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# ATRAZINE TOLERANCE IN FIVE TROPICAL PASTURE GRASSES

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## ABSTRACT

*Five glasshouse experiments were carried out to investigate the effect of different rates of atrazine on plants at four stages of development. Two were pre-emergence treatments and three were designed to study the effect of applying atrazine at 3, 5 and 9 weeks after sowing.*

*Pre-emergence application of atrazine at 1 and 4 kg ha$^{-1}$ caused mean reduction in seedling emergence of grasses grown in one of two clay soils. However the effect on individual grasses was not significant.*

*Mortality of emerged* Panicum coloratum, Chloris gayana *and* Cenchrus ciliaris *on both soils was increased by atrazine at 4 kg ha$^{-1}$.*

*Root and shoot yields plant$^{-1}$ of* C. gayana *only were significantly reduced by pre-emergence atrazine application. Root/shoot ratios were not significantly affected.*

*Root and shoot yields pot$^{-1}$ of* C. gayana *and* C. ciliaris *were significantly reduced by pre-emergence atrazine. On one soil atrazine at 4 kg ha$^{-1}$ significantly reduced shoot yields pot$^{-1}$ of* P. maximum *and* P. coloratum.

*Post-emergence application of atrazine at 1 and 4 kg ha$^{-1}$ at the 2- to 4-leaf stage (3 weeks after sowing) and beyond had no significant effect on plant survival or shoot yield.*

*Overall, the decreasing order of atrazine tolerances was*: Bothriochloa insculpta, P. maximum, P. coloratum, C. ciliaris *and* C. gayana.

## INTRODUCTION

Atrazine (2-chloro-6-ethylamino-4-isopropylamino—1,3,5—triazine) has been recommended to effectively control many annual grass and broadleaved weeds when applied pre-plant or pre- or post-emergence depending on the particular situation (Swarbrick 1976).

One of the most troublesome broadleaved weeds in spring- and summer-sown tropical grass pastures on the Darling Downs in south-eastern Queensland is *Salvia reflexa* (mintweed). Felton and Strang (1974) and Rawson *et al.* (1976) recommend low atrazine rates (0.5 to 1.0 kg ha$^{-1}$) for its control.

Little information is available on the susceptibility of the important pasture grasses to atrazine.

*Brachiaria decumbens* and *Panicum maximum* have a high degree of tolerance to pre-emergence application of atrazine whereas *Paspalum plicatulum* and *Setaria anceps* are susceptible to this herbicide (Hawton 1976).

Thompson (1972) showed that for weed grasses within the genera *Setaria* and *Panicum* selectivity patterns of atrazine for several species and/or varieties are related to differential rates of detoxification of the herbicide.

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Jensen *et al.* (1977) found that none of the selected festucoid and eragrostoid species showed high levels of tolerance to the applied rate of atrazine while panicoid species exhibited a wide range in ability to metabolize atrazine. In comparison with panicoid and festucoid species, the tested eragrostoid grasses were intermediate in their ability to recover from the atrazine treatment.

Tolerance of five commercial pasture grasses, four panicoid and one eragrostoid species, to pre- and post-emergence atrazine application was tested at Toowoomba in south-eastern Queensland.

## MATERIALS AND METHODS

Five glasshouse experiments were carried out to investigate the effect of different rates of atrazine on plants at different stages of development. Experiments 1 and 2 were pre-emergence treatments, 1 on a Lockyer dark brown clay soil (pH 7.5, % clay 43, % org.C 1.85), 2 on a Mywybilla clay soil (Thompson and Beckman 1959) (pH 8, % clay 70, % org.C 1.5). Both were Ug 5.1 soils (Northcote 1974). Experiments 3, 4, 5 were on the Lockyer dark brown clay soil and were designed to study the effect of applying atrazine at 3, 5 and 9 weeks after sowing. The experiments were sown at different times so that atrazine could be applied on the same day for all experiments and hence post-spraying environmental conditions would be similar for all experiments.

Each experiment, comprising three randomized blocks of a complete factorial combination of five grasses with three atrazine rates, was maintained on a single glasshouse bench. Positions of pots within each block were re-randomized at two week intervals from sowing to harvest.

