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EFFECT OF TRIALLATE AND BARBAN ON FIVE STRAINS OF WILD OAT (AVENA SPECIES) FROM THE DARLING DOWNS, QUEENSLAND

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SUMMARY

The effect of the herbicides on three strains of *A. ludoviciana* and two of *A. fatua* were investigated in the glasshouse.

Generally the two *A. fatua* strains had a higher tolerance to triallate than the three *A. ludoviciana* strains. The reverse occurred with barban, where grey and brown *A. ludoviciana* particularly were very resistant. Despite a kill in some strains with barban, the final plant populations as a result of tillering were generally greater than the original.

Since the *A. ludoviciana* strains are predominant on the Darling Downs, this could explain the poor results very often obtained with barban and the comparatively good results often obtained with triallate.

I. INTRODUCTION

Over the last few years much has been written about the effect of triallate (S-2,3,3, trichloroallyl N.N.-diisopropylthiocarbamate) and barban (4 chloro-2-butynyl-N- (3-chlorophenyl) carbamate) on wild oats in general and on various cereal crops. But very little, if anything, has been written about the selectivity of wild oat strains to these two chemicals.

Several workers (Dodel *et al.* 1964; Sandfaer, Doll and Jensen 1965; Hayes, Pfeiffer and Rana 1965) have indicated that some wheat and barley varieties are more susceptible to barban and triallate than others. They also showed that this difference in resistance was a genetic factor.

That differing genetically stable wild oat strains exist has been established by Thurston (1954). Watkins (1967) has also shown that at least five wild oat strains exist on the Darling Downs. The fact that such strains are present may be the reason why both chemicals under investigation, particularly barban, have given inconsistent results in this area of Queensland.

Only two workers have reported any selectivity work on wild oat. Rydrych and Seely (1964) selected 63 strains of *Avena fatua* and tested I.P.C. on them. This chemical is also a carbamate (isopropyl N-phenylcarbamate). They found that they could divide the strains quite easily into resistant and non-resistant types. The majority of resistant lines were narrow-leaved, short, late-maturing plants of prostrate habit, producing seed with grey, glabrous lemmas.

This paper presents some data on the selectivity of wild oat strains on the Darling Downs to triallate and barban.

II. MATERIALS AND METHODS

Five wild oat strains were investigated, three from *Avena ludoviciana* ("ludo") and two from *Avena fatua* ("fatua"). The strains were differentiated by their floret colours, namely, cream, grey and brown in the former species and grey and brown in the latter. Florets were collected during the previous season (1966).

The soil in each experiment was a grey clay of the Cecilvale series (Beckmann and Thompson 1960). This soil type, on which wild oat occurs in abundance, covers a large area of the eastern Darling Downs.

The design for both trials was a randomized block with 7 rates of chemical and 5 wild oat strains with 4 replications. Rates used were 0, ¼, ½, 1, 2, 4 and 8 oz a.i./ac of triallate and 0, 2, 4, 6, 8, 10 and 20 oz a.i./ac of barban. Twenty single untreated florets were used in each pot in the triallate experiment and 20 pricked, dehusked caryopses (to ensure even and quick germination) per pot for the barban. The wild oat stand in the latter case was thinned to 15 seedlings per pot.

The chemicals were applied with an experimental low-pressure gas spray rig. Triallate was applied by passing the spray rig over soil in a frame 1 in. deep and of equivalent surface area to 20 x 6 in. pots, since there were 20 pots for each chemical rate. The sprayed soil was thoroughly mixed. The florets were placed on the surface of soil in the pots and covered with 1 in. of treated soil. The soil was lightly tamped and all pots were given a light surface watering. After 4 weeks, visual assessments were made on seedling survival, and all florets and seedlings were washed from the pots.

The barban was applied to seedlings, the majority of which were in the early 2-leaf stage (3 weeks after planting), by passing the spray rig over the established plants in the pots.

After a further 2 weeks, all plants in the barban experiment were subjected to moisture stress for 1 week, during which they wilted severely. Pots were rewatered and kept moist for a further week. Number of plants killed, number of tillers and length of the longest leaf were recorded. The seedlings from both experiments were divided into aboveground and below-ground parts, dried and weighed.

III. RESULTS

Data showing survival of wild oat strains after triallate application are presented in Table 1. These figures were assessed visually and all surviving seedlings were included regardless of the amount of plant distortion. One point of particular interest is the survival of some brown fatua at the highest rate (8 oz a.i./ac).

