NS

^a A rating scale of 1 to 5 was used to describe degree of plant injury. One indicates no symptoms and 5 indicates death of plant. All control plots had a rating of 1. For a complete description of ratings see section in material and methods.

^b Duncan's Multiple Range test was used to test significance of mean differences between control and 2,4-D treatments within each variety (P. 0.05). NS indicates no significant difference between means and X indicates significance at the 0.05 probability level.

On the second date of observation, Aug. 9, under the T_1 treatment, only Roma showed moderate injury, while all the other varieties showed severe injury.

At the same date under the T_2 treatment, Roma only showed slight injury, while Heinz 1439, Heinz 1350, Moreton Hybrid, Glamour and Galaxy showed moderate injury and VF 145-21-4 showed severe injury.

On the second date, the degree of plant injury was higher than on the first date in the case of the varieties VF 145-21-4, Heinz 1439, Heinz 1350, Moreton Hybrid and Galaxy under both T_1 and T_2 treatments.

However, under T_1 treatment both Roma and Glamour showed a considerable improvement from plant injury by Aug. 9. There was also no significant difference between plant height and width of Roma between all treatments (Table 3).

The high resistance of the variety Roma to injury from 2,4-D sprays, and the severe plant injury of the susceptible varieties Glamour and VF 145-21-4 are shown in Figure 5. This figure also shows the abnormal fruit shape of VF 145-21-4 due to the 2,4-D spray.

Probably 2,4-D drift on the variety Roma under ordinary conditions would cause only slight plant injury and yield reduction. Roma is an excellent processing tomato variety and is suggested for planting where 2,4-D drift is a frequent problem.

Figure 6 shows a transverse view of rows containing varieties which were unsprayed and which received the two different 2,4-D spray treatments. The row of the variety Roma can be picked out in the treated plots because of its vigorous growth and tolerance to 2,4-D injury.

Notes were recorded on the effect of the 2,4-D sprays on fruit shape and seediness of the different varieties, and are shown in Table 4. Notes on the fruit of the control plants are presented in this table only if they differ from the treated plants. The shape and seediness of the fruit of Heinz 1439 and Moreton Hybrid were not affected by the 2,4-D treatments.

The fruit of VF 145-21-4 became pointed at the blossom ends under both T_1 and T_2 treatments. The following varieties had low fruit seediness: Roma and Glamour under treatment T_2 and Heinz 1350 and Galaxy under both treatments T_1 and T_2 .

Results of experiment two (1967), in which was studied the effect of 2,4-D amine on dates of harvest and yield of fruit of twelve tomato varieties, are presented in Table 5.

For nine of the 12 varieties, treated plots were harvested at much earlier dates than the control plots. Ten of the varieties in the control plots were harvested on Sept. 18 because of the possible advent of cold

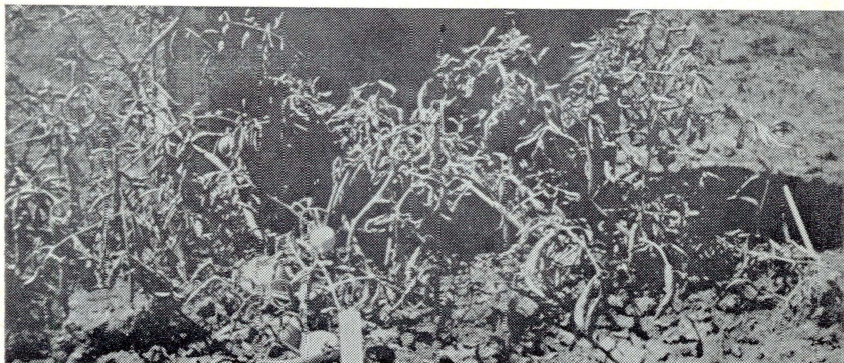
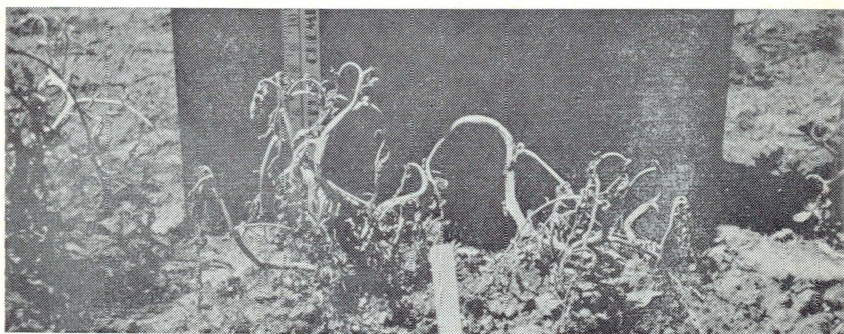


