Proceedings of the Iowa Academy of Science

Volume 55 | Annual Issue Article 26

1948

External Responses of Galinsoga Ciliata (Raf.) Blake to Treatment With Low Concentrations of 2,4-Dichlorophenoxyacetic Acid

S. N. Postlethwait
State University of Iowa

External Responses of Galinsoga Ciliata (Raf.) Blake to Treatment With Low Concentrations of 2,4-Dichlorophenoxyacetic Acid

S. N. POSTLETHWAIT

INTRODUCTION

Soon after the discovery and use of synthetic plant hormones it became apparent that the degree and type of response of plants treated with such hormones depend upon a number of factors. Individual plants of the same species may not react the same, even though subjected to similar environmental conditions. Early investigations were characterized by the use of very low concentrations and minute amounts of hormonal material in an attempt, primarily, to induce root formation (Zimmerman and Hitchcock, 1942). When the economic value of such compounds as herbicides was discovered it caused the investigators to shift attention to quantities and concentrations which were toxic. The responses of a large number of plants to toxic doses of such compounds have been reported (Beal, 1945, Tukey, Hammer and Imhofe, 1944, et al.). In view of the variable responses exhibited by plants of the same species to different concentrations of growth-regulating substances, it seems desirable to determine the pattern of responses to concentrations below or near the threshold of toxicity.

Galinsoga ciliata (Raf.) Blake has been chosen for this study because this weed is difficult to kill by mechanical means. It is a composite of tropical origin which has moved north and in certain areas has become a pernicious weed.

The writer's first work with 2,4-D involved its use to exterminate *Galinsoga*. Several series of experiments were conducted in which concentrations of 100 ppm to 2000 ppm 2,4-D were applied to the foliage in an aqueous spray. It was found that a concentration of 1000 ppm was adequate to completely kill this weed and that plants of this species grown in shaded area were more easily killed. It was also found that many of the achenes formed on the treated plants lost their viability. Viable achenes removed from a plant and treated directly with 50 ppm 2,4-D failed to germinate. Treating the soil with 100 mgs. of 2,4-D per square foot prevented germination of 83% of the achenes planted.

Since certain aspects of this work are still in progress it is the purpose of this paper to report only characteristic, external, gross responses of *Galinsoga* to low concentrations of 2,4-D.

MATERIALS AND METHODS

All experiments were conducted in the greenhouse of the State University of Iowa. *Galinsoga* plants used for series 1 and 2 were collected outdoors, potted, and brought into the plant house on October 5, 1947. Plants used in series 3, 4 and 5 were grown from

seed obtained from control plants of series 1 and 2. All treatments were applied directly to the foliage in an aqueous spray, except the soil treatment experiments in which 100 cc. of solution was slowly added to the soil in 5 inch pots. Solutions were prepared from a commercial weed killer called "Garden Master" sold by Sear's Roebuck and Co. This preparation contains 14 per cent 2,4-Dichlorophenoxyacetic acid. For foliage treatment in series 3, 4 and 5 a concentration of 100 ppm was used. For the soil treatment experiments concentrations of 10 ppm, 25 ppm, 50 ppm, and 100 ppm were used. Pictures of gross responses were taken at regular intervals and portions of plants preserved for later anatomical study.

RESULTS

Foliage treatment series 1 and 2

Galinsoga plants treated with 1000 ppm soon became chlorotic and began to dry out one week following treatment (Fig. 1C). This drying continued throughout the experiments with little or no other apparent change in the treated plants. After 30 days, the treated plants were dead and completely dry and at this time were discarded (Fig. 2C).

Plants treated with 500 ppm 2,4-D exhibited characteristic curvature of stems at the first internode (Fig. 1B) and downward folding of the leaves within 24 hours. This condition persisted and the leaves became chlorotic and dry, similar to those on plants treated with 1000 ppm. During the first week, wartlike swellings were produced in the stems, especially at the areas of greatest curvature (Fig. 5). The number of the swellings increased during the second week, coalescing in many cases to produce a solid welt and, in some areas, a rupture of the epidermis (Fig. 6). These swollen areas were attacked with a vengeance by invading catapillars (Fig. 13) and all plants treated with 500 ppm were almost completely defoliated (Fig. 3B). Control plants growing nearby and those treated with 1000 ppm, were little or not at all, eaten by the catapillars. Plants treated with 500 ppm 2,4-D of this series were dead at the end of the thirty day period (Fig. 2B) and they were also discarded.

