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CONTENTS

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Effects of the Interaction of Varying Temperatures and Light Intensities on the Response of Flax to 2,4-D

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IN THE DEVELOPMENT OF CHEMICAL WEED CONTROL, 2,4-D has become the most widely used herbicide. Investigations have shown that environmental factors, dosage, formulations, and time of application influence the response of plants to 2,4-D. The factors affecting the response of monocotyledons, especially cereals, to 2,4-D have received much attention and the results have been presented in several publications (Derscheid, 1952; Derscheid, *et al.*, 1952; Derscheid, *et al.*, 1953; Elder and Gassaway, 1949; Shaw and Willard, 1949; and Staniforth, 1952). The factors affecting the response of dicotyledons to 2,4-D have also been studied but there has been little success in formulating a workable hypothesis for the differential response of different species or of the same species at various stages of development.

The purpose of this study was to determine the effects of the interaction of varying temperatures and light intensities on the response of flax (*Linum usitatissimum* L.) to 2,4-D. Flax was chosen as a test plant because it is sufficiently tolerant to 2,4-D to make the study possible and yet susceptible enough to respond to treatment and research had been conducted to determine some of the factors which influence its response to 2,4-D and related herbicides.

Review of Literature

Studies have been made to determine the factors which influence the response of flax to 2,4-D and related substances. Paatela and Dunham (1949) studied the effects of the rate of growth on the susceptibility of flax to 2,4-D. Shulstad (1950) found that varietal response changes throughout the growing season. Sharma (1950) stated that response was affected by the stage at which the flax was treated. Dunham (1954) reports that:

> "As a result of trials for three years with one variety and two years with three varieties, spraying separate weed-free plots every other day from emergence until full bloom has shown that response to time of spraying varies with years."

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The effect of light intensity on the response of plants to 2,4-D has been studied by several research workers. Some report that plants were more susceptible when grown under high light intensities than when grown under low light intensities (Blackman and Robertson-Cunninghame, 1955; Rice, 1948). Others report that plants were more susceptible to 2,4-D when grown under low light conditions (Hitchcock and Zimmerman, 1948; Penfound and Minyard, 1947).

Blackman (1946) reported that increased light intensity increased the surface area of sunflower leaves which allowed them to intercept more 2,4-D. He claimed that there was more penetration under high light intensity than low light intensity. Blackman also reported that the light intensity after spraying was more important than the light intensity before spraying, but a combination of low light intensity before and after spraying made possible a decrease in the dose required to give 50 percent mortality.

Several investigators have noted a relationship between temperature and plant response to 2,4-D. Marth and Davis (1945) found that *Barbarea verna* and *Plantago lanceolata* survived when grown at 32-40° F. for 1 week before spraying with 2,4-D but died if the temperature before treatment was 50-65°, 65-75°, or 75-90° F. If the treated plants were moved from the coldest to warmer temperatures, 2,4-D injury occurred.

Kelly (1949) noted that kidney beans, perennial ryegrass, and crabgrass were most susceptible to 2,4-D when grown at 25° C. (77° F.) before treatment, less at 15° C. (59° F.), and least susceptible at 5° C. (41° F.).

Paatela and Dunham (1949) found that flax plants that had grown slowly (at 50° F.) before and after spraying with 2,4-D did not show as distinct stem bending or as great reduction in height as did those which grew rapidly before spraying (at 85° F.).

Staniforth and Bryan (1950) found that the response of beans to 2,4-D doubled with each 10° C. (50° F.) rise in temperature if they were exposed to 5° to 25° C. (41° to 77° F.) after treatment.

Alban (1953) found that sweet corn grown at 61° F. was not damaged by 2,4-D treatment if the temperature was increased to 70 or 80° F. for 12-72 hours prior to treatment. When the conditioning period was increased to 96 hours some damage occurred. Corn grown at 80° F. and then conditioned at 60° F. for 12-72 hours before treatment was damaged by 2,4-D. When the conditioning period was increased to 92 hours the response was decreased. Elle (1952) found that sweet corn exposed to 90° F. for 3 or 7 hours before and 1 hour after treatment with 2,4-D was damaged more than when exposed to 60° F. for the same duration. Blackman and Robertson-Cunninghame (1955) reported that 2,4-D depressed the growth of *Lemna minor* more at 30° C. (86° F.) than at 20° C. (68° F.).

Materials and Methods

Flax plants were grown in pots in chambers in which light intensities and temperature could be controlled. The day temperature in the chambers was 65, 75, or 85° F. ±2° F. At night the temperature in all chambers was 65° F. The light in each chamber was adjusted so that the intensity 2.5 inches above the base of the plants was 200, 500, 800, or 1,100 ft.-c. Light intensity was measured with a Weston Illumination Meter No. 476. Light was furnished 12 hours daily by fluorescent tubes with emission maxima at 540 and 600 mμ and by incandescent bulbs which furnished additional light above 600 mμ.

PLANT CULTURE

Twenty seeds of a pure line of Marine flax were planted at a uniform depth and spacing in 6-inch pots containing Waukegan silt loam soil. The plants were allowed to emerge in a controlled environment room at 65° F. and 800 ft.-c. light intensity. When the cotyledons were fully expanded, the plants were thinned to eight per pot. They were than placed in chambers to grow under pre-treatment light and temperature combinations before being sprayed with 2,4-D.

