Herbicide antidotes in tomatoes

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SUMMARY

The efficacy of a range of rates of N, N-diallyl 2, 2-dichloroacetamide (R25788) and 1, 8-naphthalic anhydride (NA) applied as seed dressings, soil applications, and foliar applications, in protecting tomatoes from a variety of pre-planting, pre-emergence and post-emergence herbicides was tested. In no case was acceptable protection obtained, and it is concluded that these protectants are unlikely to be of use in the tomato crop.

INTRODUCTION

Despite the wide variety of herbicides now available, there are still situations in which adequate selectivity between crop and weed cannot be achieved, particularly when the crop and weed species are closely related. Herbicide selectivity has been increased in some crops by the use of antidotes which apparently inhibit herbicide activity at cellular level. The literature on this subject has been fully reviewed by Blair, Parker and Kasasian (1976).

Two herbicide antidotes have been developed commercially, N, N-diallyl 2, 2-dichloroacetamide (R25788) and 1, 8-naphthalic anhydride (NA). R25788 reduces damage to maize crops when it is added to thiolcarbamate herbicides. It has also been shown to have some activity with some other herbicides and on other crops. NA is usually applied to crop plants as a seed dressing at sowing, and has been shown to give protection from subsequent pre- and post-emergence applications of a number of herbicides.

The use of herbicides in large scale tomato (*Lycopersicon esculentum* Mill.) cropping has led to the development of a resistant weed flora. The major weeds are usually adventive *Solanum* spp., particularly *S. nigrum*. No herbicide is currently available which will selectively remove these weeds from the tomato crop.

A series of experiments with tomatoes was carried out between 1974 and 1977, in which the interactions of NA and R25788, applied by a number of methods, with a range of herbicides were studied.

MATERIALS AND METHODS

All experiments were carried out in a glasshouse heated to maintain air temperature above 15°C, and ventilated when the temperature reached 20°C. The maximum temperatures reached were approximately 25°C. Pots in these experiments were watered by sub-irrigation.

In Experiments 1 to 4 plant vigour was assessed on a 0 (plants dead) to 10 (equivalent to best pot in experiment) scale, in most cases at two growth stages. In experiments 3 to 5, tomato plants were cut and weighed at the termination of the experiment.

Experiments 1 and 2

Five herbicides were applied in aqueous solution to Levin silt loam, a soil containing approximately 5% organic carbon, and thoroughly mixed to give the concentrations shown in Tables 1 and 2. In Experiment 1, NA and R25788 were applied as dressings to the tomato seed at 0.5% seed weight, while in Experiment 2 the antidotes were mixed into the soil at rates of 0.5, 5.0 and 50 ppm. The tomato cultivar used was VF 145-21-4P. There were two replications in each experiment.

Experiment 3

This experiment tested the effectiveness of seed dressings of NA and R25788, both at 0.5% seed weight, in protecting tomatoes (cv. VF 145-B7879) against 19 herbicides. Herbicides were applied pre-sowing soil incorporated, pre-emergence, and post-emergence (Table 3). There were two replications.

The soil used was a mixture of Levin silt loam and coarse sand (5:2 by volume). The mixture received a balanced fertilizer dressing and sufficient lime to bring the pH to approximately 6.

Herbicides were applied with a laboratory pot sprayer in 408 ℓ/ha. Pre-sowing incorporated treatments were sprayed and thoroughly mixed into the soil. After planting, pots were sub-irrigated and allowed to drain. The following day pre-emergence treatments were applied.

Twenty-seven days after sowing, when the plants had two true leaves, post-emergence applications were made.

Table 1. Plant vigour scores* 34 days after sowing, as affected by herbicides and antidote combinations, Experiment 1

Herbicide	Concentration in soil (ppm)	Antidote seed treatment		
		NA	R25788	Nil
Alachlor	3	8.5	8.5	9.5
Sulfallate	7	9.0	9.5	9.5
Dinitramine	1	10.0	10.0	10.0
Aziprotryne	3	2.0	2.0	3.0
EPTC	7	0.0	3.0	1.5
Nil		9.5	9.0	9.0

* Plant vigour scores 0 (= plants dead) to 10 (equivalent to best pot in experiment).

