THE EFFECT OF N-META-TOLYLPHTHALAMIC ACID AND LIGHT INTENSITIES ON TRANSPLANTED GREENHOUSE GROWN TOMATOES

by

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INTRODUCTION

The tomato, *Lycopersicum esculentum*, is one of the major vegetable crops. It is grown as a fresh market crop, as a processing crop and is the most important forced vegetable crop.

It is probable that more research has been conducted on the tomato than any other horticultural plant. The control of fruiting and vegetative responses has been extensively studied (Hemphill 5, Howlett and Manth 7, Randhama and Thompson 12, and Westover 20). However, little work has been done on factors that influence flower formation. Recently some studies were conducted on tomato plants in an attempt to increase flower formation in the first and second flower clusters. This objective was accomplished by exposing tomato seedlings during the critical period in which initiation of the first flower cluster occurs during the two to three weeks period immediately following the expansion of the cotyledons, to temperature of 50 to 55°F (Learner and Wittwer 8, Wittwer and Teubner 23, 24; Went 17, 18, and Wittwer 24).

More recently a chemical treatment of tomato seedlings to produce more flowers appeared in the literature. This treatment was to substitute or to supplement the cold treatment. The growth regulator used for this treatment was N-meta-tolylphthalamic acid. Teubner and Wittwer (15), Cordner and Hedger (4), Wittwer (21) and Moore (10) made significant contributions on the use of this chemical. Dr. George Taylor of the Naugatuck Chemical Division of the U. S. Rubber Company mentioned that it was impossible to get consistent results on the use of this material on various crops under field conditions. It was assumed that environmental conditions played a role in preventing the repetition of results. As light affects plant growth (Shirley 13, Hemphill and Murneek 6, and Went 17, 18), it was decided to grow tomato transplants under different light intensities to see if light was a factor in obtaining consistent results with the use of N-meta-tolylphthalamic acid on tomato transplants.

The objectives of this study were: (1) to evaluate the effects of different colored plastics and glass as propagation structures for greenhouse tomato transplants and (2) to evaluate some effects of N-meta-tolylphthalamic acid sprays on transplants grown under different light intensities.

REVIEW OF LITERATURE

Shirley (13) observed that the rate of photosynthesis of plants was almost directly proportional to light intensity and temperature. He reported that stem thickness, leaf thickness, leaf area per plant, dry weight of tops, dry weight of root, and differentiation were influenced by the same factors. He indicated that flower development occurred earlier when plants received higher light intensity. He also reported that plants grew to a maximum height earlier if grown under high light intensity.

Burkholder (3) stated that light intensity, quality, and duration had a marked influence upon growth rate, leaf mass, dry weight of tops, dry weight of roots, and differentiation of organs of tomato plants as well as other species.

Went (17, 18) observed that light intensity and temperature had a great influence upon the rate of photosynthesis and growth of plants grown in the greenhouse. Day temperature of 26°C. with light intensity of 1000 f.c. and night temperature of 17 to 20°C. were optimum for most of the physiological processes. Also he reported that high night temperature of 26.5°C. was responsible for the low rate of translocation, excess stem elongation, and for fewer flowers per cluster, less fruit set, decreased top and root weights of plants, when contrasted with lower night temperature of 17 to 20°C.

Hemphill and Murneek (6) observed that total solar radiation had a marked influence upon yield of tomato plants. They indicated that the yield from fall and winter crops was always smaller than that of spring and summer crops. Plants grown during fall and winter were less efficient in utilizing light for flower production than plants grown during spring and summer. They confirmed that tomato plants which received an application of the growth regulator p-chlorophenoxyacetic acid at 10 ppm. produced larger and earlier yields than untreated plants.

Moore and Thomas (11) observed that high temperature combined with high light intensity were detrimental to fruit setting with tomatoes. They indicated that different light intensities had no effect on blooming date of the first and second flower clusters.

Learner and Wittwer (8) and Moore and Thomas (11) reported that tomato plants set fruit abundantly only when night temperature ranged between 15 and 20°C. and day temperature about 25°C. Lower or higher night temperature reduced fruit set.

Wittwer and Teubner (23, 24, 25) and Wittwer (22) observed that exposing tomato seedlings grown in the greenhouse to cool temperature between 50 and 55°F. during the sensitive period two to three weeks following the expansion of the cotyledons had a marked influence upon plant growth and development compared with higher temperature of 65 to 70^{o}F. They observed that plants grown under these low temperatures produced shorter internodes, stronger side shoots, thicker stems, and fewer leaves preceded the first flower cluster as compared to plants grown under higher temperatures. Also they reported that plants which were exposed to low temperature during the sensitive period produced more flowers, set more fruits, and produced earlier yields than plants that were exposed to higher temperatures. They also indicated that the total marketable yield was not affected by the cold treatment.

Leopold and Thimann (9) observed that flower imitation in barley plants was promoted by application of the growth regulator alpha-naphthalene acetic acid as a concentration of .01 to 1 mg/l. They also observed that vegetative primordia and tillering were reduced when high concentration of the growth regulator was applied at 400 mg/l. Some other plant growth regulators that promoted flower imitation were reported by: Moore (10), Bukovac et al. (2), Teubner and Wittwer (15), Cordner and Hedger (4), Wittwer (21), Waddington and Teubner (16), and Andrews and Lu (1). Moore (10) observed that tomato plants which were sprayed with p-chlorophenoxyacetic acid at concentration of 30 ppm. and with N-meta-tolylphthalamic acid at 750 ppm. produced earlier and higher yield over the checks. However, dwarfing was observed in plants that were sprayed with N-meta-tolylphthalamic acid.

Bukovac et al. (2) found that application of gibberellin at a concentration of 100 ppm. as a foliage spray for tomato seedlings reduced the number of flowers in the first cluster and increased the number of nodes preceding this cluster. They also reported that the color of leaves of the gibberillin treated plants was a lighter green whereas the reverse took place when plants were sprayed with N-meta-tolylphthalamic acid.

Teubner and Wittwer (15) reported that spraying tomato seedlings with N-meta-tolylphthalamic acid at 200 ppm. nine to twelve days after cotyledons expansion produced maximum number of flowers in the first cluster; whereas, application of the growth regulator eighteen days after cotyledon expansion was optimum for flower number in the second cluster. Furthermore, they found increased yields for individual clusters as well as for the mean of all clusters. They confirmed that no inhibition of vegetative growth occurred from the growth regulator at concentration of 200 ppm., however, plants sprayed with concentration of 500 ppm. terminated with a large flower cluster and soon after a side shoot attained the terminal position found in non-treated plants.

Cordner and Hedger (4) observed that the axillary shoots in some plants were suppressed entirely when N-meta-tolylphthalamic acid was applied at 400 ppm. and the stems were terminated by the inflorescence. They also observed that the peduncles of the first cluster were long and thick in treated plants.

Wittwer (21) observed that the number of flowers per cluster was increased up to three to four times when tomato plants were sprayed with N-meta-tolylphthalamic acid at one to two grams per gallon of water. He observed that tomato seedlings were drooped, flagged slightly, and turned to darker green after spraying with the growth regulator. He indicated that high concentration of this chemical caused many plants to terminate in flower clusters and one or more flower clusters may be skipped.

Waddington and Teubner (16) reported that yield of canning tomato was doubled when the growth regulator N-meta-tolylphthalamic acid was applied to seedlings at concentration 200 ppm. during the sensitive period two to three weeks after cotyledon expansion.

MATERIALS AND METHODS

An experiment was conducted in the fall and winter of 1960 in greenhouse structures at Kansas State University. This experiment was repeated in the spring and summer of 1961. In the fall, tomato seeds of the Tuckcross O variety were planted in sand in a glass house on September 23, 1960, and in the spring they were planted on January 27, 1961. These seedlings were grown under night temperatures of 60 to 65^{o}F. and 70 to 75^{o}F. day temperature. The plants were watered regularly.