In the two pre-emergence experiments equal numbers of pure live seeds of *Panicum maximum* var. *trichoglume* (green panic) cv. Petrie, *Panicum coloratum* var. *makarikariense* (Makarikari grass) cv. Bambatsi, *Chloris gayana* (Rhodes grass) cv. Pioneer, *Cenchrus ciliaris* (buffel grass) cv. Biloela and *Bothriochloa insculpta* (creeping bluegrass) cv. Hatch were sown 1 cm deep in 15 cm diameter free-draining pots containing 1 kg air-dry soil. In the three post-emergence experiments three plants pot$^{-1}$ of each grass were established.

Atrazine (Gesaprim 80*) at 1 and 4 kg ai ha$^{-1}$ with 0.12% non-ionic wetting agent (Agral 60*) in a spray volume of 300 l ha$^{-1}$ with water was applied with a boom spray to pots which were moved outside the glasshouse for treatment and immediately returned.

Pre-emergence pots were watered immediately after spraying and post-emergence pots two days after herbicide application. Pots were watered from the top at two day intervals ensuring that the whole soil surface was covered equally.

Glasshouse temperature varied from 15°C minimum to 30°C maximum during the course of the experiments.

Experiments were harvested 33 days after atrazine application. Grass shoots were clipped and roots recovered in the pre-emergence experiments and shoots only in the post-emergence experiments. Harvested material was dried at 80°C for 36 hours and weighed.

## RESULTS

### *Experiments* 1 *and* 2

Pre-emergence atrazine had no significant effect on percent emergence (percent of greatest number of plants emerged pot$^{-1}$ for each grass) on Lockyer clay. However pre-emergence atrazine at 1 and 4 kg ha$^{-1}$ significantly reduced mean seedling emergence on Mywybilla clay but the effect on individual grasses was not significant (Table 1).

* Trade name.

TABLE 1

*Emergence and survival in pre-emergence atrazine experiments*

| Soil | Atrazine rate (kg ha$^{-1}$) | *P. maximum* | *P. coloratum* | *C. gayana* | *C. ciliaris* | *B. insculpta* | Mean |
|---|---|---|---|---|---|---|---|
| | | % emergence (relative to maximum emergence for each grass) | | | | | |
| Lockyer clay | 0 | 81 a* | 91 a | 79 a | 94 a | 94 a | 89 a |
| | 1 | 87 a | 96 a | 93 a | 85 a | 77 a | 88 a |
| | 4 | 71 a | 84 a | 95 a | 75 a | 68 a | 80 a |
| | | % survival after emergence | | | | | |
| | 0 | 96 a | 98 a | 83 a | 97 a | 100 a | 96 a |
| | 1 | 95 a | 96 a | 86 a | 95 a | 98 a | 95 a |
| | 4 | 86 a | 75 b | 42 b | 36 b | 95 a | 70 b |
| Mywybilla clay | | % emergence (relative to maximum emergence for each grass) | | | | | |
| | 0 | 94 a | 93 a | 81 a | 90 a | 90 a | 90 a |
| | 1 | 81 a | 81 a | 59 a | 78 a | 71 a | 75 b |
| | 4 | 73 a | 98 a | 53 a | 78 a | 75 a | 77 b |
| | | % survival after emergence | | | | | |
| | 0 | 100 a | 98 a | 99 a | 99 a | 99 a | 99 a |
| | 1 | 99 a | 98 a | 99 a | 99 a | 100 a | 99 a |
| | 4 | 96 a | 81 b | 60 b | 62 b | 98 a | 83 b |

* Arcsine transformed data subjected to analysis of variance. Values within grasses and means followed by the same letter are not significantly different (p> 0·05).

On both soils survival of *P. coloratum*, *C. gayana* and *C. ciliaris* was significantly reduced by atrazine at 4 kg ha$^{-1}$ (Table 1).

Pre-emergence atrazine on both soils at 4 kg ha$^{-1}$ significantly reduced root yields plant$^{-1}$ of *C. gayana* and at 1 and 4 kg ha$^{-1}$ produced progressive significant reductions in shoot yields plant$^{-1}$ (Table 2).