Table 2. Effect of herbicide - antidote soil treatments on plant vigour* 26 days after sowing, Experiment 2

Herbicide	Concentration in soil (ppm)	Antidote soil treatment						
		NA (ppm)			R25788 (ppm)			Nil
		0.5	5	50	0.5	5	50	
Alachlor	3	7.0	7.5	8.0	8.0	9.0	5.0	6.5
Sulfallate	7	8.5	8.0	8.5	9.0	8.5	7.0	8.0
Dinitramine	1	7.0	6.0	5.5	6.5	4.5	6.5	6.0
Aziprotryne	3	2.0	2.0	2.0	2.0	0.5	0.0	1.5
EPTC	7	2.0	2.5	0.5	2.5	2.0	2.5	2.0
Nil		9.0	9.0	9.5	9.5	9.5	9.0	10.0

* Plant vigour scores 0 (= plants dead) to 10 (equivalent to best pot in experiment).

Experiment 4

Tomato plants, cvs. Scoresby Dwarf and VF 145-21-4P, were grown in a potting mix similar to that used in Experiment 3. Twenty-seven days after sowing, when plants were 4 to 5 cm tall with two true leaves, each cultivar was sprayed with R25788 at 0.25 kg/ha or 0.025 kg/ha. After the antidote had dried on the leaves, alachlor at 1.5 kg/ha was sprayed onto these plants, and onto plants which had received no antidote, with a laboratory pot sprayer in 408 ℓ/ha. A treatment which received neither R25788 nor alachlor was included. There were five replications.

Experiment 5

Alachlor was mixed into Levin silt loam soil to give five herbicide concentrations (Table 5). Either untreated tomato (cv. VF 145-B7879) seed, or seed treated with NA at 2% of seed weight, were sown. Methyl cellulose solution was used to retain the NA on the seed. There were four replications.

Twelve days after sowing the number of plants in each pot was recorded, and all pots were thinned to three plants.

RESULTS AND DISCUSSION

Experiment 1

Vigour scores taken 34 days after sowing are presented in Table 1. Earlier observations showed similar trends.

Only with EPTC was there any indication of a beneficial effect from the antidotes. R25788 appeared to give some slight protection from this herbicide, however the EPTC + NA combination was more damaging than the herbicide alone, and completely eliminated the tomato plants.

With both alachlor and aziprotyrne tomatoes were more severly damaged where either antidote was present than where the herbicide was applied alone.

Table 3. The effect of herbicide treatments and antidote seed treatments on fresh weight (g/pot) of tomato plants, Experiment 3

Herbicide	Rate (kg/ha)	Time of application	Antidote treatment		
			NA	R25788	Nil
Dinitramine	0.8	pre-sowing	0.56	0.69	0.65
EPTC	6.0	pre-sowing	0.0	0.0	0.0
Alachlor	1.5	pre-emergence	0.0	0.0	1.12
Aziprotryne	1.5	pre-emergence	5.18	2.54	4.42
Methazole	1.5	pre-emergence	0.0	0.0	0.0
Chloroxuron	4.0	pre-emergence	8.85	9.30	7.76
Linuron	0.5	pre-emergence	0.0	0.0	0.0
Metribuzin	0.5	pre-emergence	4.85	4.73	1.80
Simazine	0.2	pre-emergence	3.96	7.04	5.87
Sulfallate	4.0	pre-emergence	8.93	9.12	8.42
Terbacil	0.2	pre-emergence	0.0	0.0	0.0
Barban	0.7	post-emergence	11.41	9.75	11.71
Bentazon	1.0	post-emergence	0.0	0.0	0.0
Desmetryne	0.3	post-emergence	0.0	0.0	0.0
Ioxynil	0.6	post-emergence	0.0	0.0	0.0
Methabenz-thiazuron	0.5	post-emergence	0.0	0.0	0.0
Terbutryne	0.3	post-emergence	0.0	0.0	0.0
Swep	4.0	post-emergence	0.0	0.0	0.0
Oxadiazon	1.5	post-emergence	0.0	0.0	0.0
Nil			9.47	11.50	9.84

L.S.D. P=0.05 2.83

Experiment 2

Table 2 gives vigour scores taken 26 days after sowing. Tomato plants were damaged severely by aziprotryne and EPTC, and were not protected by any antidote treatment. R25788 at 5.0 and 50 ppm increased damage from aziprotryne, while NA at 50 ppm increased the severity of EPTC damage. Sulfallate and dinitramine caused moderate damage, but there was no indication of any effect of antidote where these herbicides were used.