The seedlings were pricked off when the cotyledons were expanded and transplanted to 3-inch clay pots filled with sterilized soil mixture which consisted of a 1:1:2 ratio of sand, peat moss, and soil, respectively. Pricking off was done on October 4 for the fall experiment and February 11 for the spring experiment.

The seedlings were then grown in greenhouses covered with the following colors of plastic: (1) clear, (2) jonquil yellow, (3) tropical coral (red), and (4) ivy green, as well as in (5) a glass greenhouse. Hereafter the treatments will be referred to as colored plastics even though a glass house was also included. These corrugated fiberglass acrylic resin plastics were furnished by the Butler Manufacturing Company, Kansas City, Missouri. Vertical illumination was recorded on October 16, 1960, and

April 7, 1961, by the use of a Weston Model 756 Sunlight Illumination Meter (Tables 1 and 2). The meter had a range of 0-12000 foot candles. This data was obtained on a clear day, except as footnoted. The plants were watered regularly, but no fertilizer was used. Average temperature under plastics was 59°F. night and 80°F. day, whereas the temperatures for the glass house were 65°F. night and 89°F. day for the fall experiment. For the spring experiment the temperatures in the plastic subdivisions were 67°F. night and 88°F. day, and for glass house were 60°F. night and 74°F. day. A portion of the plants grown in each of the propagating structures were sprayed with N-meta-tolylphthalamic acid at the rate of 175 ppm. until the foliage dripped. This spraying was accomplished by a compressed air sprayer and was done eleven days after transplanting for the fall experiment (October 4, 1960), and on February 22, 1961, for the spring experiment. The seedlings had two true leaves which were approximately one inch in length at the time of the first application (Plate I). Both the treated and untreated plants were grown under these different structures until four or five true leaves were developed. At this stage a portion of the plants that were sprayed with 175 ppm. received a second application of this growth regulator at a concentration of 87.5 ppm. The second application was applied on October 27, 1960, for the fall experiment and on March 2, 1961, for the spring experiment (Plate II). This reduced concentration was employed because the higher concentration adversely influenced the growth of seedlings in the fall experiment. The transplants were grown for five additional days under the colored plastic structures before they were taken to a glass house on October 31, 1960, for the fall experiment and on

Table 1. Vertical illumination reading in foot candles on October 16, 1960.

Place	9 a.m.	10a.m.	11a.m.	12:00	1p.m.	2p.m.	3p.m.	4p.m.	Average/ hour
Outside	2900	4700	6100	6800	6600	5600	3800	2000	4812
Glass	1400	2400	3600	4500	4300	3500	1800	700	2775
Clear	1200	2200	3200	3600	3400	2000	1800	700	2262
Yellow	900	1600	1900	2100	2000	1500	1100	200	1412
Red	800	1400	1700	2100	2000	1300	1000	200	1312
Green	500	1100	1400	1600	1400	1100	900	100	1012

Table 2. Vertical illumination readings in foot candles on April 7, 1961.

Place	9 a.m.	10a.m.	11a.m.	12:00	1p.m.	2p.m.	3p.m.[1]	4p.m.[1]	Average/ hour
Outside	4600	6400	8600	9400	8200	7000	4200	2800	6400
Glass	3100	4400	7200	7600	7000	4900	2500	1300	4750
Clear	1400	2600	3600	4100	4800	2800	1600	800	2712
Yellow	1200	2000	3000	3200	3000	2200	1100	600	2037
Red	1100	1800	3000	3200	2700	1800	1000	500	1887
Green	1100	1800	2800	2800	2800	2000	900	600	1195

[1] Reading taken on clear days, except it became slightly overcast for the 3:00 and 4:00 p.m. readings on this date.

March 7, 1961, for the spring experiment (Plate III). A 6' x 100' bed in a glass house was prepared and the soil in the glass house was fertilized with triple superphosphate at the rate of 290 pounds per acre on October 4, 1960. This soil also received an application of 145 pounds per acre of 60 percent $K_{2}0$. A liberal quantity of manure was supplied as a source of organic matter for the fall planting. For the spring experiment, the same bed was employed, prepared, and fertilized on March 3, 1961. Fertilizer employed was 10-10-10 at the rate of 500 pounds per acre plus two bales of peat moss as a source of organic matter. In both experiments the fertilizer was applied, broadcast, and spaded into the soil to a depth of six to eight inches. The bed was then roto-tilled until it was in good physical condition.

EXPLANATION OF PLATE I

Close-up of tomato seedlings at the stage of growth when the first application of the growth regulator N-meta-tolylphthalamic acid was applied for the respective treatments: 1) glass, 2) clear plastic, 3) green plastic, 4) red plastic, and 5) yellow plastic. Observe the difference in plant height and stem diameter. Photographed February 22, 1961.

PLATE I

EXPLANATION OF PLATE II

Fig. 1. Close-up of tomato seedlings at the stage of growth when the second application of the growth regulator, N-meta-tolylphthalamic acid, was applied for the respective treatments, and the differences in growth between treatments: 1) glass, 2) clear plastic, 3) green plastic, 4) red plastic, and 5) yellow plastic. Photographed March 2, 1961.

Fig. 2. Close-up of tomato seedlings at the stage of growth that the second application of the growth regulator was applied. Treatments: as in Fig. 1, from left to right.

PLATE II

Fig. 1

Fig. 2

EXPLANATION OF PLATE III

Fig. 1. Close-up of untreated tomato seedlings from the 5 different treatments at the time of transplanting to the ground bed: 1) glass, 2) clear plastic, 3) green plastic, 4) red plastic and 5) yellow plastic. Photographed on March 7, 1961.

Fig. 2. Close-up of typical seedling from the corresponding treatments above at the same time. These seedlings had received one application of N-meta-tolylphthalamic acid (2-leaf stage) at 175 ppm.

Fig. 3. Close-up of typical tomato seedlings from the corresponding treatments above, showing the effect of two applications of the growth regulator on plant growth.

PLATE III

Fig. 1

Fig. 2

Fig. 3

The plants from the different treatments were set in a randomized block design. They were placed 15 inches apart in 3-foot rows for the fall experiment and 18 inches apart in 32-inch rows for the spring planting. There were fifteen treatments in both experiments with eleven replications in the fall, and seven replications in the spring. Single plants comprised a replication. The plants were pruned to a single stem and staked. The plants were topped four leaves above the third flower cluster. The number of flowers in the first, second, and third clusters were counted on an individual plant basis for all treatments. It was necessary to count the blossoms on each cluster several times because of the large size of some flower clusters. Dates of blossom opening were recorded for all clusters. Number of fruits set in each of the three clusters was determined for each treatment. Fruits were picked for all clusters when ripe. They were then graded and weighed. Marketable fruits were defined as sound, normal fruits weighing at least 3.2 ounces. Total weight of marketable fruits was obtained for each of the three clusters. Total weight of marketable fruits per plant was also obtained for each treatment.

Suckers, lateral shoots, were removed at six to ten day intervals for six times from all plants. The suckers were collected in paper bags for each plant for all treatments. The suckers were kept in the greenhouse until all suckers had been removed. They were then oven dried at a temperature of 70°C. for three days. Dry weights of suckers per treatment were obtained for each plant.

Height of plants was measured in inches for both experiments. The measurements for the fall experiment were obtained during December 11 to December 24, 1960, after each plant had a height of four leaves above the third flower cluster. For the spring experiment, measurements were obtained on April 7, 1961, only 30 days after they had been set in the ground bed.

Peduncle length of the first cluster of all plants of the spring experiment were measured in centimeters. Distance measured was from the point of attachment at the stem to the first fruit on the flower cluster. All data were analyzed statistically according to Snedecor (14). The F tests for differences between treatments means are expressed as probability for significance. L.S.D. values were determined to express differences in treatment means. An additional study was conducted in the spring of 1961. The objective of this study was to observe the effect of the different propagation structures on top and root ratio of unsprayed tomato transplants (Plate IV).