After the flax had received a pre-treatment conditioning at the desired combination of day temperature and light intensities, the plants were removed from the chambers. Twelve pots of flax were selected for each light and temperature combination to be studied. The height of the five most uniform plants in each pot was measured and the number of internodes longer than 1 millimeter was counted. The plants in 8 pots from each group of 12 were sprayed uniformly with an 1,100 p.p.m. dilution of the triethanolamine salt of 2,4-D in water. The volume was adjusted so that rate was equivalent to field treatments of 6 ounces per acre. The plants in the remaining four pots were retained as checks. After treatment the plants were allowed to stand for 30 minutes before being placed in appropriate post-treatment temperature and light conditions.

At the end of each 28-day trial the plants were harvested by cutting at the soil level. Immediately after harvest, plant heights were measured and the internodes longer than 1 millimeter were counted. The plants were then oven-dried at 212° F. for 24 hours and weighed.

EXPERIMENTAL DESIGN

The major variables in the study were day temperature and light intensity to which plants were exposed for varying periods both before and after treatment with 2,4-D. The day temperatures used were 65°, 75°, and 85° F. and the light intensities were 200, 500, 800, and 1,100 ft.-c. making possible 12 combinations of temperature and light. The study was divided into three parts as follows:

Constant day temperature and light intensity. The flax was grown for 14 days before spraying at each of 12 combinations of day temperature and light intensity. After treatment the plants were grown another 14 days under the same temperature and light combination. For example, 1 of the 12 combinations used follows:

Temperature-light combination before treatment	Treated	Temperature-light combination after treatment
14 days at 65° F. and 800 ft.-c.	2,4-D	14 days at 65° F. and 800 ft.-c.

Post-treatment variation of day temperature and light intensity. In this trial the same temperatures and light intensities were used except that the 500 ft.-c. light intensity was omitted as a pre-treatment variable. The flax was grown for 14 days before spraying at each of 9 combinations of day temperature and light intensity. After treatment the plants were grown for 14 days at each of 12 post-treatment combinations of day temperature and light intensity. An example of 1 of the 9 constant pre-treatment and 12 varied post-treatment combinations follows:

Temperature-light combination before treatment	Treated	Temperature-light combination after treatment
14 days at 65° F. and 800 ft.-c.	2,4-D	14 days at 12 combinations of temperature and light

Pre-treatment variation of day temperature and light intensity. This trial was divided into two parts:

1. Pre-treatment variation continued as post-treatment. Plants were grown under constant and then varied pre-treatment conditions as follows: (a) 65° F. and 800 ft.-c. for 14 days and 12 combinations for 2 days, (b) 65° F. and 800 ft.-c. for 16 days and 12 combinations

Diagram of one of the combinations of temperature and light intensity used in the study of the first pre-treatment variation of day-temperature and light intensity

Temperature and light combinations before treatment	Treated	Temperature and light combinations after treatment
(a) 12 days at 65° F. and 800 ft.-c. *plus* (b) 2 days at 65° F. and 200, 500, 800, and 1,100 ft.-c. or 75° F. and 200, 500, 800, and 1,100 ft.-c. or 85° F. and 200, 500, 800, and 1,100 ft.-c.	2,4-D	14 days at the same conditions shown for (b) under temperature and light combinations before treatment

for 2 days, (c) 65° F. and 800 ft.-c. for 8 days and 12 combinations for 8 days. After treatment the plants were grown for the remainder of the 28-day growing period under the same combinations as obtained 2 or 8 days before treatment. One of the combinations used is shown in the diagram above.

2. Pre-treatment variations of day temperature and light intensity with constant temperature and light intensity after treatment. Plants were grown before treatment for 12, 14, or 18 days at each of 12 combinations of day temperature and light intensity. After treatment the plants were grown for the remainder of the 28-day growing period at 65° F. and 800 ft.-c. An example of one of the combinations follows:

Temperature-light combinations before treatment	Treated	Temperature-light combination after treatment
14 days at 12 combinations of temperature and light	2,4-D	14 days at 65° F. and 800 ft.-c.

Experimental Results

Experiments were designed to study the effects of the interaction of varying day temperatures and light intensities on the response of flax to 2,4-D. The experimental results are presented in three phases as follows: effects of constant day temperature and light intensity, effects of post-treatment variation of day temperature and light intensity, and effects of pre-treatment variation of day temperature and light intensity.

The data are presented in 16 tables. Data concerned with measures of response (height, number of internodes, and dry weight) to 2,4-D represent averages for 40 treated plants and 20 untreated plants. Each table reports the temperature and light conditions under which the plants grew, the plant height and percent reduction in plant height, the number and percent reduction of the number of internodes longer than 1 millimeter, and the dry weight and percent reduction of dry weight of harvested plants.

EFFECTS OF CONSTANT DAY TEMPERATURE AND LIGHT INTENSITY

In this phase of the experiment, plants received the same temperature and light conditions both before and after spraying. Twelve combinations of temperature and light intensity were used. The data are shown in table 1.

The plants varied in size at the time of spraying depending on the temperature-light combinations at which they grew prior to treatment. As shown in the third and fourth columns of table 1, the average plant heights varied from 78 to 140 mm. and the average number of internodes longer than 1 mm. ranged from 3 to 16.

