Selective Use of Phenmedipham and EP-475 in Michigan for Weed Control in Sugarbeets[1]

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Introduction

Effective herbicidal weed control in Michigan sugar beets frequently involves the combined use of preemergence and postemergence applications. The trend toward minimum labor used in sugar beet fields necessitates total weed control.

The preemergence herbicide treatment often used on heavier soils in Michigan is a pyrazon plus TCA at 4.5 kg + 6.7 kg/ha (4 lb + 6 lb/A). In a favorable environment, good control of many broadleaf and grass weeds is obtained. However, frequently an application of a postemergence herbicide such as phenmedipham is needed to control many of the escaped broadleaf weeds or some grasses (1, 3, 4, 5)[3] Redroot pigweed is an annual broadleaf weed that phenmedipham will not control. EP-475, an analog of phenmedipham, is effective on pigweed (10).

Phenmedipham and EP-475 have phytotoxic activity only when applied as a foliage treatment. Upon contact with soil, the chemicals are no longer active (6, 7, 11).

Phenmedipham and EP-475 may cause foliar injury to sugar beets under adverse environmental conditions or when used in combinations with preemergence herbicides. However, crop stand, final yield, and sugar content are usually not affected (2, 3, 5, 10). Addition of nonphytotoxic oils or concentrates will increase herbicidal activity of these compounds on many weed species (8, 10).

The objective of this research was to examine the possible use of phenmedipham and EP-475 for weed control in sugar beets by evaluating the efficacy, effect on yield, and effect on recoverable sugar content of the sugar beet root by these compounds.

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[3]Numbers in parentheses refer to literature cited.

Materials and Methods

To evaluate the efficacy of these two compounds, research plots were maintained on farmers' sugar beet fields at different locations in Michigan. Plot size was 3 or 4 70-cm (28 in) wide rows by 13.5 m (45 feet) long arranged in a randomized complete block design with three replications. All applications were broadcast by a tractor-mounted sprayer in 215 L/ha (23 gpa) of water (7).

In 1971, preemergence and postemergence treatments alone and in combination were applied to sugar beets on a sandy loam soil with 4 percent organic matter in Lenawee County, Michigan. Preemergence treatments were applied on April 12 and postemergence treatments were applied on May 11, when the sugar beet was in a 2-leaf stage. Rainfall within 1 week after preemergence treatment was 1.3 cm (0.5 in) and the total rainfall received for a 3-week period after application was 1.7 cm (0.7 in), the latter being 70 percent below the seasonal mean.

At a second location in 1971, similar applications were made on a clay loam soil with 12 percent organic matter in Saginaw County, Michigan. Preemergence applications were made on April 23 and postemergence applications were made on June 2, when sugar beets had full leaves. Rainfall within 1 week after preemergence application was 0.2 cm (0.1 in) and within 4 weeks was 1.4 cm (0.6 in), the latter being 56 percent below the seasonal mean.

In 1972, the soil used in Lenawee County was a sandy loam with 2 percent organic matter. Preemergence treatments were applied on April 28 and the postemergence treatments applied on May 17, when the first part of sugar beet leaves were one-half expanded. Rainfall within 1 week after preemergence application was 3.5 cm (1.4 in), and within 4 weeks after application was 7.3 cm (2.9 in), which approximates the seasonal mean.

In 1972, a second location was used in Bay County, Michigan with a sandy clay loam soil with 33 percent organic matter. Preemergence treatments were applied on May 9 and postemergence treatments applied on June 5, when the sugar beet was in the two-leaf stage, and again on June 14 on selected plots. Rainfall within 7 days after preemergence application was 0.5 cm (0.2 in) and within 4 weeks was 2.1 cm (0.8 in), the latter being 52 percent below seasonal mean.

Visual ratings of herbicidal effectiveness were usually obtained 1 to 2 weeks after postemergence application. Ratings on crop injury represent initial crop injury. Yields were taken in 1971 at Lenawee County by harvesting the center two rows of the 4-row plots. In 1972, juice from samples of sugar beet roots were taken from plots in Bay County and analyzed for percent recoverable sugar at Michigan Sugar Company, Saginaw, Michigan. Yields and sugar contents were analyzed for significant differences.