For this study, twenty-four plants of each treatment were grown in 3-inch clay pots. The soil mixture was screened to pass through 1/16" mesh and were placed under each of the five different propagation structures. They were grown from February 11 to March 10, 1961.

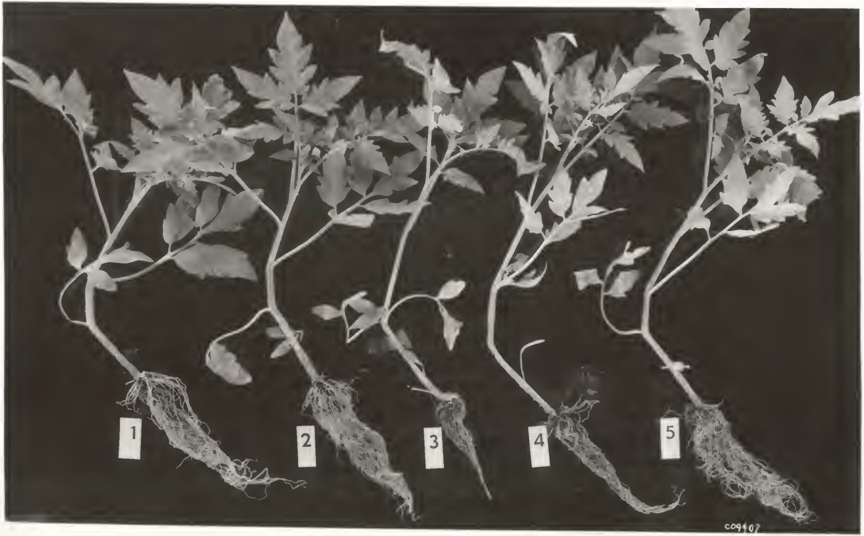
Three replications of eight plants each were grown under each treatment. On March 10, 1961, tops were cut off at the soil level, and the fresh weight obtained. The tops were placed in paper sacks for drying. Roots of the same corresponding groups were washed and collected. The roots and tops were oven dried at 65 to 70°C. for three days. Dry weights of roots and tops were obtained.

EXPLANATION OF PLATE IV

Spring Experiment

Close-up of typical plants from the 5 different treatments showing the differences in growth of both roots and tops. The treatments were: 1) glass, 2) clear plastic, 3) green plastic, 4) red plastic, 5) yellow plastic. Photographed March 27, 1961.

PLATE IV



EXPERIMENTAL RESULTS

Fall Experiment

Characteristics studied in the fall experiment were: number of blossoms, number of fruits and weight of marketable fruits for each of the first three flower clusters, total marketable fruit weight, plant height, and dry weight of suckers per treatment.

Number of flowers in the first cluster was influenced significantly by treatments (Table 3).

Table 3. Effects of frequencies of N-meta-tolylphthalamic acid sprays on number of flowers (1st cluster) for tomato transplants grown under different colored plastics (fall).

Treatments	Frequencies			Grand mean
	0	1	2	
Glass	5.7	10.2	18.9	11.6
Clear	5.9	9.4	10.8	8.7
Red	6.0	9.2	9.8	8.3
Yellow	5.7	6.4	11.5	7.9
Green	6.2	6.4	7.4	6.7
Grand mean	5.9	8.3	11.7	
LSD 5%	T 1.4	F 1.1	T x F 2.4	

Plants grown in the glass house had significantly more blossoms than plants in any other treatment. Flower number on plants grown under the green treatment was significantly decreased when compared with plants grown under glass, clear and red plastics. There were also significant differences between frequencies of spraying with N-meta-tolylphthalamic acid sprays. One spray application with this growth regulator significantly increased the number of flowers in the first cluster compared to no sprays. Two sprays also significantly increased flower number over one spray. Plants which received two sprays and were grown under glass had significantly more blossoms than plants grown under any other treatment. An interaction occurred between treatments and frequency in number of flowers in the first cluster. There was no significant difference between treatments at the zero frequency, but at the first frequency of spraying plants grown under the glass, clear, and red plastics had significantly more blossoms than plants grown under yellow or green plastic. Plants grown under the different propagation structures which received two applications of the growth regulator differed significantly in flower number. Plants grown under glass had significantly more flowers than any other treatment. Plants grown under green plastic had significantly less flowers than plants from any other treatment that received two sprays of the growth regulator.

Number of flowers in the second cluster was influenced by treatment. Transplants grown under the glass treatment had significantly more flowers than transplants grown under red, yellow or green plastics (Table 4).

Table 4. Effects of frequencies of N-meta-tolylphthalamic acid sprays on number of flowers (2nd cluster) for tomato transplants grown under different colored plastics (fall).

	Frequencies			Grand
Treatments	0	1	2	mean
Glass	6.7	7.3	9.1	7.7
Clear	7.0	7.2	7.7	7.3
Red	7.4	5.4	4.9	5.9
Yellow	6.8	6.2	6.7	6.6
Green	6.4	5.4	4.5	5.4
Grand mean	6.9	6.3	4.5	
LSD 5%	T 0.9	F n.s.	T x F 1.6	

Plants grown under clear plastic had significantly more blossoms than transplants grown under red and green plastics. There were no significant differences due to frequency of application of the growth regulator for the second cluster. However, an interaction occurred between treatment and frequency in number of flowers in the second cluster. There was no significant difference between treatments at the zero frequency, but at the first and second frequencies of spraying plants grown under glass, clear and yellow plastics had significantly more blossoms than plants grown under red or green plastics.

Number of flowers in the third cluster did not differ significantly between treatments (Table 5).

Table 5. Effects of frequencies of N-meta-tolylphthalamic acid sprays on number of flowers (3rd cluster) for tomato transplants grown under different colored plastics (fall).

Treatments	Frequencies 0	1	2	Grand mean
Glass	7.8	10.1	11.8	9.9
Clear	7.0	8.6	11.2	8.9
Red	9.8	9.2	6.5	8.5
Yellow	7.3	8.5	12.4	9.4
Green	8.3	8.3	7.4	8.0
Grand mean	8.0	8.9	9.9	
LSD 5%	T n.s.	F n.s.	T x F 3.7	

However, an interaction occurred between treatment and frequency in number of flowers in the third cluster. There was no significant difference between treatments at the zero and first spraying frequencies, but at the second frequency of spraying, plants grown under glass, clear, and yellow plastics had significantly more flowers than plants grown under red, or green plastics.

There was no significant difference in number of flowers for the transplants grown under glass, clear and yellow plastic treatments when they received two applications of the growth regulator. Number of fruits for each treatment for the first, second, and the third clusters are given in Tables 6, 7 and 8, respectively.

Table 6. Effects of frequencies of N-meta-tolylphthalamic acid sprays on number of fruits (1st cluster) for tomato transplants grown under different colored plastics (fall).

Treatments	Frequencies 0	1	2	Grand mean
Glass	1.9	2.7	3.6	2.7
Clear	1.4	0.8	0.7	1.0
Red	0.4	0.4	0.3	0.4
Yellow	0.5	0.2	0.4	0.4
Green	0.8	0.1	0.0	0.3
Grand mean	1.0	0.8	1.0	
LSD 5%	T 0.8	F n.s.	T x F n.s.	

Significant differences occurred between treatments for the first cluster. Plants grown under the glass house had more fruits than plants from any other plastic treatment. There was no significant difference between other treatments or frequencies.

Significant differences in number of fruits per plant occurred in the second cluster (Table 7). Plants grown in the glass house set significantly more fruits than plants grown under red, yellow, or green plastics, but there was no significant difference between plants grown in the glass house and plants grown under clear plastic. The plants grown in clear plastic had significantly more fruits per cluster than those grown in red, green, or yellow plastic houses. Significant differences in number of fruits did not occur

Table 7. Effects of frequencies of N-meta-tolylphthalamic acid sprays on number of fruits (2nd cluster) for tomato plants grown under different colored plastics (fall).