Plants grown at 85° F. and 200 ft.-c. were dead 4 days after treatment and those grown at 75° F. and 200 ft.-c. were dead 8 days after treatment. Dead plants are indicated by a dash in the columns of figures in table 1. Plants grown at 65° F. and any light intensity

Table 1. The temperatures and light intensities under which flax was grown for 14 days before and after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction of dry weight of plants at spraying and after harvest*

Pre-treatment and post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	78	3	139	118	15.1	17	12	29.4	24	14	41.7
65	500	91	7	176	146	17.1	23	17	26.1	36	23	36.2
65	800	97	9	198	174	12.1	26	21	19.2	50	38	24.0
65	1,100	107	11	213	201	5.6	30	26	13.3	58	53	8.6
75	200	81	5	140	—	—	19	—	—	18	—	—
75	500	98	8	205	148	27.8	28	17	39.3	41	20	51.2
75	800	115	11	233	190	18.5	32	25	21.9	69	35	49.3
75	1,100	121	12	251	239	4.8	37	33	10.8	86	73	15.1
85	200	85	4	131	—	—	14	—	—	11	—	—
85	500	106	10	223	143	35.9	31	16	48.4	56	16	71.4
85	800	128	13	249	185	25.7	35	27	22.9	78	32	58.9
85	1,100	140	16	269	256	4.8	44	39	11.4	99	84	15.2

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

survived the 2,4-D treatment. The data taken at harvest show a decrease in the percent reduction of height, internodes, and dry weight as the light intensity increased. When the plants were grown at 200, 500, or 800 ft.-c. the greatest percent reduction of height, internodes, and dry weight occurred at 85° F. and the smallest percent reduction occurred at 65° F. When the plants were grown at 1,100 ft.-c. the percent reduction in height was about the same at all three temperatures, and percent reductions of the number of internodes was the greatest at 65° F. and the smallest at 75° F., while the percent reduction of dry weight was greatest at 85° F. and smallest at 65° F.

EFFECTS OF POST-TREATMENT VARIATION OF DAY TEMPERATURE AND LIGHT INTENSITY

In this phase of the study, experiments were designed to determine the effect of post-treatment variation of day temperatures and light intensities on the response of flax to 2,4-D. Nine pre-treatment combinations of constant temperature and light intensity were used. After treatment the plants from each pre-treatment combination were grown at 12 post-treatment combinations of temperature and light intensity. The data are reported in tables 2 through 10. The 9 tables differ in the pre-treatment combinations of temperature and light. Thus, table 2 presents data for flax conditioned before treatment at 65° F. and 200 ft.-c. while table 3 reports data for flax conditioned at 75° F. and 200 ft.-c., etc.

Variations in heights of plants and number of internodes at the time of spraying were the results of differences in the temperature-light combinations used as pre-treatment conditions. A comparison of tables 2, 3, and 4 exposes some differences and some similarities among the results. When the plants were grown at 65° or 75° F. and 200 ft.-c. before treatment they were killed by 2,4-D at temperatures of 75° or 85° F. and 200 ft.-c. of light after treatment. Plants grown before treatment at 85° F. and 200 ft.-c. were killed by 2,4-D when grown at 200 ft.-c. of light after treatment regardless of temperature. At any post-treatment temperature-light combination the greatest reduction in height occurred when the pre-treatment temperature was 85° F. and the least when it was 65° F. An examination of tables 2, 3, and 4 shows a general trend toward greater reduction in height, internodes, and dry weight with increasing temperatures either before or after treatment.

Tables 5, 6, and 7 show that plants died when grown at 65°, 75°, or 85° F. and 800 ft.-c. before treatment and 85° F. and 200 ft.-c. after treatment. When the percentages of reduction in height, internodes, and dry weight are compared for each temperature, whether before or after treatment, the largest effect resulted from a light intensity of 200 ft.-c. and the smallest from 1,100 ft.-c. When either pre-treatment or post-treatment temperatures are compared, the percent reduction of height and dry weight was largest at 85° F. and smallest at 65° F. In none of the three tables does the percent reduction of internodes follow a definite trend when the three temperatures at each light intensity are compared.

Plants grown before treatment at 65°, 75°, or 85° F. and 1,100 ft.-c. (tables 8, 9, and 10) were killed by 2,4-D when exposed to 85° F. and 200 ft.-c. of light after treatment. A comparison of the data given in the three tables reveals a decrease in the percent reduction of height, internodes, and dry weight with an increase in light intensity at all post-treatment temperatures. The only exception is found in table 9 where the percent reduction of internodes at 75° F. and 800 ft.-c. is 9.4 but is 11.2 where the light intensity was 1,100 ft.-c. In table 8 the percent reduction of height generally follows a trend of de-

Table 2. The temperatures and light intensities under which flax (conditioned at 65° F. and 200 ft.-c. for 14 days) was grown for 14 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction of dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	77	3	136	113	16.9	16	11	31.3	22	13	40.9
65	500	77	3	148	117	20.9	17	11	35.3	23	15	34.8
65	800	77	3	154	126	18.2	19	13	31.6	24	16	33.3
65	1,100	77	3	162	155	11.3	19	16	15.8	29	21	27.6
75	200	77	3	143	—	—	14	—	—	14	—	—
75	500	77	3	155	114	26.5	18	11	38.9	21	9	57.2
75	800	77	3	168	135	19.7	19	15	21.1	28	15	46.4
75	1,100	77	3	182	158	13.2	23	19	17.4	33	23	30.3
85	200	77	3	125	—	—	11	—	—	10	—	—
85	500	77	3	163	124	23.9	20	12	40.0	23	11	52.2
85	800	77	3	178	143	19.7	22	16	27.3	26	14	46.2
85	1,100	77	3	195	155	20.5	27	22	18.5	32	19	40.7

