Response of Weeds and Sugarbeets to EP-475, A Phenmedipham Analog

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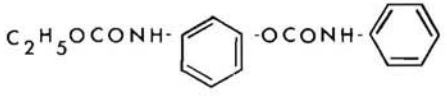
Introduction

Herbicides being used today in sugarbeets are all limited in the spectrum of weeds they control. Attempts to overcome these shortcomings have resulted in the development of several herbicide systems or programs. These weed control programs are usually based on the use of combinations of well-chosen pre- and post-emergence herbicides in order to broaden the spectrum and achieve season-long control. In spite of this, there often are problem weeds which are not adequately controlled, such as redroot pigweed (*Amaranthus retroflexus* L.). An example of this lack of control is evident with methyl *m*-hydroxycarbanilate *m*-methylcarbanilate (phenmedipham), which generally controls pigweed in the cotyledonary stage only. Recognizing this weakness in phenmedipham, research with phenmedipham analogs has been continued. Arndt et al. (1) found two N-phenyl-analogs to be more active against redroot pigweed than phenmedipham. Their findings have been confirmed by a number of investigators (2,3,6) in preliminary field tests. During 1970 and 1971 a broad testing program was conducted. The results of these tests will be presented in this report.

Physical, Chemical, and Toxicological Properties

The most promising compound was ethyl *m*-hydroxycarbanilate carbanilate (ester) (coded EP-475) and a 1:1 mixture of this compound with phenmedipham (coded SN 503). Both EP-475 and SN 503 were formulated as emulsion concentrates containing 1.3 lbs. active ingredient/gallon to allow for direct comparisons with phenmedipham.

The structural formula of the active ingredient in EP-475 is:



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In many respects, it is similar to phenmedipham:

Acute LD_{50} oral, rates:

a) Active ingredients

EP-475	10,250 mg/kg
phenmedipham	8,000 mg/kg

b) Formulations

EP-475 EC	3,720 mg/kg
phenmedipham EC	2,000 mg/kg
SN 503 EC	5,042 mg/kg

EP-475 is quickly metabolized in plants. Sixty days after treatment residues in sugar beet roots and tops are below the detectable level of 0.02 ppm.

Slight differences in solubility in organic solvents between phenmedipham and EP-475 are of importance for the practical use of the compounds.

Table 1.—Comparison of solubility of EP-475 and phenmedipham.

	EP-475	Phenmedipham
Acetone	about 40%	about 20%
Methanol	about 18%	about 5%
Chloroform	about 8%	about 2%

Phenmedipham has the tendency to precipitate from formulation dilutions containing more than 1 lb. active in 25 gallons of water. Norris (4,5) suggests that the solubility of the solvent in water (approximately 1.5 percent) is responsible for the precipitation in the tank. At high dilutions, more of the solvent dissolves in water. Since less solvent is then available for phenmedipham, crystallization occurs. Since EP-475 and SN 503 are more soluble than phenmedipham, a reduction of available solvent in the spray tank is less critical. Therefore, both compounds allow for greater dilutions in water than phenmedipham.

Table 2.—Stability of phenmedipham, EP-475, and SN 503 Sprays.
% Precipitate

Concentration*	Phenmedipham		EP-475		SN 503	
(% formulation)	1 hr.	3 hrs.	1 hr.	3 hrs.	1 hr.	3 hrs.
0.5	99	99	3-4	24-29	0	0
1.0	88	94	0	0	0	0
1.5	17	36-53	0	0	0	0
2.0	0	11-21	0	0	0	0

* 1% approximately 1 lb. active in 77 gals of water.

Comparative Performance of EP-475, SN 503, and Phenmedipham

The primary objectives of the tests with EP-475 and SN 503 have been to determine redroot pigweed control and crop reaction in comparison to phenmedipham.

We have experienced enormous variations in the control of pigweed with phenmedipham, ranging from 0 to 100% control. The degree of pigweed control depends primarily on the timing of the spray, with good control in the cotyledonary stage only.