Treatments	Frequencies 0	1	2	Grand mean
Glass	2.0	2.9	2.2	2.4
Clear	0.9	1.1	2.4	1.7
Red	0.5	0.4	0.9	0.6
Yellow	1.1	0.5	1.2	0.9
Green	0.4	0.5	0.5	0.5
Grand mean	1.0	1.1	1.4	
LSD 5%	T 0.8	F n.s.	T x F 0.7	

between frequencies of spraying. However, an interaction between treatment and frequency in number of fruits in the second cluster did occur. There was no significant difference between frequencies for fruit set in this cluster. An interaction between treatments and frequencies indicated that transplants grown under glass and clear plastic which received two spray applications of the growth regulator had significantly more fruits than plants in the other plastic treatments. In addition, plants grown under glass set more fruits than plants grown under any plastic treatment at the first two frequencies of application of the growth regulator.

Significant differences for number of fruits in the third cluster did not occur (Table 8). However, there were significant differences between frequencies of spraying. Fruit set was significantly increased when either one or two spray applications of the growth regulator was applied. There was no significant difference between the first and second frequencies in number of fruits. An interaction occurred between treatment and frequencies in number of fruits in the third cluster, although this difference occurred only when the plants received two applications of the growth regulator.

Table 8. Effects of frequencies of N-meta-tolylphthalamic acid sprays on number of fruits (3rd cluster) for tomato transplants grown under different colored plastics (fall).

Treatments	Frequencies 0	1	2	Grand mean
Glass	2.4	5.8	6.4	4.9
Clear	2.2	4.8	5.6	4.2
Red	4.4	5.0	4.3	4.6
Yellow	2.4	4.4	8.4	5.1
Green	3.4	4.3	3.1	3.6
Grand mean	3.0	4.9	5.6	
LSD 5%	T n.s.	F 1.3	T x F 2.8	

Plants grown under yellow plastic had significantly more fruits than plants grown under clear, red, or green plastics. Also, plants grown under glass set significantly more fruits than plants grown under green plastic. Significant differences in weight of marketable fruits occurred between treatments for the first cluster (Table 9).

Table 9. Effects of frequencies of N-meta-tolylphthalamic acid sprays on weight of marketable fruits (1st cluster) in ounces per plant for tomato transplants grown under different colored plastics (fall).

Treatments	Frequencies 0	1	2	Grand mean
Glass	6.1	6.0	7.8	6.6
Clear	2.8	1.3	2.7	2.3
Red	0.6	1.2	0.3	0.7
Yellow	1.1	0.3	0.9	0.8
Green	0.9	0.4	0.9	0.7
Grand mean	2.3	1.8	2.5	
LSD 5%	T 1.9	F n.s.	T x F n.s.	

Plants grown in the glass house produced significantly more marketable fruits than plants grown in any of the plastic treatments. There were no other significant differences between treatments. There was no significant difference in marketable fruits between frequencies of spraying.

Significant differences between treatments for marketable fruit weight for the second cluster are shown in Table 10.

Table 10. Effects of frequencies of N-meta-tolylphthalamic acid sprays on weight of marketable fruits (2nd cluster) in ounces per plant for tomato transplants grown under different colored plastics (fall).

Treatments	Frequencies 0	1	2	Grand mean
Glass	6.1	2.7	5.0	4.6
Clear	1.0	0.6	4.7	2.1
Red	1.4	0.9	1.4	1.2
Yellow	2.2	0.4	1.3	1.3
Green	0	0	0.4	0.1
Grand mean	2.1	0.9	2.6	
LSD 5%	T 1.8	F 1.4	T x F n.s.	

Plants grown in the glass house produced significantly more marketable fruits than any other treatment. Plants grown under clear plastic produced significantly more marketable fruits than those grown under green plastic. There were no other significant differences for marketable fruit weight in the second cluster. Marketable fruit weight was significantly reduced by the application of one chemical application. There were no significant differences between the zero and second frequencies of the growth regulator.

Significant differences in marketable fruit weight occurred between treatments for the third cluster (Table 11). Plants grown under red plastic produced significantly more marketable fruits than plants grown in the glass

Table 11. Effects of frequencies of N-meta-tolylphthalamic acid sprays on weight of marketable fruits (3rd cluster) in ounces per plant for tomato transplants grown under different colored plastics (fall).

Treatments	Frequencies 0	1	2	Grand mean
Glass	1.8	8.8	10.5	7.0
Clear	5.3	8.3	12.5	8.7
Red	8.9	13.4	11.6	11.3
Yellow	5.3	9.2	12.5	9.0
Green	8.9	10.0	7.4	8.7
Grand mean	6.0	9.9	10.9	
LSD 5%	T 2.7	F 2.1	T x F n.s.	

house. There were no significant differences in marketable fruit weight for plants grown under the other plastic treatments. Significant differences occurred between frequencies of spraying. Plants that received either one or two sprays produced significantly more marketable fruit weight than those plants that were not sprayed. However, there was no significant difference in marketable fruits between the first and second frequencies of spraying.

Total marketable fruit weight per plant is given in Table 12.

Table 12. Effects of frequencies of N-meta-tolylphthalamic acid sprays on weight of total marketable fruits in ounces per plant for tomato transplants grown under different colored plastics (fall).

Treatments	Frequencies 0	1	2	Grand mean
Glass	13.9	17.6	23.3	18.2
Clear	9.1	10.3	20.0	13.1
Red	11.0	15.5	13.3	13.3
Yellow	8.6	9.9	14.7	11.9
Green	9.8	10.4	8.7	9.6
Grand mean	10.5	12.7	16.0	
LSD 5%	T 5.2	F 4.0	T x F n.s.	

Significant differences occurred between treatments. Plants grown under the glass house produced significantly more marketable fruit weight than those plants grown under yellow or green plastics. Significant differences occurred between frequencies of spraying. Plants that received two sprays produced significantly more marketable fruit weight than those plants that were not sprayed. There was no significant difference between first and second frequencies for total marketable fruit weight per plant.

Plants grown in the glass house were significantly taller than plants grown in any plastic treatment (Table 13).

Table 13. Effects of frequencies of N-meta-tolylphthalamic acid sprays on plant height in inches for tomato transplants grown under different colored plastics (fall).

Treatments	Frequencies 0	1	2	Grand mean
Glass	42.8	39.6	40.6	41.0
Clear	36.4	36.9	39.9	37.7
Red	35.2	35.8	35.8	35.6
Yellow	35.3	34.3	36.1	35.2
Green	35.0	35.0	35.4	35.1
Grand mean	36.9	36.3	37.6	
LSD 5%	T 1.7	F n.s.	T x F n.s.	

Plants grown under clear plastic were significantly taller than plants grown under the red, yellow, or green plastics. There was no other significant differences in plant height. Significant differences in plant height did not occur between frequencies of spraying.

Dry weight of suckers per plant are given in Table 14. Significant differences occurred between treatments. Plants grown in glass house produced significantly more sucker weight than those grown under red, green and yellow plastics, but there was no significant difference between plants grown in glass house and clear plastic. Plants grown under green plastic produced significantly more suckers than those grown under red plastic. Significant difference occurred in sucker production between frequencies of spraying. Sucker weight was decreased by either one or two applications of the growth regulator. Sucker weight was further reduced when two applications of the chemical were applied.

Table 14. Effects of frequencies of N-meta-tolylphthalamic acid sprays on dry weight of suckers in grams per plant for tomato transplants grown under different colored plastics (fall).

Treatments	Frequencies 0	1	2	Grand mean
Glass	11.4	8.1	7.2	8.9
Clear	9.9	8.1	6.0	8.0
Red	7.7	5.5	3.8	5.7
Yellow	8.2	6.6	4.0	6.3
Green	8.7	7.2	6.1	7.3
Grand mean	9.2	7.1	5.4	
LSD 5%	T 1.4	F 1.1	T x F n.s.	

