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HERBICIDES IN SEED CROPS OF PASPALUM PLICATULUM

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SUMMARY

Six different herbicides and mixtures were tested either pre- or post-emergence for weed control in *Paspalum plicatulum* cv. Rodds Bay grown for seed. The most promising chemical, methabenzthiazuron (N-benzothiazol-2-yl)-N, N'-dimethylurea) was tested on two different seeding rates. None of the chemical treatments produced seed yields as high as the hand-weeded control. Low yields were due to chemical phytotoxic effects on the crop, poor weed control, or both.

I. INTRODUCTION

Weed control in tropical grass seed crops has traditionally been by the use of cultivation, spraying with 2,4-D (2,4-dichlorophenoxyacetic acid) and slashing. Control of broad-leaved weeds by these methods is usually effective, but grass weeds then become the problem. On the Atherton Tableland of Queensland grass seed crops are normally grown in the Tolga-Kairi area (latitude 17° 10′S and altitude 760 m). The annual rainfall is about 1 130 mm and the main soil type is a fertile basaltic loam. In this region annual broad-leaved weeds tend to predominate in cultivated areas unless controlled. However once these weeds have been controlled annual grass weeds, especially crowsfoot grass (*Eleusine indica*), can become so troublesome that worthwhile seed crops cannot be produced in the year of crop establishment. During the second year the perennial grass crop grows faster than the annual weeds and usually produces a worthwhile crop.

Paspalum plicatulum is a hardy pasture grass which tolerates both the seasonal drought and waterlogged conditions which occur in many parts of Queensland's pastoral country. Before the recent establishment of large areas of *P. plicatulum* in Queensland the grass seed producers of the Atherton Tableland planted several small areas of this species as opportunity seed crops.

P. plicatulum is susceptible to various herbicides. Bowmer and McCully (1966) showed that it was adversely affected by both the sodium salt and the ester of TCA (trichloroacetic acid), prometon (4,6,-bisisopropylamino-2-methoxy-1,3,5-triazine), erbon (2-(2,4,5-trichlorophenoxy)ethyl (2,2-dichloropropionate), chlorfenac (2,3,6-trichlorophenylacetic acid) and 2,3,6-trichlorobenzyloxypropanol. Kern (1962) showed that *P. plicatulum* was killed by propanil (N-(3,4-dichlorophenyl)propionamide). Botton (1973) showed that of 2,4-D as the amine salt, 2,4-DB (4-(2,4-dichlorophenoxy)butyric acid) as the potassium salt and dinoseb (2-(1-methylpropyl)-4,6-dinitrophenol) as the amine salt, only dinoseb controlled weeds without harming established *P. plicatulum*. Unfortunately, while dinoseb is very effective on many broad-leaved weeds it is relatively ineffective on grasses.

Preliminary observations (unpublished data) took the form of a pot experiment and a field experiment: logarithmic strips of chemicals applied to various grass species indicated that *P. plicatulum* cv. Rodds Bay was susceptible to pre-emergence applications of diuron (N'-(3,4-dichlorophenyl)-N,N-dimethylurea), atrazine (2-chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine), prometryne (4,6-bisisopropylamino-2-methylthio-1,3,5-triazine), karbutilate (m-(3,3-dimethylureido)phenyl-t-butylcarbamate), chloroxuron (N-4-(4-chlorophenoxy) phenyl-N,N-dimethylurea), siduron (N-2-methylcyclohexyl)-N-phenylurea) and SN40624 (N,N-dimethyl-N'-(3-N"-methyl-N"-phenyl-carbamoyloxy)phenyl) urea. *P. plicatulum* tolerated SN40454 (3-(methoxycarbonylamino)-phenyl-N-methyl-N phenylcarbamate) but this chemical was ineffective in controlling either broad-leaved or grassy weeds. *P. plicatulum* showed some tolerance to simazine (2-chloro-4,6-bisethylamino-1,3,5-triazine) applied pre-emergence and also of ioxynil (4-hydroxy-3,5-di-iodobenzonitrile) and bromoxynil (3,5-dibromo-4-hydroxybenzonitrile), either alone or mixed with MCPA (4-chloro-2-methylphenoxyacetic acid), used post-emergence. These latter chemicals gave some weed control and were selected for further testing together with methabenzthiazuron (N-(benzothiazol-2-yl)-N,N'-dimethylurea) and terbutryne (4-ethylamino-2-methylthio-6-t-butylamino-1,3,5-triazine). Veenstra and Boonman (1974) claim that both methabenzthiazuron and terbutryne are effective in controlling *Eleusine spp.* in other tropical grass seed crops.

