The Effect Of Herbicides On The Germination Of Water Hyacinth Seeds

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INTRODUCTION

Water hyacinth (*Eichhornia crassipes* (Mart.) Solms) is an obnoxious aquatic weed distributed all over tropical and subtropical regions of the world. Herbicides have become an important method for the control of this weed.

Chatterji (5), Hseuh and Lou (9), and Mohan Ram and Satsangi (10) reported that low concentrations of (2,4-dichlorophenoxy) acetic acid stimulated seed germination whereas at higher concentrations it inhibited this process partially or completely. Hammer and Hukey (7), Bradley and Crane (4), Rojas-Garciduenas and Kommedahl (11), and Dnyasagar and Khosla (6), however, observed no stimulatory effect of the 2,4-D, rather it inhibited seed germination. Audus (1) elucidated the cause of inhibition of growth in *Lipidium sativum* by this chemical on the basis of pH relationship of the concentration. Hansen and Buchholtz (8) observed that pH of the soaking solutions was an important factor in the amount of 2,4-D absorbed.

A perusal of available literature indicates, as far as the authors are aware, that there is no information on the action of 2-(2,4,5-trichlorophenoxy) propoinic acid (silvex), acrylaldehyde (acrolein), and NaPCP (sodium pentachlorophenate) on seed germination and length of the cotyledon. The present paper deals with the effect of silvex, sodium pentachlorophenate, and acrolein on germination of seed of water hyacinth.

METHODS AND MATERIALS

Solutions of silvex, sodium pentachlorophenate, and acrolein were prepared with distilled water at concentrations from 1 to 20 ppm. Fifty seeds were soaked in 15 ml of each herbicide concentration for 24 hours at room temperature. They were then rinsed thoroughly with tap water and allowed to germinate on moistened filter paper in petri dishes. Similarly, a set of 50 seeds were soaked in tap water to serve as a control. All treatments were kept in bright sunlight and replicated four times.

Observations were recorded daily until germination ceased. Germination was defined as the emergence of the radicle from the seed coat. The length of the cotyledon

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was measured and observations were made regarding the morphological abnormalities which were noted with respect to particular treatments. The difference in the cotyledon lengths is shown graphically in Figure I.

RESULTS

Silvex inhibited the germination of seeds gradually as the concentration of the herbicide was increased (Table 1). No seed germination was observed at 10 ppm and hence it was determined as the lethal dose. There was a difference between the percent germination and the survival of seedlings. Germination of the control was 75% and survival was only 30%. At 2 ppm and 6 ppm the percent germination was 65 and 38, respectively; but survival of the seedlings was only 16 and 2%, respectively. No seedling survived at silvex concentrations of 8 ppm or higher. the pH of the control, and the 6 and 10 ppm was 7.3, 6.5, and 5.8, respectively.

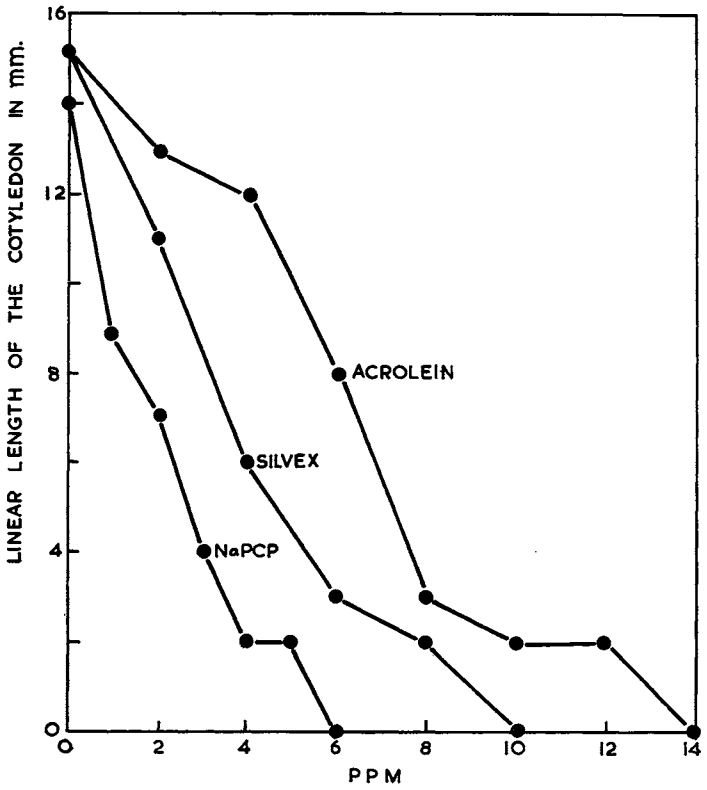

Fig. 1.—Reduction in the length of cotyledons of water hyacinth seedlings treated with silvex, sodium pentachlorophenate, and acrolein.