Results and Discussion

The weed control due to postemergence and preemergence plus postemergence herbicide combinations are shown in Tables 1, 2, 3, 4, and 5. Crop injury due to postemergence applications only was low except for the combinations shown in Table 1. Especially notable was the lack of sugar beet injury due to two postemergence applications (Tables 4, 5). Stand counts were made in 1972 but no significant differences due to treatments were observed.[4]

In general, weed control was greater with a combination of treatments. When more than 10 cm (0.4 in) of rain fell the first week after preemergence application, the best weed control was obtained (Tables 1 and 2). Due to drier soil conditions at two locations, the preemergence application resulted in poor weed control (Tables 3 and 4). However, when the postemergence treatments were applied, a substantial increase in weed control was obtained over postemergence applications alone. This indicates that, even though no visual toxicity to susceptible weeds was seen, the preemergence treatment affected these plants sufficiently to allow much greater phytotoxicity by the postemergence herbicides.

Phenmedipham controlled redroot pigweed as well as many other broadleaf weeds in the cotyledonary and prior to the full two-leaf stage (Table 1). Larger redroot pigweed plants were not controlled by phenmedipham, but activity was increased when pyrazon was added to the postemergence mixture (Tables 2, 3, 4, and 5) (2, 8). EP-475 controlled pigweed effectively at 0.8 kg/ha (¾ lb/A) a.i. with a nonphytotoxic oil or 1.12 kg to 1.68 kg/ha (1 lb to 1.5 lb/A) or greater without an oil.

Mixtures of phenmedipham and EP-475 can also be used. Lower rates of SN503[5], a 1:1 mixture of phenmedipham and EP-475, controlled many broadleaves, but higher rates were necessary to control pigweed.

If the weeds had not emerged, a postemergence application of a herbicide alone that does not exhibit soil activity after application was not effective (Table 2).

A high amount of crop injury was observed with herbicide combinations at Lenawee County in 1971 (Table 1). With this amount of initial foliar inhibition, it seemed possible that yields would be affected. However, an analysis of variance performed on yields of various plots showed there were no significant differences among the mean yields (Table 6).

Also of concern was the effect of herbicides on the recoverable sugar content in the root. As shown in Table 7, an analysis of variance

[4]Meggitt, W. F. and L. W. Hendrick, unpublished data, 1972.
[5]Designation by Nor-Am Agricultural Chemicals, Woodstock, Illinois.

Table 1.—Visual weed control ratings of postemergence and preemergence plus postemergence herbicidal combinations in sugar beets in Lenawee County, Michigan, 1971.[a]

Treatment	Rate	Postemergence only			Preemergence + postemergence combination		
		Crop injury	Redroot pigweed	Lambs-quarters[b]	Crop injury	Redroot pigweed	Lambs-quarters
	(kg/ha)						
Pyrazon + phenmedipham	2.24+1.12	0.0	8.0	7.3	3.7	10.0	10.0
Phenmedipham	1.12	0.0	9.0	8.7	5.0	10.0	10.0
Phenmedipham	1.68	0.7	9.3	8.3	4.3	10.0	10.0
SN503	1.12	0.0	9.3	9.3	4.0	10.0	10.0
SN503	1.68	0.3	10.0	9.3	4.7	10.0	10.0
EP-475	1.12	0.7	9.7	9.0	5.0	10.0	10.0
EP-475	1.68	1.7	10.0	9.0	6.0	10.0	10.0
No postemergence application	–	0.0	0.0	0.0	0.7	9.7	7.7

[a]0 = no injury or no control, 10 = complete control or kill. The preemergence herbicide application consisted of pyrazon + TCA at 2.24 + 6.72 kg/ha.
[b]Lambsquarters (*Chenopodium album* L.).

Table 2.—Visual weed control rating of postemergence and preemergence plus postemergence herbicidal combinations in sugar beets in Lenawee County, Michigan, 1972.[a]

Treatment	Rate	Postemergence only			Preemergence + postemergence combination		
		Crop injury	Redroot pigweed	Broad-leaves[b]	Crop injury	Redroot pigweed	Broad-leaves
	(kg/ha)						
Pyrazon + phenmedipham + oil	2.24+0.84+3.8 L	0.3	2.3	4.0	2.0	10.0	10.0
Pyrazon + EP-475 + oil	2.24+0.56+3.8 L	0.3	1.3	1.0	1.0	10.0	10.0
Phenmedipham + oil	1.12+3.8 L	0.3	1.3	2.0	1.7	9.5	10.0
Phenmedipham	1.68	0.0	1.0	1.0	0.7	9.5	10.0
SN503	1.12	0.0	1.7	4.0	1.3	10.0	10.0
SN503	1.68	0.7	1.7	8.0	0.7	9.8	10.0
SN503 + oil	1.12+3.8 L	0.7	1.7	1.3	1.7	10.0	10.0
EP-475 + oil	0.84+3.8 L	0.7	1.0	0.5	1.0	10.0	10.0
EP-475	1.68	0.0	–	–	1.3	10.0	10.0
No postemergence application	–	0.0	0.0	0.0	0.0	8.5	9.8

[a]0 = no injury or no control, 10 = complete control or kill. The preemergence herbicide application consisted of pyrazon + TCA at 3.36 + 6.72 kg/ha.
[b]Broadleaves consisted of predominantly lambsquarters (*Chenopodium album* L.) with some purslane (*Portulaca oleracea* L.), and ragweed (*Ambrosia artemisiifolia* L.).