II. MATERIALS AND METHODS

Two herbicide screening experiments were conducted followed by a herbicide-rate by seeding-rate experiment using the safest and most effective chemical found in the screening experiments.

In all experiments the treatments were laid out in a randomised block design with four replicates of each. The plot size was 3·5 m (8 rows) by 3·7 m. *P. plicatulum* cv. Rodds Bay seed was planted with a four row Øyjord precision plot drill at a row spacing of 44 cm. Unless otherwise stated the planting rate of seed was 5·56 kg ha^{-1}. Herbicides were applied with an Oxford precision sprayer with a boom fitted with five flat fan nozzles (Tee Jet 8002) spaced 34 cm apart. Spray volume was 337 *l* ha^{-1} applied at 207 kPa. All post-emergence treatments contained a wetting agent (Agral 60) at 0·1%. In the herbicide screening experiments the centre 2·6 m (6 rows) by 2·85 m were harvested for seed yield.

Experiments 1 and 2

These experiments were planted on 19 December 1973 and 27 December 1974, respectively. The chemical treatments are shown in tables 1 and 2. The pre-emergence treatments were applied to a moist soil 2 (experiment 2) and 4 (experiment 1) days after planting. The post-emergence treatments were applied 10 (experiment 2) and 20 (experiment 1) days after planting. Hand-weeded plots were maintained weed-free with hoes.

During the season of establishment both experiments were slashed 2 months after planting. During the second season experiment 1 was slashed one month after the commencement of the wet season. In each case all plots received nitrogen at 112 kg N ha^{-1} applied as ammonium nitrate immediately after slashing.

Seed heads were hand harvested when it was judged that the bulk of the seed was ripe. Heads were then dried and threshed, and the seed was cleaned. Yields of clean seed were recorded.

Experiment 3

From the observations made on the screening experiments it was judged that methabenzthiazuron was the most selective of the chemicals used. A two by five factorial design employed two seeding rates (2·78 and 5·56 kg ha^{-1}) and five methods of weed control (i.e. none, hand-weeding and three rates of methabenzthiazuron). This experiment was laid down one month after planting experiment 2 (24 January 1975). The methabenzthiazuron (see table 3 for rates) was applied 8 days after planting. All plots were slashed 3 months after planting and fertilized with ammonium nitrate at 112 kg N ha^{-1}. The survival of seedlings was measured 6 weeks after planting: quadrat counts were made on the centre rows so that 62 cm x 2 rows were counted, 62 cm from the northern edge of each plot (untreated plots were not counted). Due to late establishment and unseasonal cold weather little seed was produced and yields were assessed as 2 x 0·5-m^2 quadrat counts of numbers of *P. plicatulum* tillers on each plot.

III. RESULTS

Yields

Experiment 1

The mean yields of seed from treatment plots in experiment 1 for both seasons are shown in table 1.

TABLE 1

Seed Yields of the Various Treatments used in Experiment 1 Over the First and Second Seasons after Planting

Treatment	Mean Yield of Clean Seed (kg ha^{-1})	
	First Season	Second Season
Untreated	11·9 b*	261·3 ab*
Hand-weeded	137·6 a	275·8 ab
Simazine at 0·84 kg ha^{-1} a.i., pre-emergence	62·3 b	324·1 a
Simazine at 1·68 kg ha^{-1} a.i., pre-emergence	63·6 b	168·6 bc
Simazine at 3·36 kg ha^{-1} a.i., pre-emergence	20·2 b	84·9 c
Ioxynil at 0·56 kg ha^{-1} ae, post-emergence	45·4 b	226·1 ab
Ioxynil at 1·12 kg ha^{-1} ae, post-emergence	76·2 ab	186·2 bc
Ioxynil at 1·68 kg ha^{-1} ae, post-emergence	49·5 b	215·0 ab
Bromoxynil: MCPA (1 : 1) at 1·12 kg ha^{-1} total ae, post-emergence	49·3 b	265·8 ab
Bromoxynil: MCPA (1 : 1) at 2·24 kg ha^{-1} total ae, post-emergence	58·4 b	305·9 a
Bromoxynil at 1·68 kg ha^{-1} ae, post emergence	58·9 b	234·4 ab

* Means within columns followed by the same letter are not significantly different at the 5% level (Duncan's New Multiple Range Test).