TABLE 1

SURVIVAL OF WILD OAT STRAINS AFTER TRIALLATE APPLICATION

Mean plants per pot

Treatment	*Avena ludoviciana*			*Avena fatua*	
	Cream	Grey	Brown	Grey	Brown
Control	16·00	18·00	19·25	19·00	15·50
¼ oz	9·50	13·75	12·75	19·00	13·25
½ oz	3·00	0·75	2·75	12·00	7·50
1 oz	2·50	1·75	1·50	2·50	5·25
2 oz	2·50	1·00	0·50	2·50	1·75
4 oz	0	0	0·50	0	0·50
8 oz	0	0	0	0	0·50

Necessary differences for significance: 5% = 3·84; 1% = 6·66. S.E. = 1·84.

Treatments 4 oz and 8 oz omitted from analysis.

The dry-matter weights of the aboveground parts are shown in Table 2. This weight was divided by the dry-matter weight of the below-ground parts and the results are expressed as a ratio in Table 3. It will be seen that the ratio decreased inversely with the rate of application, indicating that root growth was less affected.

TABLE 2

EFFECT OF TRIALLATE ON DRY-MATTER PRODUCTION OF ABOVEGROUND PARTS IN WILD OAT STRAINS

Dry matter (g/plant)

Treatment	*Avena ludoviciana*			*Avena fatua*	
	Cream	Grey	Brown	Grey	Brown
Control	0·0765	0·0488	0·0605	0·0658	0·0654
¼ oz	0·0337	0·0304	0·0493	0·0510	0·0487
½ oz	0·0133	0·0063	0·0068	0·0580	0·0298
1 oz	0·0024	0·0052	0·0041	0·0113	0·0177
2 oz	0·0078	0·0027	0·0036	0·0098	0·0084
4 oz	0	0·0020	0	0	0·0012
8 oz	0	0	0	0	0·0010

Necessary differences for significance: 5% = 0·0155; 1% = 0·0206. S.E. = 0·0055.

Treatments 4 oz and 8 oz omitted from analysis.

TABLE 3

EFFECT OF TRIALLATE ON SHOOT DRY MATTER/ROOT DRY MATTER RATIO IN WILD OAT STRAINS

Shoot dry matter/root dry matter ratio

Treatment	*Avena ludoviciana*			*Avena fatua*	
	Cream	Grey	Brown	Grey	Brown
Control	0·7821	0·8171	0·7365	0·9126	0·8571
¼ oz	0·6283	0·5846	0·7732	0·9729	0·8671
½ oz	0·4550	0·1982	0·3489	0·9186	0·5914
1 oz	0·0995	0·2337	0·1691	0·2547	0·5432
2 oz	0·2594	0·1283	0·1467	0·2181	0·3540
4 oz	0	0·1258	0	0	0·0723
8 oz	0	0	0	0	0·0571

Necessary differences for significance: 5% = 0·2487; 1% = 0·3274. S.E. = 0·1269.

Treatments 4 oz and 8 oz omitted from analysis.

The effect of barban on the survival of the wild oat strains is presented in Table 4. The number of primary plants killed is expressed as a percentage of total number of plants. Significant kills occurred at 4 oz a.i./ac in grey fatua, 6 oz in cream ludo and 8 oz in brown fatua. No significant kills occurred in brown and grey ludo. Grey ludo results were excluded from analysis in Tables 4, 8 and 9. Maximum significant "kills" were recorded at 20 oz in cream ludo, 6 oz in grey fatua and 8 oz in brown fatua. The reason for the low kill at 8 oz in grey fatua and 20 oz in brown fatua is not known.

TABLE 4

PERCENTAGE OF PRIMARY SHOOTS OF WILD OAT KILLED BY BARBAN

Treatment	*Avena ludoviciana*					*Avena fatua*			
	Cream		Grey	Brown		Grey		Brown	
	M	Equiv. Mean		M	Equiv. Mean	M	Equiv. Mean	M	Equiv. Mean
Control	0	0	0	0	0	0	0	0	0
2 oz	0	0	0	0	0	0·181	3·2	0·077	0·6
4 oz	0·070	0·5	0	0	0	0·299	8·7	0	0
6 oz	0·362	12·5	0	0	0	0·588	30·8	0·247	6·0
8 oz	0·332	10·6	0	0	0	0·234	5·4	0·385	14·1
10 oz	0·358	12·3	0	0·060	0·4	0·606	32·4	0·307	9·1
20 oz	0·724	43·9	0	0·206	4·2	0·606	32·4	0·073	0·5

M = Inverse sine transformation mean. Necessary differences for significance (transformed mean): 5% = 0·293; 1% = 0·388.

S.E. = 0·104.

No significant (5%) reduction in shoot dry matter per plant occurred in either grey or brown ludo (Table 5). However, grey fatua showed a reduction at the 10 oz and brown fatua at the 20 oz rates. Cream ludo was affected at the 4 oz rate. Shoot dry matter/root dry matter ratio (Table 6) showed a significant (1%) reduction only in brown fatua at 6 oz a.i./acre.