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

Table 3. The temperatures and light intensities under which flax (conditioned at 75° F. and 200 ft.-c. for 14 days) was grown for 14 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction in dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	79	3	148	102	31.1	16	8	50.0	25	13	48.0
65	500	79	3	154	119	22.7	18	12	33.3	26	15	42.3
65	800	79	3	163	129	20.8	20	14	30.0	30	20	33.3
65	1,100	79	3	176	145	17.6	24	17	29.2	35	24	31.4
75	200	79	3	140	—	—	15	—	—	16	—	—
75	500	79	3	164	119	27.4	21	13	38.1	26	10	66.5
75	800	79	3	169	131	22.5	23	17	26.1	28	14	50.0
75	1,100	79	3	184	151	17.9	27	19	29.6	32	20	37.5
85	200	79	3	134	—	—	13	—	—	11	—	—
85	500	79	3	171	109	36.3	20	11	45.0	22	6	72.7
85	800	79	3	187	132	29.4	23	14	39.1	30	11	64.3
85	1,100	79	3	201	160	20.4	25	19	24.0	37	20	46.0

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

Table 4. The temperatures and light intensities under which flax (conditioned at 85° F. and 200 ft.-c. for 14 days) was grown for 14 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction in dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	82	4	122	—	—	13	—	—	12	—	—
65	500	82	4	163	113	30.7	20	11	45.0	29	14	51.7
65	800	82	4	174	122	29.9	21	14	33.1	31	17	45.0
65	1,100	82	4	182	146	19.8	23	18	21.7	37	24	35.1
75	200	82	4	131	—	—	16	—	—	14	—	—
75	500	82	4	170	109	35.9	22	9	59.1	28	9	78.0
75	800	82	4	178	125	29.8	23	13	43.5	30	12	60.1
75	1,100	82	4	191	150	21.5	25	17	32.0	36	19	47.2
85	200	82	4	115	—	—	12	—	—	8	—	—
85	500	82	4	186	105	43.6	24	10	58.4	28	6	85.7
85	800	82	4	198	135	31.8	26	16	38.5	31	11	64.5
85	1,100	82	4	225	178	20.9	32	23	28.2	54	25	53.7

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

Table 5. The temperatures and light intensities under which flax (conditioned at 65° F. and 800 ft.-c. for 14 days) was grown for 14 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction in dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	97	8	155	132	14.8	16	14	12.5	24	16	33.3
65	500	97	8	171	152	11.1	21	18	14.3	32	23	28.2
65	800	97	8	194	175	9.8	25	22	12.0	44	33	25.0
65	1,100	97	8	201	188	6.5	28	24	14.3	48	41	14.6
75	200	97	8	159	127	20.2	19	14	26.4	23	11	52.2
75	500	97	8	172	143	16.9	21	16	23.9	25	16	36.0
75	800	97	8	188	164	12.8	24	21	12.5	35	24	31.4
75	1,100	97	8	207	195	5.8	28	25	10.7	46	37	19.6
85	200	97	8	123	—	—	12	—	—	9	—	—
85	500	97	8	183	149	18.6	23	18	21.8	30	16	46.7
85	800	97	8	198	172	13.1	28	21	25.0	36	25	30.6
85	1,100	97	8	218	202	7.3	30	27	10.0	49	38	22.5

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

Table 6. The temperatures and light intensities under which flax (conditioned at 75° F. and 800 ft.-c. for 14 days) was grown for 14 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction in dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	112	11	164	138	15.9	21	13	38.1	29	18	37.9
65	500	112	11	171	149	12.9	21	16	23.9	33	23	30.4
65	800	112	11	178	161	9.6	23	18	21.8	36	27	25.0
65	1,100	112	11	189	175	7.5	24	20	16.7	41	35	14.7
75	200	112	11	168	122	27.4	19	11	42.2	25	11	56.0
75	500	112	11	196	162	17.4	27	20	26.0	36	22	38.9
75	800	112	11	229	197	14.0	30	26	13.4	59	38	35.6
75	1,100	112	11	238	218	8.4	33	29	12.2	72	51	29.2
85	200	112	11	148	—	—	17	—	—	16	—	—
85	500	112	11	208	159	23.6	29	20	31.1	43	21	51.2
85	800	112	11	234	194	17.1	33	26	21.3	62	33	46.8
85	1,100	112	11	246	216	12.2	36	31	13.9	73	47	35.6

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

Table 7. The temperature and light intensities under which flax (conditioned at 85° F. and 800 ft.-c. for 14 days) was grown for 14 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction in dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	125	12	189	140	26.0	24	13	45.8	38	19	50.0
65	500	125	12	193	157	18.7	26	17	30.6	42	24	42.8
65	800	125	12	205	174	15.1	27	21	22.3	47	33	29.8
65	1,100	125	12	213	189	11.0	29	21	17.1	51	41	19.6
75	200	125	12	186	133	28.5	24	16	33.4	35	13	62.9
75	500	125	12	211	171	19.0	29	23	20.7	51	28	54.9
75	800	125	12	236	204	13.6	33	27	18.2	70	42	40.0
75	1,100	125	12	244	221	9.4	35	29	17.2	75	54	28.0
85	200	125	12	158	—	—	18	—	—	16	—	—
85	500	125	12	213	145	53.7	30	17	43.4	45	15	66.7
85	800	125	12	243	192	44.0	33	27	18.2	73	34	53.4
85	1,100	125	12	251	222	11.6	37	32	13.6	79	51	35.5