Table 3.—Visual weed control ratings of postemergence and preemergence plus postemergence herbicidal combinations in sugar beets in Saginaw County, Michigan, 1971.[a]

Treatment	Rate	Postemergence only			Preemergence + postemergence combination		
		Crop injury	Redroot pigweed	Broad-leaves[b]	Crop injury	Redroot pigweed	Broad-leaves
	(kg/ha)						
Pyrazon + phenmedipham	2.24 + 1.12	0.0	5.7	7.0	0.0	4.0	9.3
Phenmedipham	1.12	0.0	0.7	6.3	0.0	0.0	10.0
Phenmedipham	1.68	0.7	0.0	7.3	1.0	3.3	10.0
SN503	1.12	0.3	7.3	9.0	1.0	8.0	9.7
SN503	1.68	0.3	7.7	6.0	2.3	10.0	9.7
EP-475	1.12	0.7	9.7	2.0	0.3	8.3	8.7
EP-475	1.68	1.7	9.3	3.7	0.7	9.7	8.7
No postemergence application	–	0.0	0.0	0.0	0.0	0.0	0.0

[a]0 = no injury or no control, 10 = complete control or kill. The preemergence herbicide application consisted of pyrazon + TCA at 4.48 + 6.72 kg/ha.
[b]Broadleaves consisted of predominantly lambsquarters (*Chenopodium album* L.), with some wild buckwheat (*Polygonum convolvulus* L.).

Table 4.—Visual weed control ratings of postemergence and preemergence plus postemergence herbicidal combinations in sugar beets in Bay County, Michigan, 1972.[a]

Treatment	Rate	Postemergence only			Preemergence + postemergence combination		
		Crop injury	Redroot pigweed	Broad-leaves[b]	Crop injury	Redroot pigweed	Broad-leaves
	(kg/ha)						
Pyrazon + phenmedipham + oil	2.24+1.12+3.8 L	1.0	5.2	9.8	1.3	7.3	10.0
Pyrazon + EP-475 + oil	2.24+0.56+3.8 L	0.3	8.8	7.8	1.7	9.5	8.0
Phenmedipham + oil	1.12+3.8 L		1.0	9.2	0.0	1.3	10.0
Phenmedipham	1.68	1.0	3.0	10.0	2.0	5.7	10.0
SN503	1.12	1.0	6.3	8.0	1.0	9.5	10.0
SN503	1.68	1.7	9.3	9.5	1.3	9.8	10.0
SN503 + oil	1.12+3.8 L	1.3	7.3	9.3	1.0	9.0	9.8
EP-475 + oil	0.84+3.8 L	1.0	9.5	7.8	0.3	9.8	9.2
EP-475	1.68	0.3	9.7	9.7	2.0	10.0	9.7
No postemergence application	–	0.0	0.0	0.0	0.0	0.0	3.3

[a]0 = no injury or no control, 10 = complete control or kill. The preemergence herbicide application consisted of pyrazon + TCA at 4.48 + 6.72 kg/ha.
[b]Broadleaves consisted of lambsquarters (*Chenopodium album* L.) and also wild buckwheat (*Polygonum convolvulus* L.), common ragweed (*Ambrosia artemisiifolia* L.) and Pennsylvania smartweed (*Polygonum pensylvanicum* L.).

Table 5.—Visual weed control ratings of double postemergence and preemergence plus double postemergence combinations in sugar beets in Bay County, Michigan, 1972.[a]

Treatment	Rate	Double postemergence treatments only			Preemergence + double postemergence treatments		
		Crop injury	Redroot pigweed	Lambs-quarters[b]	Crop injury	Redroot pigweed	Lambs-quarters
	(kg/ha)						
Pyrazon + phenmedipham + oil	2.24+1.12+3.8 L						
	2.24+0.56+3.8 L	1.3	9.1	9.7	1.7	9.5	10.0
Pyrazon + EP-475 + oil	2(2.24+0.56+3.8 L)	1.3	9.3	8.0	1.3	10.0	8.5
Phenmedipham + oil	1.12+3.8 L						
	0.56+3.8 L	1.0	1.7	9.7	1.7	4.0	10.0
Phenmedipham	1.68						
	0.84	1.0	4.7	10.0	2.3	4.7	10.0
SN503	2(0.84)	0.3	8.8	9.7	1.0	9.2	9.8
SN503 + oil	1.12+3.8 L						
	0.56+3.8 L	3.3	9.5	10.0	2.7	10.0	9.8
EP-475 + oil	2(3.35+3.8 L)	1.7	9.7	8.3	2.0	9.7	10.0
EP-475	1.68						
	0.84	0.3	9.8	9.3	1.3	10.0	10.0
No postemergence application	–	0.0	0.0	0.0	0.0	0.0	3.3