Foliage treatment series 3, 4 and 5

All plants treated with 100 ppm 2,4-D were seedlings, each bearing 6 to 10 leaves at the time 2,4-D was applied. These plants lived varying lengths of time, up to 68 days after treatment. Curvature of the leaf petioles was observed within 6 hours (Figs. 7A and 8A) and swelling similar to those described for series 1 and 2 appeared during the first week (Fig. 9A). These swellings later gave rise to short roots when maintained under moist conditions (Fig. 15). In addition to the above, a variety of other responses were observed which did not occur with the higher concentrations. In some cases the ray flowers fused (Figs. 11 and 12). Fusion of opposite leaves often occurred on one or both sides of the stem,

creating a perfoliate condition (Fig. 14). New leaves were narrower and had relatively more vascular tissue (Figs. 10 and 11) than control plants. Some leaves produced knob-like structures on the tips of their marginal serrations (Fig. 10).

Soil treatment series

Seedlings of *Galinsoga* growing in soil treated with 100 cc. 50 ppm and 100 ppm 2,4-D frequently exhibited fusion of the leaves (Fig. 16) similar to those produced during experiments 3, 4 and 5 of the foliage treatment series. Growth did not proceed farther from the stem apex but was resumed by lateral buds (Fig. 17). Fusion did not always occur at the margin but sometimes developed near the middle of two laminas (Fig. 18). New growth from the lateral buds showed no further response to the original 2,4-D treatment. Germination was less and slower in the soil treated with 50 and 100 ppm. Concentrations of 25 ppm and 10 ppm apparently had little or no effect upon germination.

DISCUSSION

Responses of *Galinsoga ciliata* (Raf.) Blake to concentrations of 500 ppm and 1000 ppm 2,4-D appear to follow closely those described for other herbaceous plants receiving toxic applications (Penfound and Minyard, 1947, Kraus and iMtchell, 1946 and Mitchell and Hammer, 1944). Swellings similar to those described by the writer have been reported previously and have been shown to be root primordia (Zimmerman and Hitchcock, 1942, Murray and Whiting, 1947 and Beal, 1945). Curvature induced in the stem and petiole has been described for a wide variety of plants.

Fusion of flower parts and of leaves appears to occur only in those plants receiving concentrations near the threshold of toxicity. A similar occurence has been reported for wild oat plants germinated in treated soil. These plants developed tubular leaves with margins grown together in the same manner as found in the coleoptiles (Van Overbeek, 1947). Leaf modifications induced by 2,4-D are common and have been completely described for several plants (Burton, 1947). The decrease in the size of the leaf is apparently not always accompanied by a corresponding decrease in vascular tissue. This results in a leaf with a relatively large number of fasciated veins. Defoliation of plants by catapillars and other insects may be of some value in helping to eradicate those weeds which may otherwise recover from 2,4-D treatment. No similar report has been found of such palatability of these activated areas and the significance, if any, of this phenomenon is not known.

SUMMARY

1. The foliage of *Galinsoga ciliata* (Raf.) Blake was treated with concentrations of 100 ppm, 550 ppm, and 1000 ppm, 2,4-D and the gross, external responses described. Seedlings grown from achenes

germinated in soil treated with 2,4-D are also described.

2. Characteristic responses observed in the foliage treatment series included (a) curvature of stem and petioles, (b) formation of swellings, (c) development of root-like structures from the swellings, (d) fusion of leaves and flower parts, and (e) a decrease in the size of the leaves.

3. Responses observed in soil treatment series included only a fusion of the leaves.

DEPARTMENT OF BOTANY,
STATE UNIVERSITY OF IOWA.

LITERATURE CITED

Beal, J. M. 1945. Histoligical reactions of bean plants to certain of the substituted phenoxy compounds. Bot. Gaz. 109:200-217.

Burton, D. F. 1947. Formative effects of certain substituted chlorophenoxy compounds on bean leaves. Bot. Gaz. 109:183-194.

Kraus, E. J. and Mitchell, J. W. 1947. Growth-regulating substances as herbicides. Bot. Gaz. 108:301-350 .

Mitchell, M. A. and Whiting, A. G. 1947. A comparison of the effectiveness of 2,4-dichlorophenoxyacetic acid and 4 of its salts inducing histological responses in bean plants. Bot. Gaz. 109: 13-39.

Penfound, W. T. and Minyard, Virginia. 1947. Relation of light intensity to effect of 2,4-dichlorophenoxyacetic acid on water hyacinth and kidney bean plants. Bot. Gaz. 109:231-234.

Tukey, H. B., Hamner, C. L. and Imhofe, Barbara. 1945. Histological changes in bindweed and sow thistle following applications of 2,4-dichlorophenoxyacetic acid in herbicidal concentrations. Bot. Gaz. 107:62-73.