Spring Experiment

Characteristics studied in the spring experiment were: number of blossoms, number of fruits and weight of marketable fruits for each of the first three clusters, total marketable fruit weight, plant height, dry weight of suckers per plant and peduncle length of the first cluster. In addition a separate study was conducted to determine the dry weight of tops and roots and fresh weight of tops for plants grown under the different propagation structures.

Number of flowers in the first cluster was influenced significantly by treatments (Table 15).

Table 15. Effects of frequencies of N-meta-tolylphthalamic acid sprays on flower number (1st cluster) from tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	6.6	16.4	6.3	9.8
Clear	6.6	17.6	29.4	17.9
Red	6.6	16.0	24.0	15.5
Yellow	6.6	11.3	32.3	16.7
Green	7.0	10.3	27.0	14.8
Grand mean	6.7	14.3	23.8	
LSD 5%	T 3.7	F 2.9	T x F 6.5	

Plants grown under glass had significantly less blossoms than plants in any other treatment. There were no other significant differences between treatments. Significant differences also occurred between frequencies of spraying with N-meta-tolylphthalamic acid. One spray application with this growth regulator significantly increased the number of flowers in the first cluster compared to no sprays. Two sprays also significantly increased flower number over one spray. Plants grown under glass that received two sprays had significantly less blossoms than plants grown under any other treatment, whereas plants grown under yellow plastic had significantly more blossoms than plants grown under any other treatment. An interaction occurred between treatments and frequency in number of flowers in the first cluster. This interaction indicated that when the plants were sprayed once with the chemical that plants grown under clear plastic produced more blossoms than those grown under green plastic. It was also found that plants grown under the different colored plastics and receiving two applications of the growth regulator differed significantly in flower number. Plants grown under glass had significantly less flowers than plants from any other treatment, whereas plants grown under yellow plastic had significantly more flowers than plants grown under red plastic that received two sprays of the growth regulator.

Number of flowers in the second cluster was also influenced by treatment. Transplants grown under the glass treatment had significantly more flowers than any other treatment (Table 16).

Table 16. Effects of frequencies of N-meta-tolylphthalamic acid sprays on flower number (2nd cluster) from tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	7.1	9.1	27.7	14.6
Clear	8.7	9.1	12.0	9.9
Red	8.1	7.6	8.1	7.9
Yellow	7.0	8.6	12.1	9.2
Green	7.0	7.1	8.4	7.5
Grand mean	7.6	8.3	13.7	
LSD 5%	T 2.6	F 2.0	T x F 4.4	

Significant differences also occurred between frequencies of spraying with the growth regulator. Two applications of this material significantly increased the number of flowers in the second cluster compared to the other frequencies. An interaction occurred between treatments and frequency in number of flowers in the second cluster. Significant differences occurred only at the second frequency of spraying. Plants grown under glass had significantly more blossoms than plants from any plastic treatment.

Number of flowers in the third cluster did not differ significantly between treatments (Table 17). However, frequency of spraying with N-meta-tolylphthalamic acid did influence flower number significantly. Two spray applications with this chemical significantly increased the number of flowers in the third cluster compared to zero and one sprays.

Table 17. Effects of frequencies of N-meta-tolylphthalamic acid sprays on flower number (3rd cluster) from tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	8.0	7.7	13.0	9.6
Clear	8.0	10.0	10.0	9.3
Red	9.6	9.6	10.0	9.7
Yellow	8.7	10.1	10.9	9.9
Green	11.4	7.4	10.3	9.7
Grand mean	9.1	9.0	10.8	
LSD 5%	T n.s.	F 1.4	T x F n.s.	

Number of fruits for each treatment for the first, second and third flower clusters are given in Tables 18, 19, and 20, respectively. Significant differences occurred between treatments for the first cluster (Table 18).

Table 18. Effects of frequencies of N-meta-tolylphthalamic acid sprays on number of fruits (1st cluster) from tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	3.3	5.6	1.9	3.6
Clear	5.4	10.0	14.1	9.8
Red	5.4	10.1	12.3	9.3
Yellow	5.6	7.7	13.1	8.8
Green	5.4	7.1	11.7	8.1
Grand mean	5.0	8.1	10.6	
LSD 5%	T 2.0	F 1.6	T x F 3.5	

Plants grown under glass had significantly less fruits than plants from any other plastic treatment. There were no significant differences among the plants grown under plastics. Significant differences occurred between frequencies of spraying with the growth regulator. One spray application with this chemical significantly increased the number of fruit in the first cluster compared to no spray. Two sprays also significantly increased fruits number over one spray. An interaction occurred between treatments and frequencies in number of fruits in the first cluster. Plants that were grown under clear, and red plastics that received one application of the growth regulator had significantly more fruits than plants grown under glass. Plants grown under different colored plastics that received two applications of the growth regulator differed significantly in number of fruits. Plants grown under glass had significantly fewer fruits than plants from any other treatment.

Significant differences in number of fruits per plant occurred in the second cluster (Table 19). Plants grown in the glass house had significantly

Table 19. Effects of frequencies of N-meta-tolylphthalamic acid sprays on number of fruits (2nd cluster) from tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	6.3	7.4	14.3	9.3
Clear	7.0	6.0	8.7	7.2
Red	7.0	4.5	5.1	5.9
Yellow	6.0	6.1	4.6	5.6
Green	5.1	5.4	4.7	5.1
Grand mean	6.3	6.1	7.5	
LSD 5%	T 1.3	F 1.0	T x F 2.2	

more fruits than plants grown in any plastic treatment. Also plants grown with clear plastic had significantly more fruits than plants grown under red, yellow, and green plastics. Significant differences also occurred between frequencies of spraying. One spray application of the growth regulator did not influence the number of fruits in the second cluster; however, two sprays increased the number of fruits significantly. Plants grown under glass and having received two sprays had significantly more fruits than plants grown under any other treatment. An interaction occurred between treatments and frequency of spray application in number of fruits in the second cluster. There were no significant differences between the zero and first frequencies of spraying, whereas two spray applications significantly increased the number of fruit from plants grown under glass and clear plastic.

Significant differences for number of fruits in the third cluster did not occur (Table 20). There were significant differences between frequencies

Table 20. Effects of frequencies of N-meta-tolylphthalamic acid sprays on number of fruits (3rd cluster) from tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	7.0	6.6	5.6	6.5
Clear	6.1	4.3	5.0	5.1
Red	7.0	3.3	4.0	4.8
Yellow	6.6	5.4	2.4	4.8
Green	7.7	5.0	2.6	5.1
Grand mean	6.9	4.9	3.9	
LSD 5%	T n.s.	F 1.0	T x F n.s.	

of spraying. Fruit set was significantly decreased when one spray application of the growth regulator was applied. Further decrease in number of fruits occurred when the second spray application was applied.

Significant differences in weight of marketable fruits occurred between treatments for the first cluster (Table 21). Plants grown under glass pro-

Table 21. Effects of frequencies of N-meta-tolylphthalamic acid sprays on marketable fruit weight (1st cluster) in ounces per plant from tomato transplants grown under different colored plastics (spring).

Treatment	Frequencies 0	1	2	Grand mean
Glass	4.6	15.0	1.3	7.0
Clear	21.4	39.8	34.5	31.9
Red	21.7	30.7	26.8	26.4
Yellow	20.8	30.6	31.7	27.7
Green	23.0	25.8	31.6	26.8
Grand mean	18.3	24.4	25.2	
LSD 5%	T 7.7	F 6.0	T x F n.s.	

duced significantly less marketable fruits than plants grown under any of the plastic treatments. Significant differences occurred in marketable fruit weight between frequencies of spraying. Marketable fruit weight was significantly increased when either one or two spray applications of the growth regulator were applied. There was no significant difference between first and second frequencies in weight of marketable fruits in the first cluster.

Significant difference between treatments for marketable fruit weight for the second cluster are shown in Table 22. Plants grown under glass produced significantly more marketable fruit weight than plants grown under red, yellow or green plastics. There was no significant difference between the plants grown under glass or those grown under clear plastic. Significant difference occurred between frequencies of spraying. Marketable fruit was significantly reduced by either one or two spray applications of the growth regulator. There was no significant difference between the first and second frequencies of application.