The first harvest yields were extremely variable (coeff. of variation = 83%) and hence lacked significant differences. In spite of this fact mean yields from all plots given chemical treatments (except for that of ioxynil used at 1·12 kg ha^{-1} acid equivalent (ae)) and from the untreated control plots were significantly less than that of the hand-weeded plots. By the second season mean yields from plots under most treatments (except for that of the 3·36 kg ha^{-1} active ingredient (a.i.) rate of simazine) did not differ significantly from that of the hand-weeded plots.

Experiment 2

Mean yields of seed are shown in table 2.

TABLE 2

First Season Seed Yields of the Various Treatments used in Experiment 2

Treatment	Mean Yield of Clean Seed (kg ha^{-1})
Untreated	0·1 b*
Hand-weeded	142·7**
Methabenzthiazuron at 1·5 kg ha^{-1} a.i., pre-emergence	30·4 a
Methabenzthiazuron at 3 kg ha^{-1} a.i., pre-emergence	17·4 ab
Terbutryne at 1·5 kg ha^{-1} a.i., pre-emergence	0·3 b
Terbutryne at 3 kg ha^{-1} a.i., pre-emergence	6·6 b
Simazine at 1 kg ha^{-1} a.i., pre-emergence	0·9 b
Ioxynil at 1 kg ha^{-1} ae, post-emergence	2·5 b
Bromoxynil at 1 kg ha^{-1} ae, post-emergence	0·1 b
Bromoxynil : MCPA (1 : 1) at 1 kg ha^{-1} total ae, post-emergence	0·3 b

* Means followed by the same letter are not significantly different from one another at the 5% level (Duncan's New Multiple Range Test).

** Omitted from the analysis because all components of this mean were greater than those of any other mean.

These results show that the mean yield of the hand-weeded plots was greater than that of any of the other treated plots. The mean yield of the methabenzthiazuron 1·5 kg ha^{-1} a.i. treated plots was not significantly different from that of the methabenzthiazuron 3 kg ha^{-1} a.i. treated plots but it significantly exceeded the mean yields obtained under all other treatments, except for that of the hand-weeded plots.

Experiment 3

In the factorial analyses of both the surviving-plants and the tillers-at-harvest data, the F values for the main effects of seeding rate and the seeding rate by weed control interactions were not significant (P = 0·05). In both cases the F values for the main effects of weed control were significant (P = 0·05 and 0·001, respectively).

The numbers of plants per metre of row surviving 6 weeks after planting and the mean numbers of tillers at harvest are shown in table 3.

Of the plots treated with methabenzthiazuron, all except those receiving the highest concentration (4 kg ha^{-1} a.i.) produced numbers of surviving plants similar to those of the hand-weeded control plots. All plots given chemical treatments, and the untreated control plots, had fewer shoots at harvest than those which were hand-weeded.

TABLE 3

MEAN NUMBERS OF SURVIVING SEEDLINGS 6 WEEKS AFTER PLANTING AND NUMBERS OF TILLERS AT HARVEST IN EXPERIMENT 3

Treatment	Number of Seedlings per Metre of Row*	Number of Tillers per Square Metre**
Hand-weeded	5·7 a***	532 a***
Methabenzthiazuron at 1 kg ha^{-1} a.i.	3·6 a	17 b
Methabenzthiazuron at 2 kg ha^{-1} a.i.	3·4 a	26 b
Methabenzthiazuron at 4 kg ha^{-1} a.i.	0·6 b	6 b
Untreated	—	5 b

— = not recorded.
* Data transformed by $\sqrt{x + \frac{1}{2}}$ prior to analysis.
** Data transformed by log (x + 1) prior to analysis.
*** Means within columns followed by the same letter are not significantly different at the 5% level (Duncan's New Multiple Range Test).