[a]0 = no injury or no control, 10 = complete control or kill. The preemergence herbicide application consisted of pyrazon + TCA at 4.48 + 6.72 kg/ha.
[b]Lambsquarters (*Chenopodium album* L.).

Table 6.—Yields of sugar beets in Lenawee County, Michigan, 1971.[a]

Postemergence treatment	Rate	Mean Yield
	(kg/ha)	(1000 kg/ha)
Pyrazon + phenmedipham	2.24+1.12	66.8
Pyrazon + phenmedipham + oil	2.24+0.84+3.8 L	60.5
Phenmedipham	1.12	59.1
Phenmedipham	1.68	66.3
SN503	1.12	70.1
SN503	1.68	59.6
EP-475	1.12	73.0
EP-475	1.68	70.3
No postemergence treatment	–	67.6
Check	–	67.4

[a]All above treatments, except the check, received a preemergence application of pyrazon + TCA at 3.36 + 6.72 kg/ha. The above means were not significantly different by an AOV at the 5 percent level.

indicated no significant differences due to single or double applications of postemergence treatments combined with the preemergence treatment.

It was advantageous to use combinations of preemergence and postemergence herbicides to obtain the greatest amount of weed control in sugar beets and not adversely affect the yields of roots even though considerable foliar injury results. Split applications of postemergence herbicides gave excellent weed control. Sugar beet injury and recoverable sugar content was not adversely affected.

Summary

Research was conducted to examine the possible use of phenmedipham (methyl *m*-hydroxycarbanilate *m*-methylcarbanilate) and EP-475 (ethyl *m*-hydroxycarbanilate carbanilate) for weed control in sugar beets (*Beta vulgaris* L.). Various treatments of phenmedipham, EP-475 and pyrazon (5-amino-4-chloro-2-phenyl-3(2H)-pyridazinone) were applied to sugar beets postemergence with and without a preemergence treatment of pyrazon + TCA (trichloroacetic acid) at various locations in different years. Weed control was greater with preemergence plus postemergence combination than with pre- or postemergence alone. Crop injury resulting from combination treatments did not affect yields. Double postemergence applications did not adversely affect the crop or recoverable sugar content compared to single postemergence treatments. EP-475 was necessary for redroot pigweed (*Amaranthus retroflexus* L.) control.

Table 7.—Kilograms recoverable white sugar per 1000 kg of sugar beet roots in Bay County, Michigan, 1972.[a]

Postemergence treatment	Rate	Weight
	(kg/ha)	(kg)
Receiving two postemergence treatments		
No postemergence application		150.5
Pyrazon + phenmedipham + oil	2.24+1.12+3.8 L	
	2.24+0.56+1.12	149.6
Pyrazon + EP-475 + oil	2(2.24+0.56+1.12)	139.4
Phenmedipham + oil	1.12+1.12	
	0.56+1.12	146.5
EP-475 + oil	2(0.84+1.12)	153.4
Phenmedipham	1.68	
	0.84	138.3
EP-475	1.68	
	0.84	148.8
EP-475	0.84	
	0.84	143.1
SN503	0.84	
	0.84	148.9
SN503	1.68	147.4
SN503	1.68	
	0.84	151.8
SN503 + oil	1.12+1.12	
	0.56+1.12	140.0
SN503 + oil	1.68+1.12	
	0.84+1.12	155.8
Receiving one postemergence treatment		
Pyrazon + EP-475 + oil	2.24+0.56+1.12	136.3
EP-475 + oil	0.84+1.12	157.0
EP-475 + oil	1.12+1.12	150.0
EP-475	1.68	150.7
SN503	1.12	145.6
SN503	1.68	146.2
SN503 + oil	1.12+1.12	140.2
SN503 + oil	1.68+1.12	149.5
Check	–	154.5

[a]All above treatments, except the check, received a preemergence application of pyrazon + TCA at 4.48 + 6.72 kg/ha. The above means were not significantly different by an AOV at the 5 percent level.

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