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

Table 8. The temperatures and light intensities under which flax (conditioned at 65° F. and 1,100 ft.-c. for 14 days) was grown for 14 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction in dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	108	10	162	144	11.1	20	16	20.0	29	23	20.7
65	500	108	10	186	171	8.1	24	20	17.5	39	31	20.5
65	800	108	10	204	189	7.4	28	24	14.3	46	40	13.1
65	1,100	108	10	215	207	3.7	31	27	13.0	51	45	11.6
75	200	108	10	171	148	13.5	22	16	27.2	27	19	29.6
75	500	108	10	189	168	11.1	25	19	24.0	34	26	23.6
75	800	108	10	211	192	9.0	29	26	10.4	48	37	22.9
75	1,100	108	10	222	212	4.5	31	28	9.7	58	49	15.6
85	200	108	10	156	—	—	18	—	—	19	—	—
85	500	108	10	198	170	14.2	26	21	19.3	36	24	33.3
85	800	108	10	220	199	9.6	30	27	10.0	51	34	33.3
85	1,100	108	10	241	228	5.4	33	31	6.1	66	57	13.7

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

Table 9. The temperatures and light intensities under which flax (conditioned at 75° F. and 1,100 ft.-c. for 14 days) was grown for 14 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction in dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	120	12	169	148	12.4	22	17	22.8	33	23	30.3
65	500	120	12	183	162	11.5	23	19	17.4	37	29	21.6
65	800	120	12	198	181	8.6	28	23	17.9	43	36	16.3
65	1,100	120	12	207	194	6.3	28	25	10.8	47	41	12.8
75	200	120	12	162	143	11.7	20	15	25.0	24	16	33.3
75	500	120	12	201	173	13.9	27	20	26.0	40	29	27.5
75	800	120	12	233	211	9.5	32	29	9.4	68	51	25.1
75	1,100	120	12	247	231	6.5	36	32	11.2	78	65	16.7
85	200	120	12	155	—	—	19	—	—	19	—	—
85	500	120	12	215	179	16.8	31	21	32.3	46	26	43.5
85	800	120	12	238	213	10.5	34	30	11.8	67	44	34.4
85	1,100	120	12	255	237	7.1	37	33	10.9	79	68	14.0

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

Table 10. The temperatures and light intensities under which flax (conditioned at 85° F. and 1,100 ft.-c. for 14 days) was grown for 14 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction in dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	139	15	194	165	15.0	26	19	27.0	43	28	34.9
65	500	139	15	203	182	10.4	28	23	17.9	48	37	23.0
65	800	139	15	213	197	7.5	29	24	17.3	58	46	20.7
65	1,100	139	15	224	210	6.3	31	28	9.7	64	53	17.2
75	200	139	15	194	152	21.7	28	16	42.9	39	19	51.3
75	500	139	15	223	196	12.1	32	26	18.8	56	39	30.4
75	800	139	15	247	225	8.9	36	30	16.7	80	58	27.5
75	1,100	139	15	255	237	7.1	37	33	10.9	84	68	16.6
85	200	139	15	163	—	—	20	—	—	18	—	—
85	500	139	15	219	165	24.7	32	21	47.7	49	21	57.2
85	800	139	15	248	236	4.8	35	30	14.3	87	58	33.4
85	1,100	139	15	269	260	3.3	43	38	11.7	104	93	15.4

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

crease with lower temperatures. In table 9 the same trend is found when the light intensities are 200 or 500 ft.-c. but is greater at 800 ft.-c. than at 1,100 ft.-c. There is no definite trend in the percent reduction of internodes when the light intensities are compared at all three temperatures. There is an increase in the percent reduction of dry weight as temperature after treatment increases except when the light intensity was 1,100 ft.-c. When the light intensity after treatment was 1,100 ft.-c. there appears to be no association in the percent reduction of dry weight with the post-treatment temperature.

EFFECTS OF PRE-TREATMENT VARIATION OF DAY TEMPERATURE AND LIGHT INTENSITY

In this phase of the study, experiments were designed to determine the effects of pre-treatment variation of day temperatures and light intensities on the response of flax to 2,4-D. Six experiments were performed: three to study the effects of pre-treatment variations of temperature-light combinations continued without change as post-treatment, and three to determine the effects of pre-treatment variations not continued as post-treatment.

The results of pre-treatment variations continued as post-treatment are shown in tables 11, 12, and 13. Table 11 shows the results when flax was grown before treatment at 65° F. and 800 ft.-c. for 14 days followed by 12 combinations of temperature and light for 2 days. After treatment the plants were grown under the same conditions at which they had been grown immediately before treatment. The experiments reported in tables 12 and 13 differ from table 11 in the length of exposure to the temperature-light conditions. A comparison of these tables shows that height of plants and number of internodes at time of spraying were affected by the light intensity at which they were conditioned. Thus, in table 11, height measurements varied from 96 to 101 mm. at 65° F. and 200 to 1,100 ft.-c.; from 97 to 103 mm. at 75° F. and the same variables of light; and from 99 to 106 mm. at 85° F.

