Further studies are now being conducted, using various other vehicles.

References

1. DOWLING, H. F., ROMANSKY, M. J., WELCH, H., ROBINSON, J. A., CHANDLER, V. L., ZELLER, W. W., and HIRSH, H. L. Liquid versus solid penicillin in oil and wax; the effect of particle size and type of penicillin. Presented at the meeting of the Syphilis Study Section, Washington, D. C., September 24, 1947.
2. KEEFER, C. S., HERWICK, R. P., VAN WINKLE, W., JR., and PUTNAM, L. E. *J.A.M.A.*, 1945, **128**, 1161.
3. KIRBY, W. M. M., LEIFER, W., MARTIN, S. P., RAMMELKAMP, C. H., and KINSMAN, J. M. *J.A.M.A.*, 1945, **129**, 940.
4. ROMANSKY, M. J., MURPHY, R. J., and RITTMAN, G. E. *J.A.M.A.*, 1945, **128**, 404.
5. ROMANSKY, M. J., and RITTMAN, G. E. *New Eng. J. Med.*, 1945, **233**, 577.
6. VAN SLYKE, C. J., and HELLER, J. R., JR. *Ven. Dis. Inform.*, 1945, **26**, 98.
7. WELCH, H., HIRSH, H. L., TAGGART, S. R., and SMITH, G. M. Penicillin in oil and pectin. A new preparation for the prolongation of the concentrations of penicillin in the blood. Presented at the meeting of the Syphilis Study Section, Washington, D. C., September 24, 1947.

Delayed Maturity of Bean Plants Sprayed With Solutions of 2,4-Dichlorophenoxyacetic Acid of Nonherbicidal Concentrations[1]

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In a study (*2*) of the effect of 2,4-D on the growth and development of bean plants it was found that their maturity was markedly delayed by concentrations of 10 ppm applied just prior to flowering. Since this response from 2,4-D has not been found in the literature and since it is thought to be of practical interest, a report on the conditions under which it was observed is presented here.

A certified strain of red kidney bean was used in experiments which were carried out under greenhouse conditions during the spring and under field conditions during the summer. The plants were sprayed when the first trifoliate leaf was expanding, using an aqueous solution of a commercial herbicide (70% 2,4-D and 30% sodium bicarbonate) acidified with 1 gm of citric acid/liter to increase activity (*1*). The solutions were applied as a fine mist by means of an atomizing nozzle, the leaves being wet on both sides.

In the greenhouse study, a stand of uniform plants was obtained in pots containing equal amounts of soil and at intervals receiving an equal amount of a dilute, complete nutrient solution. On April 7 (1 week after germination) half the plants were sprayed with a solution of 2,4-D at 10 ppm. The treatment caused slight epinasty of stem and petioles, and inhibited temporarily the rate of top growth, while the root growth seemed to be accelerated.

Flowering began about May 1. At this time the top growth of treated plants was as vigorous as that of untreated plants, although the former were somewhat greener, and some of the younger leaves of the treated plants showed toxicity symptoms. Affected leaves became dark green, dwarfed, and lanceolate and felt thicker and stiffer than leaves on untreated plants. By the end of May there was a definite, more vigorous growth of treated than of untreated plants. At harvest time, the middle of June, the treated plants carried a significantly higher number of leaves per plant (an average of 11.2 leaves per treated plant and only 6.6 leaves per untreated plant). This difference reflects the more extensive lateral growth of treated plants. Fig. 1 shows representative plants, treated and untreated, from which all leaves and petioles were removed to indicate this development of lateral branches from the second node of the treated plants.

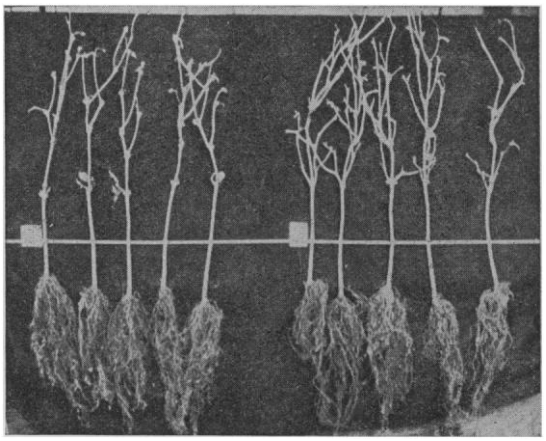

FIG. 1. Development of lateral branches from the second node of plants treated with 2,4-D at 10 ppm just prior to flowering (*right*) as compared with untreated plants (*left*).

TABLE 1

AVERAGE NUMBER AND WEIGHT PER PLANT OF PODS AND SEEDS OF 14 UNTREATED PLANTS AND 12 PLANTS SPRAYED WITH A SOLUTION OF 10 PPM OF THE SODIUM SALT OF 2,4-D

Plants	No. of pods	Wt. of pods (gm)	No. of seeds	Wt. of seeds (gm)
Untreated	3.2	9.6	10.2	7.4
Treated	4.1	10.6	11.6	7.6

On June 2, counts showed a greater set of fruits on treated than on untreated plants. Of fruits which actually developed, however, there were not significantly more on treated than on untreated plants (Table 1).