Visible effects of chemicals

In experiment 1 the main weeds present at harvest were crowsfoot grass, blue top (*Ageratum conyzoides*), *Eragrostis* sp., Guinea grass (*Panicum maximum*) and woolly top Rhodes grass (*Chloris virgata*). Apple-of-Peru (*Nicandra physalodes*) was also present in abundance on plots of the untreated control in the early stages of growth but was completely controlled by the slashing process. This latter species was also effectively controlled by all of the chemical treatments.

At harvest, the weed spectra of all the bromoxynil, bromoxynil:MCPA and ioxynil treated plots were similar to those of the untreated plots and consisted almost entirely of blue top and the various grass weeds. Also at this time there was a large variety of broad-leaved weeds on the simazine treated plots, including those species listed above and wild radish (*Raphanus raphanistrum*), tall fleabane (*Erigeron floribundus*) and sow thistle (*Sonchus oleraceus*). The numbers of these weeds was greatest on plots treated with the highest rate of simazine.

P. plicatulum plant density was less on all plots treated with simazine than on the untreated control plots, and was least on plots treated with the highest rate of simazine. The lower density was visually apparent at harvest in the cover provided by the crop. There appeared to be slightly lower plant vigour on those plots treated with bromoxynil:MCPA at 2·24 kg ha^{-1} ae and on those plots treated with ioxynil at 1·68 kg ha^{-1} ae. No adverse effects on cover were noticed on these plots at harvest, however, and no other adverse effects on the crop were observed.

In experiment 2 the weed spectrum was similar to that of the first experiment. The effects on crop and weeds for the simazine, bromoxynil, bromoxynil: MCPA and ioxynil treated plots were similar to those described for experiment 1. Most of the plants (both crops and weeds) which emerged early in the experiment on the terbutryne treated plots died soon after emergence. By harvest time these plots were covered with weeds, mostly apple-of-Peru, which had germinated later in the experiment. On the methabenzthiazuron treated plots moderate control of apple-of-Peru and crowsfoot grass was obtained but there was little control of *Setaria anceps,* blue top, woolly top Rhodes grass and guinea grass.

In experiment 3 there was little problem with most of the tropical grasses, such as crowsfoot and guinea grass. At harvest much of the experimental area was covered with star grass (*Cynodon* sp.) and Mexican poppy (*Argemone ochroleuca*). This latter species was particularly prevalent on plots of the low seeding rate which received either 2 or 4 kg ha^{-1} a.i. of methabenzthiazuron.

IV. DISCUSSION

Of the chemicals tested none is suitable for weed control in *P. plicatulum* because of phytotoxic effects on the crop, or poor weed control, or both. In experiment 1 no chemical treatment produced yields significantly higher than that of the untreated control (table 1). In experiment 2 methabenzthiazuron applied at 1·5 kg ha^{-1} a.i. was the only chemical treatment to produce *P. plicatulum* seed yields significantly higher than that of the untreated control (table 2). However, this treatment produced a much poorer mean yield than the hand-weeded control.

In experiments 1 and 2 both simazine and terbutryne produced severe crop phytotoxicity effects as well as controlling the weeds. This was evidenced both by the reduction in crop density and by the reduction in crop cover at harvest time. The presence of a variety of broad-leaved weed species at harvest on plots treated with these chemicals indicates bare ground being present after slashing, followed by later colonization as the chemicals were leached or broke down. The similar weed spectra on the methabenzthiazuron treated and untreated plots indicates poor weed control by this chemical.

The yield data for the second season for experiment 1 (table 1) show that the effects of either weeds or effective weed control in the first season did not persist into the second season since the untreated and hand-weeded plots did not differ significantly in yield at the second harvest. This is undoubtedly due to the established perennial crop growing faster than the annual seedling weeds at the start of the second season. It was observed that there were very few weeds present on this experiment during the second season. The lower yield of the simazine 3·36 kg ha^{-1} a.i. treated plots at the second harvest is undoubtedly due to the fewer *P. plicatulum* plants originally established under this chemical.

Table 3 shows that even though the populations of *P. plicatulum* were not significantly less under 1 and 2 kg ha^{-1} a.i. of methabenzthiazuron treatments, yields from plots under these treatments were well below those of the hand-weeded plots. This supports the inference that methabenzthiazuron at 1 and 2 kg ha^{-1} a.i. was not particularly effective in controlling weeds.

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