The results presented in tables 11, 12, and 13 are similar in that at any given temperature the largest percent reduction of height, internodes, and dry weight by 2,4-D occurred at 200 ft.-c. and the smallest reduction occurred at 1,100 ft.-c.

The overall similarity between tables 11 and 13 and their differences from table 12 should be noted. It can be seen that under the conditions represented by tables 11 and 13 the plants were killed by 2,4-D when the temperature-light combination for the 2 or 8 days immediately prior to treatment and also following treatment was 75° or 85° F. and 200 ft.-c. The data in table 11 show that when the plants were grown at 65° F. and 800 ft.-c. for 16 days before treatment they were not killed by 2,4-D regardless of the temperature-light combinations for 2 days before treatment and 10 days after treatment. In all three tables there is a decrease in the percent reduction of height, internodes, and dry weight as the light intensity increases. When temperatures are compared at each light intensity it appears that generally there is an increase in the percent reduction of height and dry weight with higher temperatures. There are, however, some exceptions which may readily be noted. The percent reduction of internodes at any given light intensity does not follow a consistent trend for all three temperatures.

The results of pre-treatment variations of day temperature and light intensity and constant temperature and light intensity after treatment are reported in tables 14, 15, and 16. Flax was grown before treatment for 12, 14, or 18 days at 12 combinations of temperature and light intensity. When sprayed the plants varied in height and

Table 11. The temperatures and light intensities under which flax (conditioned at 65° F. and 800 ft.-c. for 14 days) was grown for 2 days before and 12 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction of dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	96	7	160	111	30.6	17	10	41.2	30	12	60.1
65	500	98	8	179	158	11.7	22	16	27.3	34	27	20.6
65	800	99	8	197	181	8.1	27	21	22.3	45	37	17.8
65	1,100	101	10	204	198	3.0	28	26	7.2	47	42	10.6
75	200	97	8	132	—	—	15	—	—	13	—	—
75	500	99	9	174	128	26.4	20	12	40.0	28	13	53.6
75	800	101	10	203	184	9.4	27	23	14.9	44	33	25.0
75	1,100	103	10	215	205	4.7	29	27	6.9	51	42	17.6
85	200	99	8	121	—	—	11	—	—	7	—	—
85	500	102	9	178	135	24.2	23	14	39.2	26	11	57.7
85	800	103	10	207	189	8.7	28	24	14.3	49	29	40.8
85	1,100	106	11	218	211	3.2	31	28	9.7	52	43	17.3

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

Table 12. The temperatures and light intensities under which flax (conditioned at 65° F. and 800 ft.-c. for 16 days) was grown for 2 days before and 10 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction of dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	99	9	157	125	20.4	19	12	36.9	27	14	48.2
65	500	101	10	181	168	7.2	24	19	20.8	37	32	13.5
65	800	102	11	208	199	4.3	29	24	17.3	49	43	12.3
65	1,100	103	11	222	218	1.8	30	28	6.7	60	55	8.3
75	200	101	9	144	115	20.1	15	9	40.3	14	7	50.0
75	500	103	11	197	182	7.6	27	19	29.7	38	30	21.1
75	800	104	11	214	205	4.2	30	26	13.4	52	40	23.1
75	1,100	106	12	231	224	3.0	34	30	11.8	66	58	12.1
85	200	102	9	133	111	16.6	14	8	42.8	10	5	50.0
85	500	104	10	202	187	8.4	28	22	21.5	44	28	36.4
85	800	106	12	221	202	8.6	31	25	19.4	53	36	32.1
85	1,100	109	13	244	232	4.9	37	34	8.2	74	63	14.9

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Table 13. The temperatures and light intensities under which flax (conditioned at 65° F. and 800 ft.-c. for 8 days) was grown for 8 days before and 12 days after spraying with 2,4-D; also average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction of dry weight of plants at spraying and after harvest*

Post-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	83	6	145	101	30.4	13	8	38.5	24	11	54.2
65	500	94	8	166	148	10.9	19	15	21.1	29	22	24.2
65	800	101	9	199	184	7.5	27	23	14.9	45	39	13.3
65	1,100	111	11	208	202	2.9	29	27	6.9	49	45	10.3
75	200	86	7	136	—	—	11	—	—	13	—	—
75	500	99	9	170	113	33.5	19	12	36.9	23	8	52.2
75	800	105	9	209	198	5.3	28	25	10.8	46	38	24.0
75	1,100	118	12	223	211	5.4	31	28	9.7	58	49	15.5
85	200	92	7	130	—	—	10	—	—	9	—	—
85	500	105	9	192	135	29.7	26	13	50.0	35	13	62.9
85	800	112	10	226	205	9.3	32	28	12.5	68	43	36.8
85	1,100	119	12	232	227	2.2	36	32	11.1	71	60	15.5

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Dashes (—) indicate dead plants.

