HERBICIDE EXTENDERS: A NEW CONCEPT IN WEED CONTROL

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SUMMARY

The phenomenon of loss of weed control with EPTC + R-25788 is described. Several chemicals were tested in the greenhouse and in the field to improve the efficacy of weed control obtained with EPTC + R-25788 when applied to "conditioned" and normal soils. One chemical, a non-insecticidal phosphorothioate, was particularly effective in restoring the herbicidal activity of EPTC + R-25788.

INTRODUCTION

EPTC + R-25788* is a pre-plant incorporated herbicide, which is widely used for annual and perennial grass and sedge control, as well as certain broadleaf weeds, in a variety of crops. In N.Z., EPTC + has been successfully used for several years to control grass weeds in maize (*Zea mays*). In the 1977-78 maize season, it was noted that EPTC + use in long term maize fertilizer trial at Manutuke Research Station near Gisborne, gave a level of weed control far below normal. It was subsequently shown by Rahman *et al* (1979) that weed control with EPTC + may decrease if used repeatedly on the same field. Further greenhouse and field trials linked the lack of weed control with a build up of micro-organisms in the soil (Rahman *et al* 1981). Greenhouse studies in the U.S. with conditioned soil (soil showing decreased activity with repeated use of EPTC +) showed that autoclaving the soil restored EPTC + activity, confirming that rapid breakdown by soil micro-organism was the major reason for the lack of weed control (Grey 1979).

Following these reports Stauffer began to study the phenomenon in the greenhouse. These studies showed that some, but not all soils, could be conditioned by repeat applications of EPTC but there were many other factors which determined whether a soil would become conditioned, besides repeat application.

A number of chemicals were tested in the greenhouse to try and restore the activity of EPTC. Some fungicides and insecticides showed activity, but high rates were required. However, a non-insecticidal phosphorothioate organophosphate, coded R-33865 (0,0-diethyl 0-phenyl phosphorothioate) showed outstanding activity in restoring EPTC performance at rates as low as 0.28 kg/ha. R-33865 restored activity of EPTC at 3.3kg/ha in a number of conditioned soils, and it was also shown that the addition of R-33865 to EPTC increased herbicidal activity in a normal loamy-sand soil not previously treated with EPTC (R. Grey 1980). For this reason, R-33865 has been referred to as a herbicide extender.

This paper describes some U.S. greenhouse tests and N.Z. field trials carried out with EPTC + in combination with R-33865 and other compounds during the development phase of the extender.

METHOD

Greenhouse trials

Three soil samples were taken from a farm at Thurman, Iowa where EPTC + had been used for four consecutive years at the maximum label rate (6.9kg/ha) for control of wild cane (*Sorghum bicolor*). Observations during the fourth year showed generally unsatisfactory wild cane control compared to performance in previous years. The samples were tested in the greenhouse to determine the initial and residual herbicidal

* hereafter referred to as EPTC +

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activity of EPTC + applied alone and in combination with R-33865, fonofos or captan. EPTC + content was also determined by chemical assay in cooperation with the residue analytical section of Stauffer.

The soil was mixed and subdivided for the various treatments, placed in 15 x 20 x 7.5 cm aluminium flats and seeded with yellow bristle grass (*Setaria glauca*), giant foxtail (*S. faberi*), barnyard grass (*Echinochloa crus-galli*), wild cane and Dekalb XL-45A maize. Ratings were taken 3 weeks after treatment, then the plants were removed, the soil screened and reseeded to determine the residual activity. In addition, 400 g of soil was taken and analysed for EPTC content by chromatography (Table 2).

N.Z. field trials

In 1980-81, seven small plot field trials were carried out in the North Island of N.Z. to assess the performance of the extender R-33865 on conditioned and normal soils. Locations were selected where EPTC + had been used for 2-3 consecutive years and where indications of a conditioned soil were previously observed. Plot size was 6 x 18m with three replications.

At site 1 (Te Puke), the soil type was a peat-loam with 10% organic matter; incorporation was by a power harrow pulled at 6.4 km/h; application was made on 20.10.80. Greenhouse bioassay and chemical assay, showed that this soil type was non-conditioned or normal in respect to performance of EPTC. At site 2 (Walton), the soil was a sandy loam; incorporation was by a ground driven spike followed by a cage roller pulled at 9 km/h; application was on 23.10.80. Tests on this soil showed that a conditioned soil situation existed. Application at both sites was made in 270 litres/ha at 175 kPa.

RESULTS AND DISCUSSION

Greenhouse trials

EPTC + applied alone at 3.36kg/ha, provided unacceptable weed control in the Thurman soil. The herbicidal activity was enhanced with the addition of R-33865, fonofos and captan (Table 1).

TABLE 1: The herbicidal activity of EPTC + initially and 3 weeks after application when applied alone and in combination with R-33865, fonofos or captan to a conditioned soil from Thurman, Iowa.