Figure 5. Top row: Plants of Roma showing only slight symptoms due to 2,4-D amine spray at one ounce per acre. Center and bottom row: Plants of Glamour and VF 145-21-4, respectively, showing severe 2,4-D injury. Note the abnormal fruit shape of VF 145-21-4. Photographs taken 20 days after spraying.

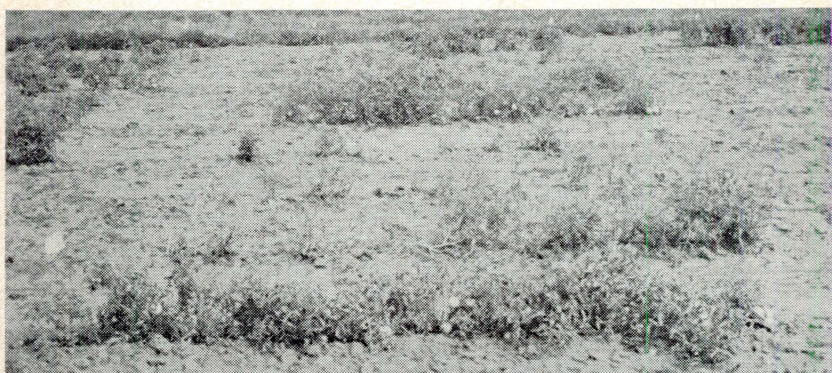
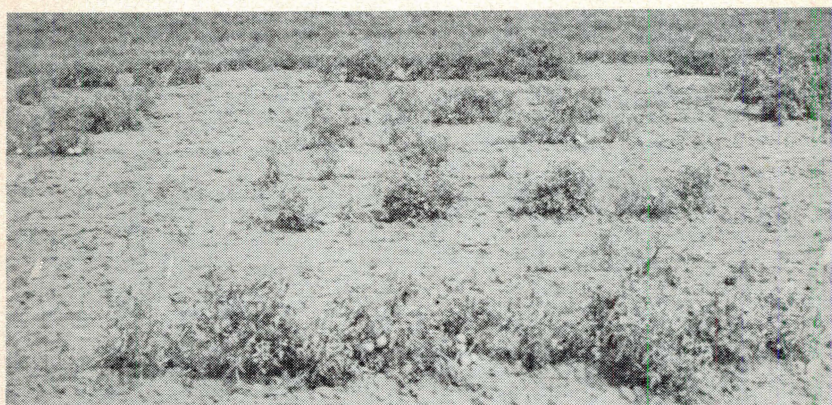
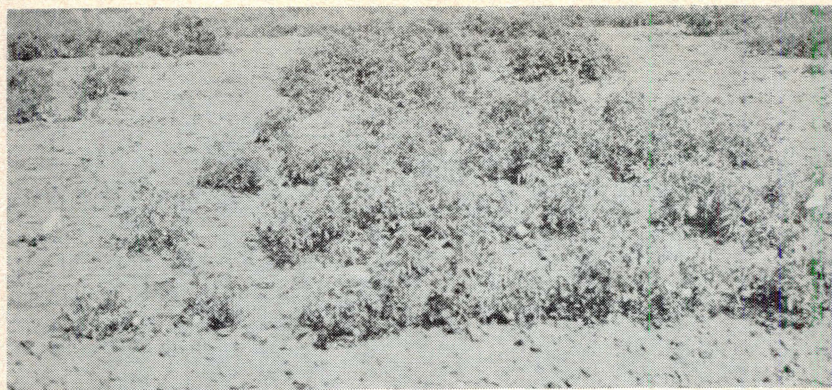


Figure 5. Photographs taken of rows of unsprayed tomatoes (top), tomatoes which received one ounce 2,4-D per acre (middle), and tomatoes which received repeated sprays of 1/5 ounce 2,4-D per acre at about weekly intervals (bottom).