TABLE 5

EFFECT OF BARBAN ON DRY-MATTER PRODUCTION OF ABOVEGROUND PARTS OF WILD OAT STRAINS

g/plant

Treatment	*Avena ludoviciana*			*Avena fatua*	
	Cream	Grey	Brown	Grey	Brown
Control	0·0727	0·0428	0·0580	0·0799	0·0562
2 oz	0·0658	0·0423	0·0517	0·0911	0·0527
4 oz	0·0574	0·0358	0·0553	0·0787	0·0453
6 oz	0·0583	0·0417	0·0487	0·0791	0·0451
8 oz	0·0493	0·0414	0·0573	0·0767	0·0444
10 oz	0·0483	0·0379	0·0547	0·0630	0·0435
20 oz	0·0440	0·0397	0·0590	0·0561	0·0373

Necessary differences for significance: 5% = 0·0138; 1% = 0·0183. S.E. = 0·0049.

TABLE 6

EFFECT OF BARBAN ON SHOOT DRY MATTER/ROOT DRY MATTER RATIO IN WILD OAT STRAINS

Treatment	*Avena ludoviciana*			*Avena fatua*	
	Cream	Grey	Brown	Grey	Brown
Control	0·876	1·060	1·035	1·320	1·063
2 oz	0·931	0·971	0·977	1·260	1·100
4 oz	0·915	0·984	1·009	1·205	0·965
6 oz	0·874	1·006	1·004	1·188	0·861
8 oz	0·823	1·061	1·073	1·221	0·857
10 oz	0·804	1·039	0·948	0·955	0·988
20 oz	0·833	1·126	1·095	1·002	0·889

Necessary differences for significance: 5% = 0·131; 1% = 0·173. S.E. = 0·047.

Data in Table 7 represent the average length of the longest leaf per plant. Because of dead leaves, it was impossible to measure the same leaf on each plant; hence the longest leaf was used as a compromise. Significant leaf length reductions occurred in cream ludo at the 16 oz rate, in grey fatua at the 20 oz rate and in brown fatua at the 10 oz rate.

TABLE 7

EFFECT OF BARBAN ON LEAF LENGTH IN WILD OAT STRAINS
Length per leaf (cm)

Treatment	*Avena ludoviciana*			*Avena fatua*	
	Cream	Grey	Brown	Grey	Brown
Control	19·00	16·80	19·20	19·60	17·55
2 oz	18·30	15·40	17·97	19·95	16·42
4 oz	18·60	15·20	18·87	19·92	15·17
6 oz	16·62	16·37	18·12	20·07	14·85
8 oz	15·15	16·12	19·50	20·72	15·25
10 oz	14·45	14·90	18·17	17·15	14·65
20 oz	13·97	14·62	18·72	15·02	13·40

Necessary differences for significance: 5% = 2·86; 1% = 3·78. S.E. = 1·02.

From the data of Table 8 it can be seen that the chief effect of barban under trial conditions was to stimulate tiller production. This production was inversely related to percentage kill. However, each strain showed a different capacity to tiller, with grey fatua being the most prolific.

TABLE 8

PERCENTAGE OF TILLERS PRODUCED AFTER BARBAN APPLICATION

Treatment	*Avena ludoviciana*					*Avena fatua*			
	Cream		Grey	Brown		Grey		Brown	
	M	Equiv. Mean		M	Equiv. Mean	M	Equiv. Mean	M	Equiv. Mean
Control	0·090	0·8	0	0	0	0	0	0	0
2 oz	0·277	7·5	0	0	0	0·464	20·0	0·077	0·6
4 oz	0·267	6·9	0	0	0	0·466	20·2	0·193	3·7
6 oz	0·594	31·3	0	0·165	2·7	0·790	50·3	0·534	25·9
8 oz	0·473	20·8	0	0·058	0·3	0·291	8·2	0·512	24·0
10 oz	0·747	46·3	0	0·168	2·8	0·928	54·3	0·403	15·4
20 oz	0·814	52·8	0	0·370	13·1	1·083	78·0	0·236	5·5

M = Inverse sine transformation mean. Necessary differences for significance (transformed mean): 5% = 0·416; 1% = 0·552. S.E. = 0·148.

To assess this tillering effect, the total number of primary plants killed was subtracted from the total number of tillers produced and the results expressed as a percentage of the total number of original plants (Table 9). No reduction of overall plant numbers occurred in any strain. Significant plant number increases were recorded in cream ludo at the 10 oz rate, grey fatua at the 2 oz rate and brown fatua at the 6 oz rate.