Root and shoot yields pot$^{-1}$ of *C. gayana* and *C. ciliaris* were significantly reduced by pre-emergence atrazine at 4 kg ha$^{-1}$ on Lockyer clay and progressively at 1 and 4 kg ha$^{-1}$ on Mywybilla clay. On the latter soil atrazine at 4 kg ha$^{-1}$ significantly reduced shoot yields pot$^{-1}$ of *P. maximum* and *P. coloratum* (Table 2).

### *Experiments* 3, 4 *and* 5

Post-emergence atrazine had no significant effect on plant survival or on shoot yield of grasses.

## FIELD EVALUATION

In a preliminary unreplicated trial atrazine was sprayed post-emergence at 0.5, 1, 2 and 4 kg ha$^{-1}$ on strips in an establishing pasture containing *P. maximum* cvv. Petrie and Gatton, *B. insculpta* and a dense stand of *S. reflexa*. At the time of spraying grasses were at the 2- to 3-leaf stage without nodal root development. All grasses established successfully with 4 kg ha$^{-1}$ atrazine application. Adequate mintweed control was achieved at 1 kg ha$^{-1}$ of atrazine, and this application rate has since been used successfully on a larger scale.

## DISCUSSION

The significant mean reduction in seedling emergence with pre-emergence atrazine on Mywybilla clay and a similar trend, although not significant, for all grasses except *C. gayana* on Lockyer clay indicates an effect of atrazine in addition to the primary mode of action in blocking photosynthesis (Ashton and Crafts 1973).

TABLE 2

*Yield of roots and shoots in pre-emergence experiments*

| Soil | Atrazine rate (kg ha⁻¹) | *P. maximum* | *P. coloratum* | *C. gayana* | *C. ciliaris* | *B. insculpta* | Mean |
|---|---|---|---|---|---|---|---|
| Lockyer clay | | | | D.W. Roots (g plant$^{-1}$ × $10^2$) | | | |
| | 0 | 2·3 a* | 0·5 a | 3·9 a | 2·2 a | 1·0 a | 2·0 a |
| | 1 | 2·2 a | 0·6 a | 2·9 a | 2·1 a | 1·3 a | 1·8 a |
| | 4 | 1·8 a | 0·3 a | 0·8 b | 1·9 a | 1·4 a | 1·2 b |
| | | | | D.W. Roots (g pot$^{-1}$ × 10) | | | |
| | 0 | 13·6 a | 4·0 a | 11·3 a | 19·1 a | 10·4 a | 11·6 a |
| | 1 | 11·6 a | 5·1 a | 13·0 a | 16·5 a | 12·0 a | 11·6 a |
| | 4 | 8·7 a | 1·7 a | 1·5 b | 5·8 b | 10·6 a | 5·7 b |
| | | | | D.W. Shoots (g plant$^{-1}$ × $10^2$) | | | |
| | 0 | 7·3 a | 2·4 a | 19·0 a | 9·1 a | 4·2 a | 8·4 a |
| | 1 | 8·8 a | 2·4 a | 12·2 b | 9·2 a | 4·0 a | 7·3 a |
| | 4 | 6·5 a | 1·3 a | 3·0 c | 8·8 a | 4·1 a | 4·7 b |
| | | | | D.W. Shoots (g pot$^{-1}$ × 10) | | | |
| | 0 | 43·7 a | 20·7 a | 53·7 a | 77·7 a | 43·7 a | 47·9 a |
| | 1 | 45·3 a | 20·3 a | 54·0 a | 73·7 a | 35·3 a | 45·7 a |
| | 4 | 30·7 a | 6·7 a | 5·7 b | 24·7 b | 31·7 a | 19·9 b |
| Mywybilla clay | | | | D.W. Roots (g plant$^{-1}$ × $10^2$) | | | |
| | 0 | 1·8 a | 0·6 a | 3·0 a | 2·3 a | 1·0 a | 1·8 a |
| | 1 | 2·0 a | 0·7 a | 2·2 a | 1·7 a | 1·1 a | 1·5 a |
| | 4 | 1·8 a | 0·2 a | 0·8 b | 1·6 a | 1·4 a | 1·2 b |
| | | | | D.W. Roots (g pot$^{-1}$ × 10) | | | |
| | 0 | 16·8 a | 5·0 a | 18·0 a | 20·4 a | 11·6 a | 14·4 a |
| | 1 | 15·7 a | 4·6 a | 10·7 b | 14·0 b | 10·9 a | 11·2 b |
| | 4 | 12·3 a | 1·7 a | 2·2 c | 8·1 c | 13·9 a | 7·6 c |
| | | | | D.W. Shoots (g plant$^{-1}$ × $10^2$) | | | |
| | 0 | 4·8 a | 2·0 a | 9·6 a | 7·0 a | 2·7 a | 5·2 a |
| | 1 | 5·7 a | 1·9 a | 7·4 b | 5·9 a | 2·9 a | 4·8 a |
| | 4 | 4·8 a | 0·7 a | 3·0 c | 5·8 a | 3·2 a | 3·5 b |
| | | | | D.W. Shoots (g pot$^{-1}$ × 10) | | | |
| | 0 | 44·7 a | 16·7 a | 55·7 a | 62·0 a | 30·3 a | 41·9 a |
| | 1 | 46·3 a | 11·7 ab | 36·0 b | 49·7 b | 27·7 a | 34·3 b |
| | 4 | 33·3 b | 4·7 b | 8·7 c | 29·3 c | 31·3 a | 21·5 c |