Table 4. Notes on effect of 2,4-D amine at the rates of one ounce per acre (T_1) and 1/5 ounce per acre repeated at five intervals (T_2) on fruit shape and degree of fruit seediness of ripe fruit at time of harvest in 1967.

Variety and source	Treatment	Fruit shape	Fruit seediness
VF 145-21-4 (Asgrow)	T_1	Blossom end of fruit pointed	Normal number of seeds
	T_2	Blossom end of fruit pointed	Normal number of seeds
	Control	Normal shape	Normal number of seeds
Roma (Asgrow)	T_1	Normal shape	Normal number of seeds
	T_2	Normal shape	Few seeds
	Control	Normal shape	Normal number of seeds
Heinz 1439 (Asgrow)	T_1	Normal shape	Normal number of seeds
	T_2	Normal shape	Normal number of seeds
Heinz 1350 (Asgrow)	T_1	Normal shape	Few seeds
	T_2	Normal shape	Few seeds
	Control	Normal shape	Normal number of seeds
Moreton Hybrid (Harris)	T_1	Normal shape	Normal number of seeds
	T_2	Normal shape	Normal number of seeds
Glamour (Asgrow)	T_1	Normal shape	Normal number of seeds
	T_2	Normal shape	Few seeds
	Control	Normal shape	Normal number of seeds
Galaxy (Harris)	T_1	Normal shape	Few seeds
	T_2	Normal shape	Few seeds
	Control	Normal shape	Normal number of seeds

Table 5. Effect of 2,4-D amine on dates of harvest and mean weight of total fruit in tons per acre of tomato varieties. The 2,4-D amine was applied at the rate of two ounces per acre on July 24 and at the rate of three ounces per acre on Aug. 11, 1967.

Variety and source	Date of harvest		Total wt. of fruit in tons/acre	
	Check	2,4-D	Check	2,4-D
VF 145-21-4 (Peto Seed Co.)	9/18	9/5	11.1	5.2 X ^a
Avalanche (Harris)	9/18	9/5	18.9	4.3 X
Tom-Tom (Harris)	9/18	9/18	16.2	3.9 X
Wonder Boy (Harris)	9/18	9/15	6.0	4.1 NS
Cardinal Hybrid (Harris)	9/18	9/15	19.0	7.2 X
Fantastic (Harris)	9/18	9/5	15.9	5.5 NS
Superman (Harris)	9/18	9/5	20.8	6.8 X
New Yorker (Harris)	9/15	8/24	9.9	3.1 X
Campbell 1327 (Harris)	9/18	8/30	10.5	0.8 X
Fireball (Harris)	9/5	8/24	10.1	3.0 NS
Heinz 1548 (Harris)	9/18	8/29	13.5	6.2 NS
Gardener (Harris)	9/18	8/29	16.2	2.9 X

^a Duncan's Multiple Range test was used to test significance of mean differences between control and 2,4-D treatments within each variety (P. 0.05). NS indicates no significant differences between means and X indicates significance at the 0.05 probability level.

weather. Eight of the varieties showed a significant reduction in the yield of total fruit weight due to 2,4-D.

The fruit of the six PI tomato varieties was not harvested because of very small fruit size, and in some cases, poor fruit shape and quality. However, a rating for degree of plant injury and plant height was measured also in these PI lines.

The effect of 2,4-D spray on degree of plant injury and height and width of plants of the eighteen varieties on Aug. 9 is shown in Table 6. Control plants of all varieties showed no symptoms from 2,4-D sprays.

The following varieties showed only slight plant injury and were regarded the most tolerant of the varieties in the experiment: Avalanche, Cardinal Hybrid, Superman, PI 129,131 (Panama), PI 190,858 (Argentina), PI 203,229 (Australia).

It may be desirable to select for tolerance to 2,4-D injury in a breeding program if any of these PI lines were used as sources of other particular traits. Campbell 1327 was severely injured by the 2,4-D spray. The following varieties showed moderate injury from the 2,4-D spray: VF 145-21-4, New Yorker, Fireball, Gardener and PI 124,038.

Only five varieties showed a significant difference in plant height between control and treated plots, while no varieties showed a significant difference in plant width.