Table 22. Effects of frequencies of N-meta-tolylphthalamic acid sprays on marketable fruit weight (2nd cluster) in ounces per plant from tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	29.7	29.3	38.4	32.5
Clear	35.0	24.2	21.0	26.7
Red	32.7	22.7	17.8	24.4
Yellow	30.7	22.5	17.1	23.4
Green	22.8	20.8	20.2	21.3
Grand mean	30.2	23.9	22.9	
LSD 5%	T 7.2	F 5.6	T x F n.s.	

Significant differences in marketable fruit weight did not occur between treatments for the third cluster (Table 23). However, significant differences

Table 23. Effects of frequencies of N-meta-tolylphthalamic acid sprays on marketable fruit weight (3rd cluster) in ounces per plant from tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	30.3	28.3	27.1	28.6
Clear	26.8	18.8	17.8	21.1
Red	36.2	16.8	13.3	22.1
Yellow	31.8	28.4	10.8	23.7
Green	29.1	25.2	14.3	22.9
Grand mean	30.8	23.5	16.7	
LSD 5%	T n.s.	F 5.3	T x F n.s.	

between frequencies of spraying did occur. Marketable fruit weight was significantly decreased by either one or two applications of the growth regulator. Marketable fruit weight was further reduced when two applications of the chemical were applied.

Total marketable fruit weight per plant is shown in Table 24. Significant

Table 24. Effects of frequencies of N-meta-tolylphthalamic acid sprays on total marketable fruit weight per plant from tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	64.6	72.5	63.3	66.8
Clear	82.7	82.8	73.3	79.6
Red	90.0	70.1	57.8	72.6
Yellow	83.3	81.4	59.8	74.8
Green	74.7	71.8	66.1	70.9
Grand mean	79.1	75.7	64.1	
LSD 5%	T n.s.	F 10.8	T x F n.s.	

differences in total marketable fruit weight per plant did not occur between treatments; however, significant differences between frequencies of spraying did occur. There was no significant difference in marketable fruit weight between zero and the first frequency of spraying. However, significant decreases occurred when two applications of the growth regulator were applied. Plants that received two spray applications of the growth regulator produced significantly less total marketable fruit weight than plants that received one application or those that received no spray of the chemical.

Plants grown under glass were significantly taller than plants grown under any plastic treatment (Table 25). Plants grown under clear plastic were significantly taller than plants grown under red, yellow, or green plastics. There were no other significant differences between treatments for plant height. Significant differences in plant height also occurred between frequencies of spray application with the growth regulator. Plants that received no spray, zero frequency, were significantly taller than plants that

Table 25. Effects of frequencies of N-meta-tolylphthalamic acid sprays on plant height (inches) of tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	26.7	23.1	22.1	24.0
Clear	26.1	18.4	19.0	21.2
Red	21.3	13.6	15.3	16.7
Yellow	22.6	15.0	14.7	17.4
Green	22.1	16.1	13.7	17.3
Grand mean	23.8	17.2	17.0	
LSD 5%	T 1.5	F 1.1	T x F n.s.	

received either one or two spray applications of the chemical. Significant difference in plant height did not occur between one and two frequencies of spraying.

Dry weight of suckers per plant are given in Table 26. Significant

Table 26. Effects of frequencies of N-meta-tolylphthalamic acid sprays on dry weight (grams) of suckers per plant from tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	13.0	13.9	9.8	12.2
Clear	14.6	12.4	9.0	12.0
Red	13.2	12.5	7.6	11.1
Yellow	15.7	10.2	8.9	11.6
Green	12.6	11.9	10.7	11.7
Grand mean	13.8	12.2	9.2	
LSD 5%	T n.s.	F n.s	T x F n.s.	

differences in sucker weight did not occur between treatments. Significant differences occurred in sucker production between frequencies of spraying. Sucker weight was decreased by one spray application of the growth regulator.

Sucker weight was further reduced when two applications of the chemical were applied.

Significant differences in peduncle length between treatments did not occur (Table 27). However, significant differences occurred between frequencies

Table 27. Effects of frequencies of N-meta-tolylphthalamic acid sprays on peduncle length (centimeters) of tomato transplants grown under different colored plastics (spring).

Treatments	Frequencies 0	1	2	Grand mean
Glass	4.7	16.4	22.9	14.7
Clear	5.0	17.0	29.4	17.1
Red	6.4	18.1	24.9	16.4
Yellow	6.1	14.3	26.6	15.7
Green	6.6	10.6	29.9	14.7
Grand mean	5.8	15.3	26.1	
LSD 5%	T n.s.	F 2.0	T x F 4.4	

of spraying. One application of the chemical increased the peduncle length significantly compared to plants that were not sprayed. Further increased peduncle length was obtained when two spray applications of the growth regulator were applied. An interaction occurred between treatments and frequency in peduncle length. There was no significant difference between treatments at the zero frequency, but at the first frequency of spraying, plants grown under green plastic produced significantly shorter peduncles than those grown under glass, clear, and red plastics. Plants grown under clear plastic that received two applications of the chemical produced significantly longer peduncles than plants grown under glass or red plastic.

Fresh top weights, dry top weights, and dry weights of roots produced by plants grown under the five different treatments are given in Table 28. These

Table 28. Effect of colored plastics on fresh top weights, dry top weights and dry root weights of tomato transplants.

Treatment	Fresh top wt.	Dry top wt.	Dry root wt.
Red	7.33	0.45	.072
Clear	7.22	0.49	.086
Yellow	6.97	0.44	.088
Glass	6.86	0.52	.092
Green	5.86	0.34	.043
LSD 5%	0.69	0.05	.021

plants were not treated with the growth regulator. Significant differences between treatments occurred in fresh top weight. Plants grown under green plastic produced significantly less fresh weight than plants grown under any other treatment. There was no other significant difference between treatments; however, there were significant differences in dry weight between treatments. Plants grown under the green plastic produced significantly less dry weight than those grown in any other treatment. Plants grown under glass produced significantly more dry weight than those grown under green, red or yellow plastics. Also there were significant differences in dry weight of roots between treatments. Plants grown under green plastic produced significantly less dry weight of roots than those grown in any other treatment. There was no other significant difference in dry weight of roots between the other treatments.

DISCUSSION OF RESULTS

Fall Experiment

The results of this experiment revealed that plants grown under glass produced more flowers in the first cluster than plants grown under any of the colored plastic treatments. Plants which were grown under green plastic produced the fewest number of flowers in this cluster. This probably was due to higher light intensity under glass, clear, yellow and red plastics than green plastic (see Table 1).

These results agreed with those of Burkholder (3) and Shirley (13), that differentiation of organs was influenced by light intensity. Also plants that were grown under glass produced more flowers in the second cluster than plants grown under any plastic treatment except those that were grown under the clear plastic. These results apparently were influenced by the same factor, light intensity, because other environmental conditions were the same for all plastic treatments.

Colored plastics did not influence the number of blossoms in the third cluster, Even though the transplants were grown under different light intensities, the transplants when exposed to the same light intensity overcame the physiological disadvantage and the third clusters had similar number of blossoms regardless of previous treatment. This indicated, that tomato plants grown under unfavorable conditions will respond to favorable environmental conditions and fruit normally.

These results showed that the number of fruits set in the first and second clusters were parallel to the results of flower number of the first and the second clusters, respectively. This was probably due to a higher initial number of flowers in the first and second clusters of plants that were grown under glass and clear plastic.

Colored plastics did not influence the number of fruits for the third cluster. It should be re-emphasized that the transplants were grown under different light intensities, but the plants were then grown under similar environmental conditions. Therefore, by the time the third cluster formed, the physiological condition of the plants was similar and number of fruits was not influenced by treatments. Fruit weights for the first and second clusters were influenced by the light passing through the colored plastics. Plants grown under glass produced more marketable fruit weight in the first and second clusters than plants grown under any plastic treatment. Plants grown under clear plastic produced more marketable fruit weight than plants grown under red, yellow, or green plastics for the second cluster only. This was probably due to the higher initial number of fruits set in these clusters for both glass and clear plastic treatments. Marketable fruit weight for the third cluster was greater for the plants that were initially grown under red plastic than for those grown under glass.