While the untreated plants turned yellow at the beginning of June, the treated ones remained green for about two weeks longer. The pods were not harvested until

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they were completely dry (Table 2). The time of delayed maturity amounted to almost two weeks.

TABLE 2

NUMBER OF FULLY RIPE PODS, ON DAYS INDICATED, FROM 14 UNTREATED PLANTS AND 12 PLANTS SPRAYED WITH A SOLUTION OF 10 PPM OF THE SODIUM SALT OF 2,4-D

Plants	June 14	June 23	June 28	Total
Untreated	45	0	0	45
Treated	7	30	12	49

In the field experiment, seed which was selected for uniformity was planted May 31. On June 24, treatments were made with solutions of 1, 10, and 100 ppm of 2,4-D, using a system of randomized blocks and 5 replications. There were 20 plants in each plot.

TABLE 3

NUMBER OF PODS HARVESTED AT DATES INDICATED FROM BEAN PLANTS SPRAYED WITH SOLUTIONS OF DIFFERENT CONCENTRATIONS OF THE SODIUM SALT OF 2,4-D

	August			September	Total	Relative
	18	21	27	3	yield	yield
Control	282	423	742	63	1,510	100
1 ppm ...	198	505	917	89	1,709	113*
10 ppm ...	138	564	920	64	1,686	111
100 ppm ...	0	72	633	685	1,390	92†

* No significant increase as compared to control.
† No significant decrease as compared to control.

The day after the treatments, the plants sprayed with 100 ppm showed pronounced epinasty, while only slight epinasty was observed at 10 ppm, and none at 1 ppm. The growth of the plants sprayed with 100 ppm was markedly inhibited and, even though the plants recovered, they never became as vigorous as those in any of the other plots. At 10 ppm there was observed only a slight decrease in top growth for a short period, after which the plants became as vigorous as those untreated. No effect upon the growth was observed from treatments with 1 ppm.

TABLE 4

PER CENT OF TOTAL NUMBERS OF PODS HARVESTED AT DATES INDICATED FROM BEAN PLANTS SPRAYED WITH SOLUTIONS OF DIFFERENT CONCENTRATIONS OF THE SODIUM SALT OF 2,4-D

	August			September
	18	21	27	3
Control	19	28	44	9
1 ppm	20	30	54	4
10 ppm	8	33	55	4
100 ppm	0	5	45	50

By the beginning of July, abnormal leaves developed in the plots sprayed with 100 ppm, 5–10 leaves on the lower lateral branches showing formative effects. In the plots sprayed with 10 ppm, only a few plants developed abnormal leaves.

In the middle of July, flowering commenced in the control plots and in plots sprayed with 1 and 10 ppm. In the 100-ppm plots, however, flowering was markedly delayed, although by the end of July the growth seemed to be somewhat accelerated, no more abnormal leaves developed, and flowering was initiated.

Harvesting of all fully matured pods was made at four different times as indicated in Table 3. Table 4 gives the distribution of the total yield as per cent on the different dates, showing that treatment with 2,4-D at 100 ppm markedly delayed maturity, with some slight decrease in number of pods and yield of seed.

The changes in the metabolism of the plant brought about by the treatment with 2,4-D seem to have a secondary effect on the axillary growth and the time of maturity of the plant. Weaver (*3*) mentions delayed and decreased pod production after treatments with 2,4-D. The opposite effect, namely, hastening of maturity, is reported by Wittwer and Murneek (*4*), who sprayed snap beans in the flowering stage with different growth substances including 2,4-D. This difference in response may be due to differences in age of plants and the parts involved. In the case of snap beans the effect seems to be a direct one on the growth of the ovary, while in the present study the effect is an indirect one following stimulated axillary growth.

References

1. LUCAS, E. H., and HAMNER, C. L. *Mich. agric. exp. Sta. Quart. Bull. 29*, 1947, 256–262.
2. STROMME, E. R. Master's thesis, Michigan State College, 1947.
3. WEAVER, R. J. *Bot. Gaz.*, 1946, **107**, 532–537.
4. WITTWER, S. H., and MURNEEK, A. E. *Amer. hort. Soc. Sci. Proc.*, 1946, **47**, 285–293.

Survival Time of Various Warm-blooded Animals in Extreme Cold

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Little is known about the resistance of homoiothermic animals to low temperatures. This paper reports some observations on the survival time and body temperature of various adult animals at an ambient temperature of −35° C.

The experiments were conducted over a four-day period in which the temperature of the cold room varied between −34° and −37° C. Previous determinations by Belding, *et al.* (*1*) had shown the wall temperature of this room

[1] Operated as a function of the Environmental Protection Section, Research & Development Branch, Quartermaster Corps. These experiments were carried out in the Cold Room of the Harvard Fatigue Laboratory; the assistance of its director, W. H. Forbes, is gratefully acknowledged.