Data collected on the effect of the 2,4-D spray on fruit shape and seediness of the different varieties are presented in Table 7. Notes on the fruit of the control plants are presented in this table only if they differed from the treated plants. There was no difference in fruit shape and seediness between treated and control plants of the varieties Avalanche, Wonder Boy and Fireball. The following varieties had a lower degree of fruit seediness in the treated plants compared with the control plants: Tom-Tom, Cardinal Hybrid, Superman, Campbell 1327 and Heinz 1548. The blossom end of the fruit was pointed in the varieties Fantastic and Superman treated with 2,4-D while the control plants had normal-shaped fruits.

Table 6. Effect of 2,4-D amine on degree of plant injury and height and width of 18 tomato varieties. The 2,4-D amine was applied at the rate of two ounces per acre on July 24 and at the rate of three ounces per acre on Aug. 11, 1967.

Variety and source	Mean rating injury 8/9/67 ^a	Plant height ins. 8/9/67		Plant width ins. 8/9/67	
		Check	2,4-D	Check	2,4-D
Campbell 1327 (Campbell Soup Co.)	4.0	24.5	15.5 X ^b	39.0	20.5 NS
VF 145-21-4 (Peto Seed Co.)	3.0	18.0	17.0 NS	29.0	22.0 NS
New Yorker (Harris)	3.0	19.0	14.8 NS	27.0	23.0 NS
Fireball (Harris)	3.0	14.5	13.5 NS	25.5	19.5 NS
Gardener (Harris)	3.0	26.0	20.0 X	32.5	22.5 NS
P.I. 124036 (Argentina)	2.8	24.5	20.0 NS	40.0	32.5 NS
Tom-Tom (Harris)	2.5	28.0	24.0 NS	37.5	32.0 NS
Wonder Boy (Harris)	2.5	28.0	21.0 X	38.5	29.5 NS
Heinz 1548 (Harris)	2.5	19.5	17.5 NS	31.0	28.0 NS
P.I. 272636 (Costa Rica)	2.5	26.5	23.5 NS	42.5	40.0 NS
P.I. 118778 (Brazil)	2.5	30.5	23.0 X	38.0	31.5 NS
Fantastic (Harris)	2.2	25.5	21.0 NS	40.0	33.0 NS
Avalanche (Harris)	2.0	25.5	22.5 NS	34.5	29.5 NS
Cardinal Hybrid (Harris)	2.0	24.5	22.0 NS	32.0	35.0 NS
Superman (Harris)	2.0	24.0	21.0 NS	35.0	32.0 NS
P.I. 129131 (Panama)	2.0	32.5	25.5 X	47.5	40.0 NS
P.I. 190858 (Argentina)	2.0	20.5	20.5 NS	40.0	38.5 NS
P.I. 203229 (Australia)	2.0	26.5	23.5 NS	42.5	40.0 NS

^a A rating scale of 1 to 5 was used to describe degree of plant injury. One indicates no symptoms and 5 indicates death of plant. All control plants had a rating of 1 so are not indicated in table. For a complete description of ratings see section in materials and methods.

^b Duncan's Multiple Range test was used to test significance of mean differences between control and 2,4-D treatments within each variety (P. 0.05). NS indicates no significant difference between means and X indicates significance at the 0.05 probability level.

Table 7. Notes on effect of 2,4-D amine on fruit shape and degree of seediness of ripe fruit of tomato varieties at time of harvest. The 2,4-D amine was applied at the rate of two ounces per acre on July 24, and at the rate of three ounces per acre on Aug. 11, 1967.

Variety and source	Fruit shape	Fruit seediness
Avalanche (Harris)	Normal fruit shape	Normal number of seeds
Tom-Tom (Harris)	Normal fruit shape	Few seeds. Fruit of control plants had normal number of seeds
Wonder Boy (Harris)	Normal fruit shape	Few seeds
Cardinal Hybrid (Harris)	Normal fruit shape	Few seeds. Fruit of control plants had normal number of seeds
Fantastic (Harris)	Blossom end of fruit pointed; Control plants had normal fruit shape	Few seeds present. Fruit of control plants had few seeds
Superman (Harris)	Blossom end of fruit pointed	Few seeds. Fruit of control plants had normal number of seeds
New Yorker (Harris)	Normal fruit shape	Few seeds. Fruit of control plants had few seeds
Campbell 1327 (Harris)	Normal fruit shape	Few seeds. Fruit of control plants had normal number of seeds
Fireball (Harris)	Normal fruit shape	Normal number of seeds
Heinz 1548 (Harris)	Normal fruit shape	Few seeds. Fruit of control plants had normal number of seeds