Table 14. The temperatures and light intensities under which flax was grown for 12 days before spraying with 2,4-D. The plants were grown for 16 days after spraying at 65° F. and 800 ft.-c. The average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction of dry weight of plants at spraying and after harvest*

Pre-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	63	2	153	121	20.9	18	12	33.3	27	15	44.5
65	500	71	3	188	156	17.1	24	18	25.0	38	30	21.1
65	800	92	7	192	173	9.9	25	21	16.0	36	32	11.1
65	1,100	103	9	202	195	3.5	27	25	7.5	47	43	8.5
75	200	71	3	168	130	22.6	22	14	36.3	24	12	50.0
75	500	82	5	186	155	16.7	24	18	25.0	30	21	30.0
75	800	103	8	194	178	8.3	26	23	11.6	31	25	19.4
75	1,100	114	10	211	205	2.9	29	27	6.9	46	42	8.7
85	200	81	4	187	137	26.7	24	16	33.3	28	13	53.6
85	500	96	7	193	168	13.0	26	19	27.0	35	24	31.4
85	800	117	11	208	191	8.2	29	25	13.8	43	32	25.6
85	1,100	132	14	216	208	3.8	31	28	9.7	49	44	10.3

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Table 15. The temperature and light intensities under which flax was grown for 14 days before spraying with 2,4-D. The plants were grown for 14 days after spraying at 65° F. and 800 ft.-c. The average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction of dry weight of plants at spraying and after harvest*

Pre-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	79	4	149	115	22.8	17	11	35.3	26	13	50.0
65	500	88	5	186	155	16.7	23	17	26.1	39	29	25.7
65	800	99	8	198	179	9.6	27	22	18.6	45	39	13.4
65	1,100	110	10	207	197	4.8	28	26	7.2	49	44	10.3
75	200	81	4	161	121	24.9	20	13	35.0	24	11	54.2
75	500	97	7	171	144	15.8	20	15	25.0	28	18	35.6
75	800	114	10	181	164	9.4	22	19	13.7	28	23	17.9
75	1,100	123	12	205	196	4.4	27	25	7.5	42	38	9.5
85	200	83	5	178	125	29.8	23	14	39.2	26	11	57.7
85	500	103	8	191	163	14.7	25	19	23.8	34	22	35.3
85	800	127	13	209	190	9.1	28	24	14.3	45	31	31.2
85	1,100	142	16	217	207	4.7	30	27	10.0	52	46	11.6

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

Table 16. The temperatures and light intensities under which flax was grown for 16 days before spraying with 2,4-D. The plants were grown for 12 days after spraying at 65° F. and 800 ft.-c. The average height, percent reduction in height, number and percent reduction of internodes, dry weight and percent reduction of dry weight of plants at spraying and after harvest*

Pre-treatment		Data at spraying		Data at harvest								
				Height			Internodes			Dry weight		
Temperature	Light	Height	Internodes	Check	Treated	Percent reduction	Check	Treated	Percent reduction	Check	Treated	Percent reduction
° F.	ft.-c.	mm.	no.	mm.	mm.	percent	no.	no.	percent	mg.	mg.	percent
65	200	82	5	146	105	28.1	15	9	40.0	20	8	60.0
65	500	94	7	173	145	16.2	21	16	23.9	33	23	30.3
65	800	111	11	201	175	12.9	27	21	22.3	42	36	14.3
65	1,100	124	13	211	202	4.3	30	28	6.7	55	50	9.1
75	200	91	6	152	103	32.2	18	11	38.9	19	7	63.2
75	500	105	10	168	147	12.5	20	15	25.0	28	16	42.9
75	800	135	14	198	182	8.1	25	21	16.0	38	29	23.6
75	1,100	148	16	207	204	1.5	29	27	6.9	44	39	10.5
85	200	96	6	149	99	33.6	18	8	55.6	17	6	64.7
85	500	136	14	188	160	14.9	24	18	25.0	33	21	36.4
85	800	149	17	217	205	5.6	32	27	15.7	62	41	33.9
85	1,100	152	18	223	214	4.0	33	30	9.1	67	58	13.5

* The data represent averages of 60 plants at spraying and 40 treated and 20 untreated plants after harvest. The number of internodes refers to those longer than 1 millimeter.

number of internodes depending on the temperature-light combinations before treatment and the length of the conditioning period. After treatment the plants were grown for the remainder of the 28-day growing period at 65° F. and 800 ft.-c.

The similarities among tables 14, 15, and 16 follow: the flax survived 2,4-D treatment under all temperature-light combinations before treatment when the temperature-light combination after treatment was 65° F. and 800 ft.-c. There was a decrease in the percent reduction of height, internodes, and dry weight as the light intensity increased. When the plants were grown at 65°, 75°, or 85° F. and 200 ft.-c. before treatment the percent reduction of height, internodes, and dry weight was smallest when the post-treatment period was 16 days and the largest when it was 12 days. When the light intensity was either 500 or 800 ft.-c. before treatment the percent reduction in height and internodes was about the same for each of the three temperatures in all three tables. Under the same conditions, the percent reduction of dry weight decreased with longer exposure to 65° F. and 800 ft.-c. after treatment. When the light intensity was 1,100 ft.-c. there appears to be no definite trend related to the time the plants were grown after treatment at 65° F. and 800 ft.-c. or to the temperature at which the plants were grown prior to treatment.

Discussion

The discussion is divided into three parts: effects of temperature on the response of flax to 2,4-D, effects of light intensity on the response of flax to 2,4-D, and interactions of temperature and light intensity on the response of flax to 2,4-D.