TABLE 9

PERCENTAGE INCREASE IN PLANT NUMBERS DUE TO TILLERING AS A RESULT OF BARBAN APPLICATION

Treatment	*Avena ludoviciana*					*Avena fatua*			
	Cream		Grey	Brown		Grey		Brown	
	M	Equiv. Mean		M	Equiv. Mean	M	Equiv. Mean	M	Equiv. Mean
Control	0·090	0·8	0	0	0	0	0	0	0
2 oz	0·277	7·5	0	0	0	0·333	10·7	0	0
4 oz	0·196	3·8	0	0	0	0·298	8·6	0·193	3·7
6 oz	0·277	7·5	0	0·165	2·7	0·371	13·1	0·442	18·3
8 oz	0·252	6·2	0	0·058	0·3	0·123	1·5	0·183	3·3
10 oz	0·571	29·2	0	0·108	1·2	0·435	17·8	0·244	5·8
20 oz	0·247	6·0	0	0·256	6·4	0·686	40·1	0·204	4·1

M = Inverse sine transformation mean. Necessary differences for significance (transformed mean): 5% = 0·297; 1% = 0·394. S.E. = 0·106.

IV. DISCUSSION

It became obvious when washing out the florets and seedlings that many of the florets had not remained at the planted depth of 1 in. The florets used were complete with awn, and some displacement occurred, probably because of awn movement after watering. This movement occurred in all strains and its effect clouded the results because the resulting shallow-placed florets had a greater survival rate. It seems likely that a significant loss of triallate could have occurred as the surface of the self-mulching soil dried out. Seedling survival rate did differ, however, between strains.

The overall significant (5%) plant number reduction at the $\frac{1}{4}$ oz rate in the ludo strains indicates that they are very susceptible to triallate. This is substantiated by the further significant (1% between $\frac{1}{4}$ oz and $\frac{1}{2}$ oz) reduction at the $\frac{1}{2}$ oz rate. No significant plant survival occurred in *A. ludoviciana* above the $\frac{1}{2}$ oz rate.

With the fatua strains, however, significant plant survival occurred in grey fatua at the $\frac{1}{2}$ oz rate and in brown fatua at the 1 oz rate. It will be noted that triallate at $\frac{1}{4}$ oz a.i./ac had no significant effect on either of the *A. fatua* strains.

These results indicate that the decreasing order of survival of wild oat strains to triallate application is grey fatua, brown fatua, grey ludo, brown ludo and cream ludo.

It has been held for some time that the chief role of barban in wild oat control on the Darling Downs is one of "check-smother".

Although a moisture stress was applied to the seedlings in this trial, this did not produce plant competition for light and nutrients which would occur under field crop conditions. It is likely that, under such field conditions, sprayed wild oat seedlings would not be able to poduce tillers, particularly if rain did not fall for some weeks after spraying.

The results of the present trial show that, although the primary plant can be killed by barban, tiller production is greatly enhanced. However, Table 4 indicates that, if weather conditions do not permit tiller production, a variation in percentage kill can be expected.

The two most susceptible wild oat strains were cream ludo (43·9% kill of primary shoots at the 20 oz rate) and grey fatua (32·4% kill of primary shoots at the 10 oz rate). Primary shoot growth of these strains was reduced by all rates exceeding 2 oz a.i./ac. Both of these strains, however, exhibited a high potential for tillering.

In the case of cream ludo, significant tillering did not occur until the 10 oz rate, while grey fatua produced significant tiller numbers at the 2 oz rate. Survival potential of these two strains is, therefore, quite high.

Brown fatua showed a peculiar susceptibility peak at the 8 oz rate. The reason for this is not known. This strain exhibited more tolerance to barban than did grey fatua and cream ludo.

A large tolerance gap was apparent between the three strains just discussed and the remaining two. Grey ludo showed no reaction to barban. This could be due either to complete tolerance or to low spray contact. In the work by Rydrych and Seely (1964), some grey fatua strains were resistant to I.P.C.

The characteristics of these resistant fatua strains are similar to those of the grey ludo of the present trial. The main differences were that the ludo strain had seed with hairy lemmas and the plants were tall and erect. This ludo strain is also characterized by a narrow seedling leaf. This could have resulted in a low spray contact, thus rendering the chemical ineffective.

Although brown ludo showed no significant response, it would appear that it is slightly less tolerant to barban than grey ludo.

The order of decreasing tolerance of wild oat strains to barban as revealed by this trial was grey ludo, brown ludo, brown fatua, grey fatua and cream ludo. This order of tolerance is of significance on the Darling Downs, as Watkins surveyed this area for wild oat strain frequency, and his results showed a frequency pattern as follows for the year 1967: 54·9% of panicles collected were grey ludo, 32·9% were brown ludo, 6·2% were brown fatua, 3·1% were grey fatua and 2·9% were cream ludo.

It is considered that these data explain the comparatively consistent results obtained on the Darling Downs with triallate and the relatively inconsistent results obtained with barban.

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