Van Overbeek, J. 1947. Use of synthetic hormones as weed killers in tropical agriculture. Economic Bot. 1:446-459.

Zimmerman, P. W. and Hitchcock, A. E. 1942. Substituted phenoxy and benzoic acid growth and the relation of structure to physiological activity. Boyce Thompson Institute for Plant Research 12:321-343.

PLATE I

Fig. 1. *Galinsoga ciliata* (Raf.) Blake seven days after treatment. A. Control. B. 500 ppm 2,4-D, C. 1000 ppm 2,4-D.

Fig. 2. Plant thirty days after treatment. A. Control, B. 500 ppm 2,4-D, C. 1000 ppm 2,4-D.

Fig. 3. Plant thirty days after treatment. A. Control. B. Plant defoliated by catapillars.

Fig. 4. Node of control plant. Compare with Fig. 5 and 6.

Fig. 5. Node seven days after treatment with 500 ppm 2,4-D. Note curved internodes and swellings on stem.

Fig. 6. Node fourteen days after treatment with 500 ppm 2,4-D. Note ruptured epidermis.

Fig. 7. A. Plant six hours after treatment with 100 ppm 2,4-D, B. Control.

Fig. 8. A. Plant twenty-eight hours after treatment with 100 ppm 2,4-D, B. Control.

Fig. 9. A. Plant seven days after treatment with 100 ppm 2,4-D, Note swellings near the base of the plant. B. Control.