Cotyledon length was reduced with increased concentrations of silvex. The cotyledons were measured after 12 days of growth. Length of the control cotyledon was 15 mm. Cotyledon length decreased sharply until at 6 ppm, cotyledon length was only 30% of the control (Figure 1).

Table 1 indicates that acrolein was less effective than silvex on the inhibition of seed germination. The lethal dose of acrolein was found to be 14 ppm. Likewise, the lower concentrations of acrolein had less effect on reducing seedling survival in comparison to silvex. Seedling survival was 18 and 4% for 2 and 6 ppm, respectively. At 8 ppm only 2% of the seedlings survived and no seedlings survived at higher concentrations. The pH of the control, and the 8 and 14 ppm was 7.3, 8.4, and 9.2, respectively.

Growth of the cotyledons was reduced drastically at acrolein concentrations of 4 to 8 ppm but little change was found from 8 to 12 ppm. The length again decreased after 12 ppm (Figure 1).

Sodium pentachlorophenate inhibited seed germination at lower concentrations than silvex or acrolein (Table 1). At 1 ppm the germination was reduced by nearly 50%. There was a steep decline in the percent germination up to 3 ppm. From 3 ppm to 6 ppm the inhibition of germination was more gradual. The survival of seedlings at 1 and 2 ppm was only 12 and 7%, respectively, and at higher concentrations no seedlings survived. Development of the seedling roots was reduced between 1 and 2 ppm and completely inhibited at 3 ppm (Figure 2). There was also a reduction in the number of leaves, and the length of the leaves between 1 and 2 ppm. Cotyledon growth was inhibited 60% at 1 ppm and more than 85% at 4 ppm (Figure 1).

DISCUSSION

Several workers who have worked on the effect of 2,4-D on seed germination have concluded that it stimulates germination at lower concentrations whereas at higher ones it inhibits this process partially or completely. Silvex which is in the same group of herbicides as 2,4-D did not show any stimulatory effect on germination. Similarly, no stimulatory action was noticed in the case of sodium pentachlorophenate or acrolein. On the other hand,

TABLE 1. MEAN OF PERCENTAGE OF SEED GERMINATION AND SURVIVAL OF SEEDLINGS OF WATER HYACINTH.

Average Mean	Control	Herbicide Concentration (ppm) 1	2	3	4	5	6	8	10	12	14
SILVEX											
% germination	75		65		52		38	12	0		
S.E.±	2.12		2.82		3.20		2.18	1.87	0		
% Survival of seedlings	30		16		6		2	0	0		
ACROLEIN											
% germination	75		68		60		48	35	20	6	0
S.E. ±	2.12		2.75		2.40		2.95	1.80	1.35	1.50	0
% Survival of seedlings	30		18		12		4	2	0	0	0
NaPCP											
% germination	75	52	34	17	13	8	0				
S.E. ±	2.12	3.25	2.65	1.65	0.80	0.95	0				
% Survival	30	12	7	0	0	0	0				

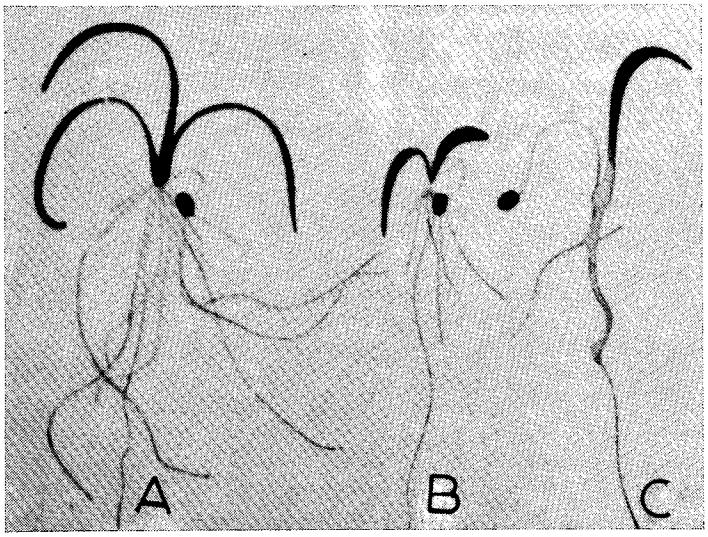

Fig. 2.—Seedlings of water hyacinths. A. Control with lateral roots. B, C. Treated with 1 and 2 ppm sodium pentachlorophenate, respectively, showing inhibition of lateral roots.

there was a general retardation in the percentage of germination in the case of all three herbicides used.