Total marketable fruit weight per plant was influenced by the different propagation structures. Glass grown transplants produced more weight than those grown under yellow or green plastics. Transplants that were grown under green plastic produced the smallest yield per plant. These transplants were grown under the lowest light intensity and therefore they had the smallest initial flower number and therefore, fewer fruit set per cluster.

Height of plant was also affected by the different treatments. Plants that were grown under glass and therefore received the highest light intensity (Tables 1 and 2) were taller than plants grown under any other treatment.

Glass grown transplants obtained maximum height, four leaves above the third cluster, earlier than all other treatments. These results agreed with the results of Burkholder (3) and Shirley (13) that the rate of photosynthesis, stem thickness, leaf area per plant, and growth rate, were influenced by light intensity. In addition, plants grown under clear plastic were taller than plants from any other plastic treatment. This was also due to higher light intensity.

Dry weight of suckers per plant was influenced by the different treatments. Plants that were grown under glass and clear plastic produced larger quantities of suckers than those grown under red, yellow and green plastics. This probably was induced by the original vigor of growth of these plants before transplanting to the ground bed, because these plants were more vigorous and had larger leaf area and larger root system. These results also agreed with those of Burkholder (3) and Shirley (13) that dry weight of plant was affected by light intensity because more dry weight was obtained with higher light intensity.

The results of this study agree with those of Cordner and Hedger (4), Teubner and Wittwer (15) and Wittwer (21) relative to the effect of this growth regulator on increasing the number of flowers in the first cluster. This increase in number of flowers in the first cluster was interpreted by Cordner and Hedger (4) as having been caused by suppression of the sympodial bud and a delayed growth of the shoot of the plant resulting from the chemical application. Therefore, under these conditions, the inflorescence was dominated and had more time to differentiate floral primodia. The results of this study revealed that one application of N-meta-tolylphthalamic acid at a concentration of 175 ppm. increased flower number in the first cluster and that a second application of 87.5 ppm. further increased flower number. Plants grown under glass and clear plastic produced more flowers than those grown under green plastic. Also plants grown under higher intensity of light, under glass, produced more flowers in the first cluster than plants grown under any plastic treatment when they received two applications of the growth regulator. Flower number in the second cluster was not influenced by the application of the growth regulator regardless of whether one or two applications were made. An interaction indicated that this growth regulator decreased flower number when plants were grown under relatively low light intensities.

Number of flowers in the third cluster was not affected by either colored plastic or frequency of application of N-meta-tolylphthalamic acid. However, an interaction occurred when plants that were grown under red and green plastics were sprayed twice with the growth regulator. In fact, in all three clusters of plants that received two applications of the growth regulator, flower number was reduced on plants grown under the two treatments with the lowest light intensity. This chemical was applied only for its influence on flower initiation and not as a fruit setting hormone. Therefore a separate discussion will not be given on other aspects of fruiting because they are probably directly related to number of blossoms per cluster. There was no effect of the growth regulator on plant height, measured four leaves above the third cluster. However, the regulator reduced the dry weight of suckers per plant as the frequency of application was increased.

Spring Experiment

The results of this experiment revealed that plants grown under glass produced fewer flowers in the first cluster than plants from any plastic treatments. This adverse effect occurred only in plants grown under glass that received two sprays of the growth regulator. Plants grown under glass and were not sprayed initiated a normal number of flowers. Plants sprayed with one application of the growth regulator had over twice as many flowers as the non-sprayed plants. However, the plants grown under glass and which received two applications of the growth regulator only had the normal number of flowers, whereas plants grown under the structures covered with colored plastic had an average of four times more flowers than non-sprayed plants. Plants grown under glass and which received two applications of the growth regulator terminated in a flower cluster. This cluster had fewer blossoms than plants that received one spray of the growth regulator (See Plate V). These results indicate that treatments were not the cause of reduced blossom number, but rather it was probably due to the growth regulator (Wittwer, 21). Flower number in the second cluster was also influenced by treatments. Plants grown under glass produced more flowers in the second cluster than any plastic treatment (Table 16). Probably the difference in flower number between the first and second clusters of plants that were grown under glass and sprayed with two applications of the growth regulator was due to physiological development of the plants (Went 17 and 18). Colored plastic structures did not influence the number of flowers in the third cluster. This was probably due to growing all the plants under uniform light intensity after the transplant stage. The results for number of fruits for the first, second, and the

EXPLANATION OF PLATE V

Spring Experiment

Fig. 1. Close-up of a typical plant that received 2 applications of the growth regulator N-meta-tolylphthalamic acid showing a temporary suppression of the main growing point, tip.

Fig. 2. Close-up of typical plant from the same treatment that was not sprayed with the growth regulator. Observe the continuous growth of the main growing point of stem and the larger plant size. Photographed on March 27, 1961.

PLATE V

Fig. 1

Fig. 2

third clusters apparently were parallel to the results of flower initiation for the corresponding clusters.

The results for the marketable fruit weight for the first cluster, Table 21, revealed that plants grown under glass produced less fruit weight than any plastic treatment. This was due to fewer flowers and therefore fewer fruits in this cluster. The results for marketable fruit weight in the second cluster, Table 22, show that plants grown under glass produced more fruit weight than those grown under red, yellow, or green plastics. This was due to more flowers in this cluster than the corresponding clusters of plants that were grown under the plastic treatments. Colored plastics did not affect the marketable fruit weight of the third cluster or total marketable fruit weight per plant. This was probably due to higher light intensity in the spring than in the fall experiment (Tables 1 and 2). Larger yields were obtained in the spring than in the fall. This agrees with the results of Hemphill and Murneek (6).

Plant height was influenced by treatment. Plants that were grown under the highest light intensities were the tallest. Also plants grown under clear plastic were taller than those grown under red, yellow, and green plastics. High light intensity caused larger leaf area per plant, thicker leaves and higher initial growth rate of plants grown under glass and clear plastic. These results agree with those of Shirley (13), Burkholder (3), and Went (17, 18).

Propagation structure did not influence the dry weight of suckers per plant, nor peduncle length of the first flower cluster. This may be explained by the same factor mentioned before.

Fresh and dry weight of tops were affected by treatment (Table 28). Plants that were grown under green plastic weighed the least. Vine growth of tomato plants grown under glass weighed more on a dry weight basis than those that were grown under red, yellow, and green plastics. Also plants that were grown under clear plastic produced more fresh and dry weight of tops than those that were grown under green plastic. These results are probably directly related to light intensity. These results agree with those of Burkholder (3) and Shirley (13). Also the dry weight of roots was influenced by treatment. Plants that were grown under green plastic produced less root weight than those grown under all other treatments.

Number of flowers in the first cluster under different light intensities was influenced by this growth regulator (Table 15). One application of this growth regulator at 175 ppm. doubled the number of blossoms per cluster. A second application of 87.5 ppm. again doubled the number of blossoms per cluster. These results agree with those of Wittwer (21). A treatment x frequency interaction occurred when two spray applications were used. Plants grown under each plastic treatment had four times as many blossoms in the first cluster as those grown under glass. Evidently the physiological development was different for the plants grown under glass at the time that the second spray application was made, because these plants produced only the normal number of blossoms. Plants from the other treatments responded to the second application of the growth regulator.

Number of flowers in the second cluster was also influenced by the application of the growth regulator. The greatest response was from two applications of this material. Plants grown under higher light intensities responded much more favorably than those grown under red and green plastics. Plants grown under glass produced more flowers in the second cluster than those grown under any plastic treatment. This was probably due to the plants being more vigorous because of smaller first clusters, therefore more flower primodia formed for this cluster. Two applications of the growth regulator also increased flower number in the third clusters.