Alachlor treated plants receiving NA at any rate, or R25788 at 0.5 or 5 ppm were more vigorous than those receiving alachlor alone, however alachlor plus R25788 at 50 ppm caused severe plant damage.

Applied alone, R25788 at 50 ppm reduced early plant vigour, but this effect decreased as the plants developed.

Experiment 3

Plant fresh weights are given in Table 3. Vigour scores and dry weights gave similar results and are not presented.

Metribuzin was the only herbicide appreciably affected by antidote treatment; seed treated with either antidote producing larger plants than untreated seed in soil containing metribuzin at 0.5 kg/ha.

Experiment 4

Plant vigour scores taken 12 days after spraying, and plant fresh weights 29 days after spraying are given in Table 4. The vigour rating indicates that both rates of R25788 gave some protection to both cultivars, however plants were still much less vigorous than the unsprayed controls. Scoresby Dwarf plants treated with R25788 at 0.025 kg/ha + alachlor at 1.5 kg/ha were significantly heavier than plants receiving alachlor alone, but significantly lighter than the unsprayed treatment.

Table 4. Effect of post-emergence alachlor and R25788 treatment on plant vigour* and fresh weight of two varieties of tomatoes, Experiment 4

Tomato variety	Alachlor rate (kg/ha)	R25788 rate (kg/ha)	Plant vigour	Fresh weight (g/pot)
Scoresby Dwarf	1.5	0.25	10.00	4.41 bc **
	1.5	0.025	6.40	5.25 b
	1.5	0.0	5.60	3.96 c
	0.0	0.0	10.00	8.78 a
VF145-21-4P	1.5	0.25	6.60	4.52 bc
	1.5	0.025	5.80	4.23 bc
	1.5	0.0	4.40	3.53 c
	0.0	0.0	10.00	7.90 a

* Plant vigour scores 0 (= plants dead) to 10 (equivalent to best pot in experiment).

** Numbers followed by the same letter do not differ significantly (P=0.05) - Duncan's Multiple Range Test.

Experiment 5

Dry matter data (Table 5) showed a consistent decrease in dry weight where NA was applied to the seed. This effect reached significance in the treatments receiving no alachlor. There were no significant treatment effects on plant numbers.

Table 5. Effect of alachlor concentration and NA seed dressing on dry matter production of tomato plants (mg/pot)

NA seed dressing	Alachlor concentration in soil (ppm)				
	0.0	0.75	1.5	3.0	6.0
+	113.4	97.5	92.6	86.4	51.3
-	138.3	105.5	94.0	96.1	62.0

L.S.D. (P=0.05) 14.2

To be acceptable in commercial practice an antidote treatment must be able to protect the crop from a herbicide treatment which will control problem weeds. From the results presented above neither of the antidotes currently available meet this criterion when used in tomatoes with the herbicide tested.

These experiments included many methods of herbicide and antidote application, a wide range of antidote concentrations, and representatives of most herbicide groups. There is little likelihood, therefore, that further manipulation of these variables will lead to significantly better results.

The literature suggests that these antidotes are most effective when used in gramineaceous crops, although Blair, Parker and Kasasian (1976) quote reports of their activity in cotton and beans. Perhaps, when there is a greater understanding of the mode of action of antidotes it will be possible to develop similar materials for use in broadleaved crops.

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REFERENCES

Blair, A.M., Parker, C. and Kasasian, L. (1976).- Herbicide protectants and antidotes - a review. *PANS* 22 : 65-74.