In the case of silvex the pH range was from 7.3 to 5.8, i.e. the concentrations became acidic, while in the case of acrolein and sodium pentachlorophenate the pH range was from 7.3 to 9.2 i.e. alkaline. In the case of acrolein and sodium pentachlorophenate it may be possible that the growth inhibition correspondingly becomes more as the alkalinity of the concentrations increases. Similar results were obtained by Dnyansagar and Khosla (6) in the case of *Achyranthus aspera* L., *Cassia tora* L., and *Ruellia tuberosa* L. treated with alkaline solutions of sodium arsenite.

In the present study it was found that seed germination of water hyacinth was inhibited by 6 ppm of sodium pentachlorophenate and 10 and 14 ppm of silvex and acrolein, respectively. The sodium pentachlorophenate was found to be more effective in checking germination than the other two chemicals. Hansen and Buchholtz (8) observed that both corn (*Zea mays* L.) and pea (*Pisum arvensis* L.) seeds absorbed more 2,4-D at pH 4 than at 7. They explained their results on the basis that greater uptake occurred at the lower pH values because of less dissociations of 2,4-D molecules or pH affected the plant material itself, so that the membrane became more permeable. Arkeri and Dunham (2) found greater injury to corn growth at low pH of 2,4-D solutions.

Behrens and Howard (3) reported that inhibition of growth was usually increased by decreasing pH, but the increase in inhibition was not proportional to the increase in concentration of undissociated phenoxy acid molecules as reported by Hansen and Buchholtz (8). They have, therefore, suggested that pH has a more important role than phenoxy acid dissociation to play in regard to the inhibitory effect.

The pH values of silvex are acidic. Therefore, it is quite clear that as the concentrations rise from lower to higher values, they became more acidic and hence check more severely the growth of the cotyledon of water hyacinth at higher concentrations of this herbicide. While in the case of acrolein and sodium pentachlorophenate the pH increases with the increase in the concentration. But the effect on cotyledon length is, however, the same whether the concentration becomes more alkaline or acidic.

LITERATURE CITED

1. Audus, L. J. 1949. Studies on the pH relationship of root growth and its inhibition. New Phytol. 48:97-114.
2. Arkeri, H. R. and R. S. Dunham. 1950. Environmental factors relating to the preemergence treatment of corn with 2,4-D and soybeans with TCA. Univ. of Minn. Tech. Bull. 190:75-81.
3. Behrens, R. and M. L. Howard. 1963. Some factors influencing the activity of 12 phenoxy acids on Mesquit root inhibition. Plant Physiol. 38: 165-170.
4. Bradley, M. V. and Crane, J. C. 1957. Effect of auxins on development of apricot seeds and seedlings. Amer. J. Bot. 44:164-175.
5. Chatterji, U. N. 1966. Preliminary studies on the germination of *Sesamum indicum* L. seeds in relation to certain growth substances. Proc. Indian Sci. Cong. Assoc. 53rd Session Part III.
6. Dnyansagar, V. R. and Khosla, S. N. 1968. Effect of herbicides on germination of seeds of some weeds. J. Biol. Sci. 11:29-40.
7. Hamner, G. L. and Tukey, H. B. 1946. Herbicidal action of 2,4-D on several shrubs, vines and trees, Bot. Gaz. 107:379-385.
8. Hansen, J. B. and Buchholtz, S. 1952. Absorption of 2,4-D by corn and pea seeds. Agron J. 44:493-496.
9. Hseuh, Y. L. and Lou, C. H. 1947. Effect of 2,4-D on seed germination and respiration. Science 105:283-285.
10. Mohan Ram, H. Y. and Satsangi, A. 1963. Histological responses of *Ricinus communis* L. to 2,4-D. Phytomorphology 13:267-284.
11. Rojas-Garciduenas, M. and Kommedahl, T. 1958. The effect of 2,4-D acid on radicle development and stem anatomy of soybeans. Weeds 6:49-51.