Fruit set in each cluster generally coincided with the number of blossoms per cluster. This growth regulator should not affect fruit set, because it was not applied as a fruit setting hormone, but rather as a growth regulator to increase flower number.

Marketable fruit weight of the first cluster was increased by the application of one or two sprays of this material. However, in the second cluster marketable fruit weight was decreased by either one or two applications of this chemical. In the third cluster marketable fruit weight was reduced by one application of the chemical and was markedly reduced by two applications. The effect of this growth regulator on total marketable fruit weight per plant indicated that two sprays definitely reduced marketable yield. There was no difference in total marketable fruit weight between non-sprayed plants and plants that received one application of the growth regulator. Therefore, this chemical does not increase the marketable yield per plant. This chemical does influence or change the number of blossoms in an individual cluster, and might be used effectively to increase the early harvest, but it did not increase total yield.

The application of either one or two sprays of this growth regulator reduced plant height. Plants that received either one or two applications of the growth regulator were similar in height, but were considerably shorter than the unsprayed plants. These results agree with those of Moore (10). Plants in this study were trained and pruned to a single stem.

Plants that were not sprayed with the growth regulator produced the largest weight of suckers. One application of N-meta-tolylphthalamic acid reduced the sucker weight only slightly; however, two applications of this material markedly reduced sucker weight. These results agree with those of Cordner and Hedger (4), and Leopold and Thimann (9). Plants treated with two applications of this material produced less marketable fruit, the plants were shorter, and they also produced less sucker weight. Therefore, two applications of this growth regulator certainly decreased vigor and growth of the plants. Peduncle length was increased approximately three times by one spray application of this growth regulator. Two spray applications resulted in a further increase in peduncle length. These results agree with those of Cordner and Hedger (4). Thus, N-meta-tolylphthalamic acid demonstrated it is an auxin by increasing peduncle length, because the peduncle is a specialized stalk.

SUMMARY

Tomato transplants grown under different light intensities were influenced by treatment.

1. The plants grown under glass produced significantly more flowers in the first cluster than plants grown under different colored plastics in the fall experiment. However, they produced significantly fewer flowers in the first cluster than plants grown under the plastic treatments in the spring experiment.

2. Plants grown under glass, for the spring experiment, produced significantly more flowers in the second cluster than those grown under any of the colored plastics.
3. The plant tops grown under the ivy green colored plastic weighed significantly less than plants from other treatments.
4. Dry weight of plant tops was greater from the glass treatment than from colored plastics.
5. Dry root weight of transplants indicated that all treatments produced plants with larger root systems than the green plastic.
6. Plants from the glass treatment were significantly taller than any other treatment. And plants from clear plastic were significantly taller than colored plastic treatments at the conclusion of the experiments.
7. Application of the growth regulator produced significantly shorter plants than plants not sprayed.
8. Light intensities did not influence sucker weight in the spring experiment, but in the fall experiment they did. Two applications of the growth regulator significantly reduced dry weight of suckers when compared with non-sprayed plants.
9. Light intensity did not influence peduncle length, but application of the growth regulator did. One application of the growth regulator increased the peduncle length. Additional increase in length occurred when two applications were used.
10. When marketable fruit weights from individual clusters were considered, differences occurred due to treatments. These differences due to treatments and frequencies varied from treatment to treatment and from frequency

of application by clusters. However, total marketable fruit weight per plant revealed that there was no significant difference due to treatment. Furthermore, it was shown that there was no beneficial effect on yield of marketable fruits from the application of the growth regulator under the conditions of this experiment. Two applications of this growth regulator reduced the yield when compared to no application.

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THE EFFECT OF N-META-TOLYLPHTHALAMIC ACID AND LIGHT INTENSITIES ON TRANSPLANTED GREENHOUSE GROWN TOMATOES

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In recent years growth regulators for plants have become increasingly important in agricultural research; this is especially true in the field of horticulture. Flower initiation, fruit set, and relative plant growth are among the objectives of employing growth regulators to plants. The use of plastic materials on plant growing structures has increased many fold in recent years. This study was conducted to investigate the following:

(1) To evaluate some effects of the growth regulator, N-meta-tolylphthalamic acid on tomato transplants grown under different light intensities.

(2) To evaluate the effects of light transmitted through different colored plastics and glass on greenhouse tomato transplants.

Two experiments were conducted, the first in the fall of 1960 and the second in the spring of 1961. In both cases seeds of the Tuck-cross O variety were germinated in sand and grown under a glass house until they were transplanted. The seedlings were placed in 3-inch clay pots containing a good fertile soil. They were then taken to the appropriate greenhouses covered with (1) clear, (2) jonquil yellow, (3) tropical coral (red), and (4) ivy green plastics as well as (5) a glass house. One group of these seedlings was sprayed with N-meta-tolylphthalamic acid at concentration 175 ppm. Another portion received two applications of this material. The first application contained a concentration of 175 ppm. The second application consisted of 87.5 ppm. The third group of seedlings was not treated with the growth regulator. These seedlings were kept under these different structures approximately 26 - 28 days in both experiments. Then all plants were transplanted to a ground bed in a glass house. A randomized block design was used in the glass house. The transplants were trained and pruned to a single stem.

All plants were topped at a point four leaves above the third cluster. The following data were recorded for the first three clusters: flower number, fruit number and marketable fruit weight per cluster. Total marketable fruit weight per plant was also obtained. Other data obtained for both experiments included dry weight of suckers per plant, and plant height. Additional information obtained only in the spring experiment included peduncle length of the first cluster. In a separate spring experiment fresh and dry top weights and dry root weights were obtained for non-treated transplants that were grown under the different colored propagating structures.

The results of this study indicated that the number of flowers in the first cluster was influenced by light intensity and by the application of the growth regulator. More flowers were initiated in the first cluster for plants that were grown under glass and received two applications of the growth regulator. In contrast, the smallest number of flowers was initiated under green plastic in the fall experiment. Clear plastic also increased flower number for the first cluster compared to green plastic. However, in the spring experiment flower number in the first cluster was smallest for plants grown under the glass treatment that received two applications of the chemical. Flower number in the second cluster was also influenced by treatment. Glass house grown plants had an increased flower number compared to plants grown under red, yellow and green plastics, in the fall experiments. However, in the spring experiment the glass house grown plants were inferior to plastic grown plants, particularly for early fruit set. The growth regulator did not influence flower number in the second cluster in the fall experiment, but in the spring experiment it did. No differences occurred in flower number for the third cluster due to treatment or frequency of application of the chemical in either experiment. Number of fruits per cluster and marketable fruit weight were approximately parallel to numbers of flowers for corresponding clusters in each treatment. Total marketable fruit weight per plant was influenced by propagation structure for the fall experiment. Glass house grown plants had the largest marketable weight per cluster and also on a plant basis. Green plastic decreased marketable fruit weight more than red and yellow plastics. Differences occurred in plant height due to light intensity and to frequency of application of the growth regulator. Glass house and clear plastic structures increased plant height compared to other plastic structures. Differences did not occur among plants grown in the colored plastic structures. Application of the growth regulator decreased plant height. Dry weight of suckers per plant was greater for plants grown under glass and clear plastic than it was for plants grown under the colored plastics in the fall experiment. However, these differences did not occur in the spring experiment. Application of the growth regulator decreased the dry weight of suckers in both experiments. This decrease was proportional to the concentration used. Light intensity did not influence the peduncle length, but application of the growth regulator did. The increase in length again was proportional to the concentration. In the spring a separate experiment was conducted to evaluate the effect of light on the growth of transplants. Transplants grown under green plastic weighed the least (fresh top weight). Other treatments did not influence fresh top weight. Green plastic also decreased the dry weight of tops. Plants grown under glass produced the largest amount of dry matter. Differences in plant weight did not occur among red, yellow and clear plastic treatments. Plants grown under green plastic also had a smaller root system (by weight) than plants from the other treatments.