Protection of Plants from Herbicides with 1,8-Naphthalic Anhydride as Illustrated with Sorghum

by L. S. JORDAN and V. A. JOLLIFFE
Department of Plant Sciences
University of California
Riverside, Calif. 92502

A large number of organic herbicides have been developed and applied to soils in the United States for weed control during the past decade. Many herbicides are selective, killing some plants but not others. Most organic herbicides dissipate from soils within 1 to 6 months after application, but some may remain toxic to plants for a year or more. Antidotes to herbicides would serve to broaden the spectrum of weeds that might be killed with short residual herbicides without injuring desirable plants. They would also make it possible to protect desirable plants from herbicides with long residual activity in soils.

Hoffmann demonstrated that a foliar activity of 4-chloro-2-butynyl m-chlorocarbanilate (barban) on wheat was reduced by 75% when the seed was treated with 4'-chloro-2'-hydroxyiminoacetanilide before planting (1). Burnside reported that corn stand and yield was protected from reduction by S-ethyl dipropylthiocarbamate (EPTC), and S-ethyl diisobutylthiocarbamate (butylate) when seed was treated before planting with 0.5% (by weight) 1,8-naphthalic anhydride (2, 3).

We conducted tests of 1,8-naphthalic anhydride on sorghum (Sorghum vulgare L.) as an antidote to three herbicides: EPTC, 2-chloro-2', 6'-diethyl-n-(methoxy-methyl)-acetamide (alachlor), and S-(2,3,-dichlorallyl) diisopropylthiocarbamate (diallate).

Sorghum seeds were treated with 0.5, 1.0, and 2 percent of 1,8-naphthalic anhydride based on seed weight and planted at a depth of 1 cm. in 8 oz. plastic cups containing 200 g. of sandy loam soil. Prior to planting, the soil for each cup was completely mixed with one of the three herbicides in dosages of 2,4, and 8 ppm of alachlor and diallate and

Bulletin of Environmental Contamination & Toxicology,
Vol. 6, No. 5, 1971, published by Springer-Verlag New York Inc.

0.25, 0.50, and 1.0 ppm of EPTC. Water was then added to the cups to field capacity. Fifteen sorghum seeds were planted in each cup. Five replications for each of the herbicide rates and each of the seed treatment rates were employed. After planting, cups were placed in growth chambers maintained at 84° F. during the day (16 hours) and 65° F. during the night (8 hours). Nine days after planting, the plants were harvested and foliage and root weights were determined.

Results of the tests are shown in Fig. 1. Treatment of the seeds with 1,8-naphthalic anhydride counteracted the activity of all three herbicides.

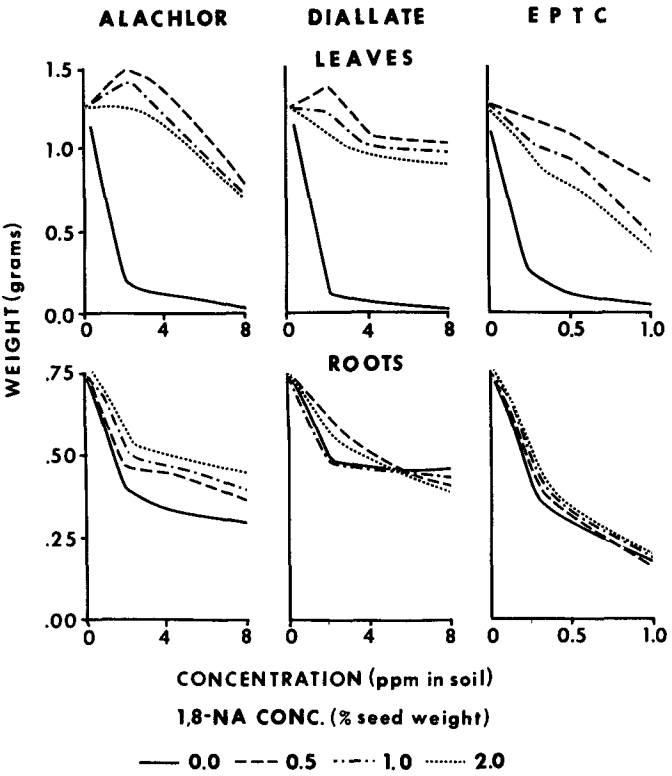

Figure 1. Weight of leaves and roots of sorghum plants grown on soil treated with different concentrations of three herbicides. Seeds were treated with different concentrations of 1,8-naphthalic anhydride before planting.