EFFECTS OF TEMPERATURE ON THE RESPONSE OF FLAX TO 2,4-D

In all three phases of the study it was found that temperature influenced the response of flax to 2,4-D. In the first phase, when the plants were grown at constant day temperature and light intensity before and after treatment, there was an increased reduction of height, number of internodes, and weight with increased temperature if the light intensity was 200, 500, or 800 ft.-c. but there was little difference in response if the light intensity was 1,100 ft.-c.

In the second phase, when the plants were grown under constant temperature and light before treatment and varied temperature-light combinations after treatment, the same effect of temperature on response was noted. It was found that temperature both before and after treatment was important. Generally with increased temperature there was an increased response of flax to 2,4-D (tables 2 through 10).

In the third phase, when the plants were grown under varied post-treatments the greatest response generally occurred at the highest temperatures although the differences due to temperature were least when the light intensity was 1,100 ft.-c.

The results agree with those obtained by all the investigators previously cited who studied the effect of temperature on the response of plants to 2,4-D.

EFFECTS OF LIGHT INTENSITY ON THE RESPONSE OF FLAX TO 2,4-D

The results of this study establish a definite relationship between light and the response of flax to 2,4-D. As with temperature, it is difficult to discuss light without considering the interactions between the two variables but it

is possible to make a few comments on light intensity before the interrelationships are considered.

In each of the three phases of the study it was found that the greatest response of flax to 2,4-D occurred at 200 ft.-c. and the least response at 1,100 ft.-c. It is apparent that light intensity both before and after treatment is important. Thus, for example, high light intensity after treatment reduced the effects of low light intensity before treatment and high light intensity before treatment reduced the effects of low light intensity after treatment. On the other hand, low light intensity either before or after treatment increased the response over that expected from continued high light intensity. Disregarding temperature, the greatest response occurred when the light intensity was 200 ft.-c. both before and after treatment and the least response when the light intensity was 1,100 ft.-c. both before and after treatment.

INTERACTIONS OF TEMPERATURE AND LIGHT INTENSITY ON THE RESPONSE OF FLAX TO 2,4-D

The results of this study clearly indicate an interaction between temperature and light intensity on the response of flax to 2,4-D. This is most clearly demonstrated by comparing the response at 200 and 1,100 ft.-c. When the light intensity was 1,100 ft.-c. both before and after treatment, there was very little difference in the response at the three temperatures. However, when the light intensity was 200 ft.-c. the differences were large with the greatest response occurring at 85° F.

On the basis of existing knowledge, any physiological interpretation of these data is largely speculative. It can be hypothesized, however, that the response of flax to 2,4-D was affected by the rate of photosynthesis and respiration. The lowest rate of photosynthesis would be expected at a light intensity of 200 ft.-c. and the highest rate at 1,100 ft.-c. With an increase in temperature the rate of photosynthesis would be greater at 1,100 ft.-c. than at 200 ft.-c. (Bonner and Galston, 1952). Respiration would be expected to increase at all light intensities when the temperature was increased (Bonner and Galston, 1952).

It has been found by some investigators that 2,4-D depresses photosynthesis (Loustalot and Musick, 1953; Wedding, *et al.*, 1954) and increases respiration (Smith, 1951; Tukey, 1954; Wedding, *et al.*, 1954). Tukey (1954) states that with increased respiration there is an increased consumption of sugars, a reduction in starch reserves, and a decrease in acid hydrolyzable polysaccharides. Perhaps the greater response of flax to 2,4-D at the lower light intensities results from an unfavorable balance between photosynthesis and respiration which in some manner accentuates the effects of 2,4-D.

It has been noted by several investigators that the response of plants to 2,4-D is related to their size or stage of growth when treated (Derscheid, 1952; Derscheid, *et al.*, 1952; Elder and Gassaway, 1949; Olson, *et al.*, 1951; Shaw and Willard, 1949; Staniforth, 1952). In this study it can be noted that plants sprayed at the same height and with equal numbers of internodes responded differently to 2,4-D depending on the light and temperature conditions under which they grew before and after treatment. This can readily be observed in tables 2 through 10 where the plants treated at the same height responded differently depending on the temperature-light conditions after treatment. In other instances the differences in response were due to temperature and light before treatment. For example, in tables 2, 3, and 4 it can be seen that the plants were about the same height when treated but the response increased as the pre-treatment temperature was raised.

Summary and Conclusions

This study was designed to determine the effect of varying temperatures and light intensities on the response of flax to 2,4-D. The major variables were day temperature (65°, 75°, and 85° F.) and light intensity (200, 500, 800, and 1,100 ft.-c.). Plants were exposed for varying periods both before and after spraying with the triethanolamine salt of 2,4-D at a rate equivalent to 6 ounces per acre in 40 gallons of water. The plant heights and number of internodes longer than 1 mm. were determined at spraying and harvest and the dry weight of the plants was ascertained at harvest. Response was measured by the percent reduction of height, internodes, and dry weight.

The conclusions derived from the results follow:

(a) Light intensity both before and after treatment affected the response of flax to 2,4-D with the greatest response occurring when the light intensity was 200 ft.-c. and the least response when it was 1,100 ft.-c.

(b) Temperature both before and after treatment affected the response of flax to 2,4-D. Generally the greatest response occurred at 85° F. and the least response at 65° F.

(c) There was an interaction between temperature and light intensity. When the light intensity was 1,100 ft.-c. both before and after treatment, there was very little difference in the response at 65°, 75°, or 85° F. However, when the light intensity was 200 ft.-c., the differences were large with the greatest response occurring at 85° F.

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