Herbicide	Additive	Rate kg/ha	Average % weed control*	
			Initially	3 weeks
EPTC +	—	3.36	63	0
EPTC +	R-33865	3.36 + 0.56	98	7
EPTC +	R-33865	3.36 + 1.12	99	67
EPTC +	fonofos	3.36 + 4.48	98	37
EPTC +	captan	3.36 + 56	98	32
untreated	—	—	0	0

* Ratings were taken 3 weeks after initial treatment and 3 weeks after rescreening soil and replanting. Figures are average percent weed control of the four species named in the method.

Table 2 shows the amount of herbicide remaining in the same soil as determined by G.C. analysis after treatment with EPTC + alone and in combination with R-33865. The analysis was done 3 weeks after treatment. Since the half-life of EPTC in most soils under greenhouse conditions is approximately one week, soil treated with EPTC alone at 3.36kg/ha should contain negligible residues. This was confirmed by bio and chemical assay. Tables 1 and 2 show that the soil persistence of EPTC was increased by the presence of R-33865, fonofos and captan.

TABLE 2: EPTC remaining 3 weeks after treatment in conditioned soil from Thurman, Iowa.

Treatment	Additive	Rate kg/ha	ppm herbicide	*Estimated % herbicide remaining
EPTC	—	3.36	0.10	3
EPTC	R-33865	3.36 + 0.56	0.81	20
EPTC	R-33865	3.36 + 1.12	1.55	39
EPTC	fonofos	3.36 + 4.48	0.81	20
EPTC	captan	3.36 + 56	0.41	10
untreated	—		<.02	

* Initial herbicide concentration was estimated to be 4ppm.

Field trials

The field trial on conditioned soil (site 2) shows that control of summer grass (*Digitaria sanguinalis*) and witchgrass (*Panicum capillare*) was improved by the extender R-33865. Fonofos also enhanced the weed control activity of EPTC + and was as active as R-33865 although at a higher rate.

The field trial on non-conditioned soil (site 1) showed enhanced weed control activity of EPTC + with R-33865 present, and R-33865 was superior to fonofos. EPTC + alone was clearly giving inferior weed control which at the low rate resulted in significant yield loss.

The presence of conditioned soils in N.Z. and elsewhere has been confirmed by both greenhouse bioassay and chemical assay techniques. In the U.S., detailed studies on a large number of soils (D. Hyzac 1980, J. Hsu 1981) in the greenhouse have shown

TABLE 3: The herbicidal efficacy of EPTC + plus atrazine alone and in combination with the extender R-33865 or fonofos in a non-conditioned and conditioned soil.

Treatment	Rates kg/ha	Site 1 Non-conditioned soil			Site 2 Conditioned soil		
		% Weed control* P.c.	% Weed control* D.s.	Yield t/ha	% Weed control* P.c.	% Weed control* D.s.	Yield t/ha
EPTC +							
+ atrazine	4.32 + 1.68	52	64	12.4 d	72	74	15.4 abc
atrazine	5.75 + 1.68	40	47	13.8 c	71	79	13.8 ef
EPTC + :R-33865							
+ atrazine	4.32:0.72 + 1.68	77	77	14.5 c	83	88	15.4 abc
	5.75:0.96 + 1.68	90	91	14.6 c	97	99	14.4 cdef
	4.32:0.54 + 1.68	86	84	15.6 ab	92	94	15.7 ab
	5.75:0.72 + 1.68	93	94	16.6 a	86	93	15.1 abc
EPTC + + fonofos							
+ atrazine	4.32 + 4.32 + 1.68	66	73	14.1 c	90	93	16.0 a
	5.75 + 4.32 + 1.68	68	70	15.1 bc	90	94	15.1 abcd
alachlor +							
atrazine	2.88 + 1.68	81	81	15.2 abc	86	90	14.7 bcde
EPTC + :							
R-33865	5.75:0.96	84	86	14.9 c	95	96	13.3 f
atrazine	1.68	19	20	7.6 e	35	30	14.0 def
untreated		0	0	7.3 e	0	0	8.2 g

* Mean of two ratings on 5-12-80 and 23-1-81 P.c. = witchgrass, D.s = summer grass; Maize injury less than 2% in all treatments.

that EPTC + performance cannot be predicted by the number of years of consecutive EPTC + use, and likewise, previous years field performance or greenhouse bioassay is not a good tool to predict EPTC + field performance. The same studies showed EPTC + performance in conditioned soils is affected by many soil factors (pH, organic matter, texture, water holding capacity, moisture and temperature) and EPTC + lack of performance in conditioned soil is independent of any single factor but dependent on the effects of several factors.

CONCLUSION

The addition of the herbicide extender R-33865 to EPTC + enhanced weed control activity in both conditioned and normal soil. The insecticide fonofos showed the same effect, at much higher rates, in conditioned soil, but was inferior in unconditioned soil.

Greenhouse bioassay and chemical assay showed that the effect of R-33865 and fonofos is to decrease the loss of EPTC from the soil, thereby extending the period after application when herbicidally active levels of EPTC will remain in the soil. This effect is critical to performance when EPTC + is used on conditioned soils, which have been confirmed to exist in N.Z. For this reason, a formulation EPTC + containing R-33865 in a 6:1 ratio of herbicide to extender has been registered and commercialized in N.Z.

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