* Values within grasses and means followed by the same letter are not significantly different ($p > 0·05$).

*B. insculpta* and *P. maximum* were very tolerant of atrazine, which for the latter species confirms the finding of Hawton (1976). *P. coloratum* was tolerant and suffered only minor reductions in survival. *C. ciliaris* and *C. gayana* were susceptible to pre-emergence atrazine application, especially the latter grass which suffered plant mortality and severe reduction in growth. The greater susceptibility to pre-emergence atrazine of the eragrostoid grass, *C. gayana*, compared with the panicoid grasses tested, is in accord with the results of Jensen *et aı* (1977).

Further field testing of *P. maximum, P. coloratum* and *B. insculpta* with pre-emergence atrazine and of the five commercial grasses included in these experiments with post-emergence atrazine, at rates sufficient to control *S. reflexa* (0.5 to 2.0 kg ha$^{-1}$), is recommended.

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# NUTRITION OF *STYLOSANTHES GUIANENSIS* ON TWO SANDY SOILS IN A HUMID TROPICAL LOWLAND ENVIRONMENT

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## ABSTRACT

*Fertilizer experiments with* Stylosanthes guianensis *were conducted on two deep sandy soils in north Queensland. In experiment* 1, *cultivar Schofield was grown on a granitic sand with treatments of four phosphorus rates, four potassium rates and two lime rates. Two sources of phosphorus were also tested. In experiment* 2, *cultivar Endeavour was grown on a beach sand with treatments of four phosphorus rates, four potassium rates and two rates of boron plus molybdenum.*

*In experiment* 1, *maximum dry matter yields were achieved at* 25 *kg* $ha^{-1}$ *P but yields were reduced by* 100 *and* 200 *kg* $ha^{-1}$ *P. Yields were increased by potassium and lime, whereas monosodium orthophosphate gave higher yields than superphosphate.*

*In experiment* 2, 50 *kg* $ha^{-1}$ *P and* 56 *kg* $ha^{-1}$ *K gave maximum dry matter yields. Higher rates of phosphorus and potassium reduced yields. There was no effect of a boron plus molybdenum treatment.*

*The ability of these soils to retain applied nutrients is discussed.*

## INTRODUCTION

Expansion of the beef industry in the humid tropical lowlands of Queensland led to the development of extensive areas of land previously regarded as unsuitable for agricultural development (Sloan *et al.* 1962). Some of the least fertile soils were sands, either from granitic parent material or of marine origin. A program based on glasshouse experiments and limited field experiments showed widespread deficiencies of phosphorus, potassium, calcium, sulphur, copper and zinc on both types of sand (Teitzel and Bruce 1971, 1973).

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