Antidotal activity was greatest against alachlor and least against EPTC. Counteracting effects were more apparent in sorghum shoots than in the roots. The antidotal compound did not counteract EPTC on roots. The low concentration treatment (0.5 percent of seed weight) was the most effective in decreasing herbicidal activity on foliage. The high concentration treatment (2 percent) was more effective in protecting roots against injury. The same pattern of plant protection was obtained in experiments in which the plants were grown for longer periods of time (14 to 22 days) after treatment.

Field trials were designed to determine if 1,8-naphthalic anhydride would counteract herbicides under agricultural conditions. Sorghum seeds were treated with 0.5 percent of 1,8-naphthalic anhydride based on seed weight. Treated seeds were sown in plots of 5 by 20 feet together with other crop and weed seeds. Plots were sprayed with alachlor at 0.5, 1, and 2 pounds per acre and diallate at 1, 2, and 4 pounds per acre. No field trials were conducted in this experiment with EPTC. Diallate was incorporated mechanically into the soil with a power-driven rotary tiller. Plots were sprinkler irrigated as required for plant growth. Evaluations were made for eight weeks to determine the effects of the two herbicides on the treated sorghum, five species of weeds, untreated sorghum, and corn (Zea Mays L.). Responses to the herbicides are shown in Table 1.

Sorghum plants grown from seeds treated with 0.5 percent of 1,8-naphthalic anhydride were protected from injury by alachlor and diallate. Injury to seed-treated sorghum became greater as the application rate of each of the two herbicides increased. Corn was more tolerent to the two herbicides than untreated sorghum. Most of the weeds tested were controlled by 1 pound per acre of alachlor without injury to corn or protected sorghum. Untreated sorghum was susceptible to diallate. At rates of 1 to 2 pounds per acre of diallate, seed treatment would permit control of weeds such as Setaria viridis L., Physalis langifolia nutt, Chenopodium album, and Echinochloa crusgalli L. without sorghum injury.

The experiments verified the earlier report that 1,8-naphthalic anhydride is an antidote to EPTC. It was also shown that the same chemical seed treatment reduces herbicidal activity of alachlor and diallate to sorghum.

These results demonstrate the potential of chemical antidotes for increasing the use of short residual herbicides

TABLE 1. Response of sorghum treated with 1,8-napthalic anhydrides, untreated sorghum, corn, and weeds to alachlor and diallate.[a/]

Rate (lb/A)	Crop Response			Weed Response				
	Treated[b/] Sorghum	Untreated Sorghum	Corn	S.[c/] vir.	P.[d/] lang.	E.[e/] crus.	A.[f/] grae.	C.[g/] alb.
Alachlor[h/]								
0.5	0	5	0	3	10	5	5	4
1.0	1	7	0	7	10	9	6	5
2.0	3	9	2	8	10	9	9	7
Diallate[i/]								
1.0	0	10	0	10	9	7	0	2
2.0	3	10	1	10	10	9	3	6
4.0	6	10	3	10	10	10	6	8

a/ Response ratings: 0 = no injury, 10 = plant death.
b/ Seed treated with 0.5% powdered 1,8-naphthalic anhydride based on weight of sorghum seed.
c/ Setaria viridis L.
d/ Physalis langifolia Nutt.
e/ Echinochloa crusgalli L.
f/ Amaranthus graecizans L.
g/ Chenopodium album.
h/ Applied to soil after planting and before irrigation.
i/ Incorporated into soil before planting and irrigation.

in crops which do not have sufficient natural tolerence. Use of the antidotes in crop production could decrease the need for developing and registering new herbicides.

REFERENCES

1. Hoffmann, O. L., Weeds, 10, 322 (1962).
2. Burnside, O. C., N. cent. Weed Control Conf. Research Report 26, 99 (1969).
3. Burnside, O. C., N. cent. Weed Control Conf. Research Report 27, 103 (1970).