PLATE I

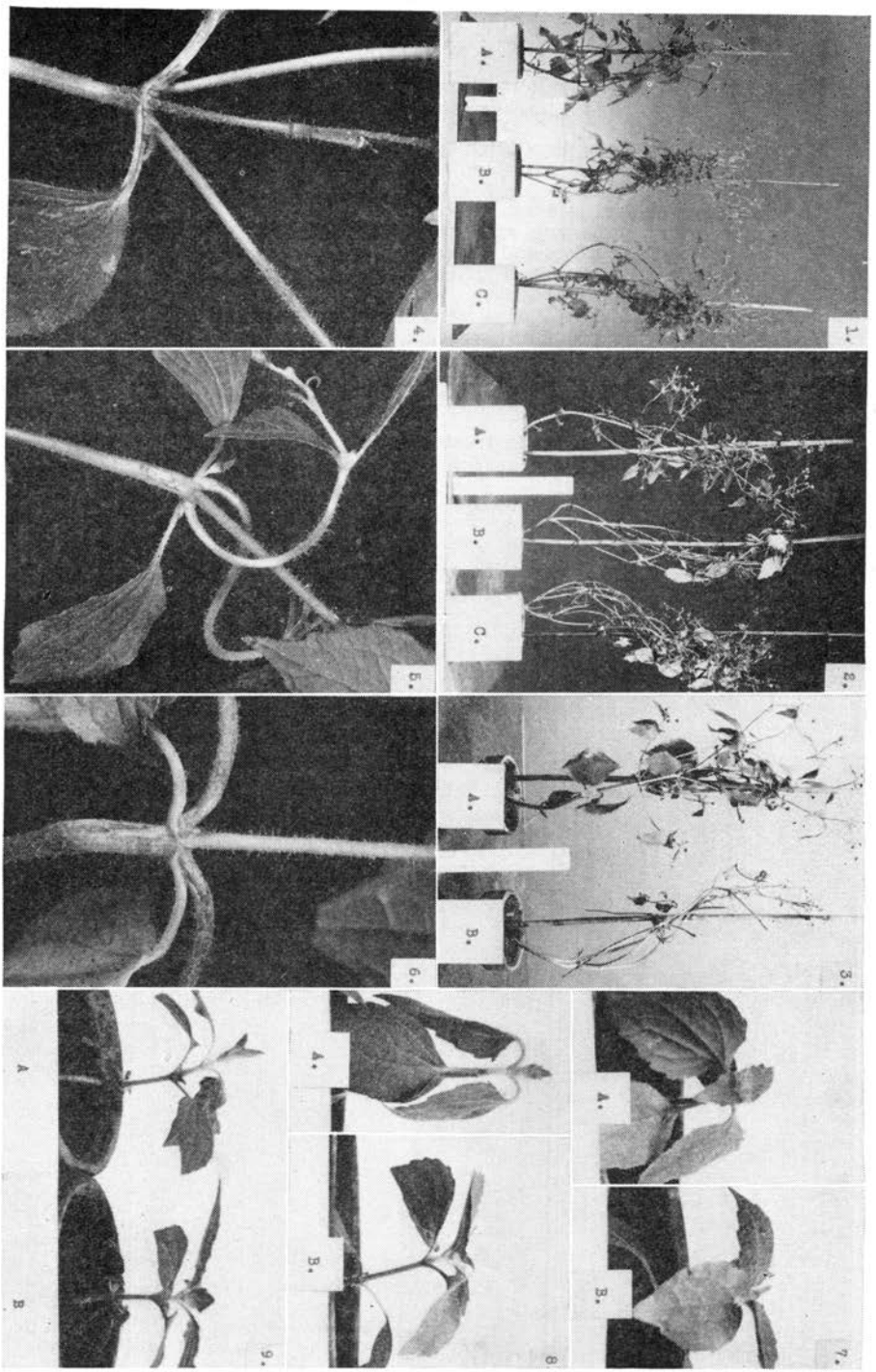

PLATE II

Fig. 10. Plant twenty-four days after treatment with 100 ppm 2,4-D showing knob-like structures on marginal serrations of leaf.
Fig. 11. Plant forty days after treatment with 100 ppm 2,4-D showing fused ray flowers.
Fig. 12. Plant eighteen days after treatment with 100 ppm 2,4-D showing fused ray flowers.
Fig. 13. Plant eight days after treatment with 500 ppm 2,4-D showing catapillar and eaten portion of stem.
Fig. 14. Plant thirty days after treatment with 100 ppm 2,4-D showing fused leaves.
Fig. 15. Plant fourteen days after treatment with 100 ppm 2,4-D showing root-like structure produced from swellings when maintained under moist conditions.
Fig. 16. *Galinsoga* seedlings grown in treated soil.
Fig. 17. Seedling grown in treated soil. Note growth from lateral bud.
Fig. 18. Seedling grown in treated soil. Note fusion of laminas.

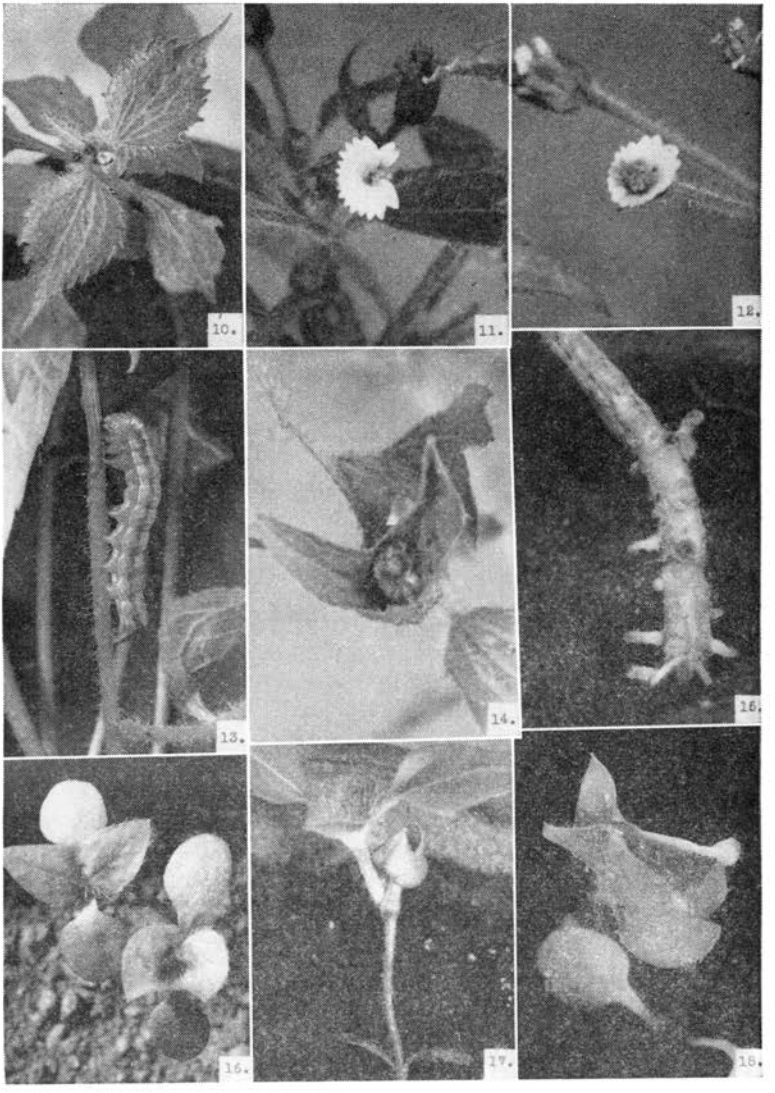

PLATE II