The major concern for the experimental compounds was whether the timing would be as critical as for phenmedipham, or if it would be possible to control pigweed at a more advanced stage. To answer this question, two tests have been conducted where redroot pigweed and/or common lambsquarters[2] were treated at different stages with rates of 1 lb./A EP-475, SN 503, or phenmedipham. The results are summarized in the following table:

Table 3.—% Control of Redroot Pigweed and Common Lambsquarters at different stages of development.

	Redroot Pigweed			Common Lambsquarters	
Stage	EP-475	SN 503	Phenmedipham	EP-475	Phenmedipham
Emerging	100	....	22	47	53
2 leaves	95	....	80	75	96
4 leaves	89	82	35	95	96
6 leaves	92	60	0	....	....
8 leaves	89	81	....	....	....
10 leaves	85	17	....	85	94
4-5 inches	40	12	....	....	....

This demonstrates that redroot pigweed beyond the cotyledonary stage can be effectively controlled with EP-475 and SN 503. Treatments during emergence resulted in reduced control ratings, since emergence of weeds was not complete at time of application.

As an average of all tests that we conducted over the two-year period, we obtained the following control of redroot pigweed at the 1 lb. rate over a period of two years: EP-475 — 88%; SN 503 — 73%; and phenmedipham — 24%. Weeds other than pigweed do not show such pronounced differences in susceptibility to either one of the compounds.

[2] The scientific names of the weed species are given in Table 4.

Table 4.—% Control of specific weeds with phenmedipham, EP-475, and SN 503, 1 lb. a.i./Acre.

Scientific Name	Common Name	EP-475	SN 503	Phenmedipham
Chenopodium album L.	Common lambsquarters	88(15)*	90(16)	92(18)
Setaria spp.	Foxtail	40(9)	53(12)	55(13)
Kochia scoparia (L.) Schrad.	Kochia	24(5)	58(8)	61(9)
Brassica nigra (L.) Koch.	Black Mustard	93(4)	93(4)	88(5)
Ambrosia artemisiifolia L.	Common ragweed	84(3)	94(2)	89(3)
Polygonum pensylvanicum L.	Pennsylvania smartweed	32(3)	51(3)	56(3)
Capsella bursa-pastoris L. Medic.	Shepherdspurse	87(2)	84(2)	84(2)
Sisymbrium irio L.	London rocket	87(2)	81(2)	83(2)
Polygonum convolvulus L.	Wild buckwheat	75(1)	89(1)	83(1)
Stellaria media (L.) Cyrill.	Common chickweed	85(1)	85(1)	78(1)
Amsinckia intermedia Fisch. & May	Coast fiddleneck	60(1)	73(1)	78(1)

*Numbers in brackets are the number of tests in which the specific weed has been evaluated.

The data indicate that some weeds, such as Kochia, smartweed, and foxtail, may be somewhat less sensitive to EP-475 than to phenmedipham or SN 503. These differences are the major reason for investigating the combination of EP-475 and phenmedipham.

Sugarbeets do not show the same stage dependence as weeds. Other factors, mainly weather, influence selectivity more than does the growth stage of the crop. Tests during 1971 provided the following average phytotoxicity ratings to sugarbeets on a 0 - 10 scale, where 0 means not affected and 10 means dead.

EP-475	1 lb./acre	0.5
SN 503	1 lb./acre	0.4
phenmedipham	1 lb./acre	0.2

There are indications that sugarbeets under stress from a pre-emergence herbicide treatment are more sensitive to all three compounds. This phenomenon has been well documented for phenmedipham over the years. Further tests will be necessary to investigate the situation for the two experimental herbicides.

Summary

1. EP-475 and SN 503 are very promising post-emergence sugarbeet herbicides, especially against redroot pigweed. Selectivity for sugarbeets to the analog and to the mixture is similar to that of phenmedipham.

2. The amount of spray liquid per acre is less critical with EP-475 or SN 503 than with phenmedipham.

3. Before either one of the products can be recommended for use on a large scale, more information about crop safety, stage susceptibility of pigweed and other weeds, weed spectrum, and especially interaction with other herbicides and factors which influence growth of sugarbeets have to be gathered.

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