MSMA for Controlling *Cyperus kyllingia, Axonopus compressus* and *Brachiara distachya* in Tifgreen Bermuda Grass Turf

LEONG CHEE CHIEW*
Parks & Recreation Department
Botanic Gardens, Singapore 1025

Abstract

Several herbicides were tested for selective control of grass and broadleaf weeds in Tifgreen Bermuda grass turf in golf courses. MSMA (monosodium methanearsonate) was found to selectively control *Cyperus kyllingia, Axonopus compressus and Brachiara distachya*, three of the most troublesome weeds in the golf courses. Metribuzin selectively controlled *Euphorbia thymifolia.*

Introduction

The high frequency of mowing, together with the low cutting height in golf courses should be expected to keep many species of weeds under control. However, there are those weeds which can thrive even under close mowing because they have leaf forms that lie under the cutting blade. These if left unchecked can intermingle and eventually take over the sward from the finer grasses (Ellis 1986). At a point where manual weeding cannot keep up with spread of such hardy weeds, use of selective herbicides may be the alternative.

In the use of herbicides various factors need consideration, perhaps the most important being the control of weeds without excessive damage to the turf. Johnson (1983) reported that some herbicides like napropamide and prosulfalin reduced root growth of Bermuda grass. Ability to resist herbicide damage was found to differ among turfgrasses eg. among the triploid hybrid Bermuda grasses, Tifway hybrids exceed the Tifgreen hybrids in tolerance to 2,4-D (Hanna 1986).

Examples of chemical weed control in Bermuda grass include the use of diclofop for controlling goosegrass (*Eleusine indica*) in Tifdwarf putting greens (Murdock and Nishimoto 1982). Batten (1984) reported the control of goosegrass by post-emergence applications of MSMA or metribuzin. Sedges such as the purple nutsedge were reported to be controlled post-emergence on the basis of a continual reduction of the leaves and plant with repeated MSMA or bentazon applications; as new shoots recur from rhizomes and tubers, another herbicide application will reduce them. MSMA, especially effective in controlling established Johnsongrass, was applied repeatedly between three to eight times per growing season in order to achieve effective control (Anderson 1977).

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*The author is currently with the Strategic Planning Division of the Ministry of National Development, Singapore.

Weeds invading Bermuda grasses used in the Serapong Golf Course of Sentosa and Tanah Merah Golf Course were described by Wong (1986). This paper reports the experiments carried out to control some of these weeds in the Tifgreen Bermuda grass fairways and driving range of the Golf Courses.

Materials and Methods

Apart from herbicides which were already available to the experimentor, 12 locally-based agrochemical companies were also requested to recommend selective herbicides for use in Bermuda grass swards. Response was limited but a total of five herbicides were finally chosen for the trial. They were metribuzin (Sencor WP 70), dicamba (Fez PE 400), bentazon (Basagran 39.6%), 2,4-D (2,4-D amine 720), and MSMA (MSMA 500).

Trials on Tifgreen Bermuda grass and weeds were conducted separately to determine the effects of the various herbicides on each. Trials on Tifgreen Bermuda grass were conducted in relatively weed free areas in a fairway at the Serapong Golf Course and those on weeds in the Tanah Merah Golf Course driving range. The weeds initially monitored were *Axonopus compressus, Cyperus kyllingia*, and *Euphorbia thymifolia. Brachiara distachya* was included at a later stage.

The randomised complete block design was used for each trial. The five herbicides were each tested at 4 levels of concentration. They were:- metribuzin (Sencor WP 70) — 0, 0.2, 0.6 and 1.2 g/1; dicamba (Fez Pe 400) — 0, 1.0, 2.0 and 3.0 ml/l; bentazon (Basagran 39.6%) — 0, 2.0, 6.0 and 10.0 ml/l; 2,4-D (2,4-D amine 720) — 0, 2.0, 4.0 and 8.0 ml/l; MSMA (MSMA 500) — 0, 2.0, 6.0 and 10.0 ml/l. In each trial, 3 blocks containing 20 treatment plots each were constructed; each treatment plot was 0.4 m by 0.4 m in size. Treatments were completely randomised within each block.

Application of herbicide was carried out using Gardena pressure sprayers. Each treatment plot was sprayed with 100 ml herbicide with teepol added as wetting agent.

Effects of herbicides on turf and weeds were monitored after herbicide application by recording visual ratings of phytotoxicity, adopting the method used by Murdoch and Nishimoto (1982). In the case of Tifgreen Bermuda grass, ratings were based on a scale of 1–10 with '1' being no phytotoxicity and '10' being complete kill of turf. For weeds, '1' meant no control of weeds while a '10' rating meant complete weed control. Visual ratings were recorded by the same person throughout. Results presented below are all average readings of three blocks/replications.

Results and Discussion

Phytotoxicity or weed control ratings in each trial were monitored for a period of one month. Ratings of phytotoxicity for Bermuda grass were based on a scale of 1–10. Ratings of '1' and '2' are to be considered as showing no phytotoxicity; in some instances 'imperfections' in the turf were caused by slight scalping during mowing etc and a rating of '2' instead of '1' was given. Ratings of '3' and '4' indicate mild phytotoxicity and '5' shows 50% turf burn. Ratings of '6' and '7' indicate increasing levels of unacceptable burn while plots given ratings of '8' and above were very badly burnt and unsightly.

Phytotoxicity symptoms in Bermuda grass, when they occurred, were in most cases very quickly apparent i.e. within two days from herbicide application (Fig. 1). It was also found that in most cases, turf that were burnt to ratings of '7' and above were able to recover to ratings of '4–6' within a month from herbicide application. It must be noted though that the seemingly rapid recovery from burn was probably due to

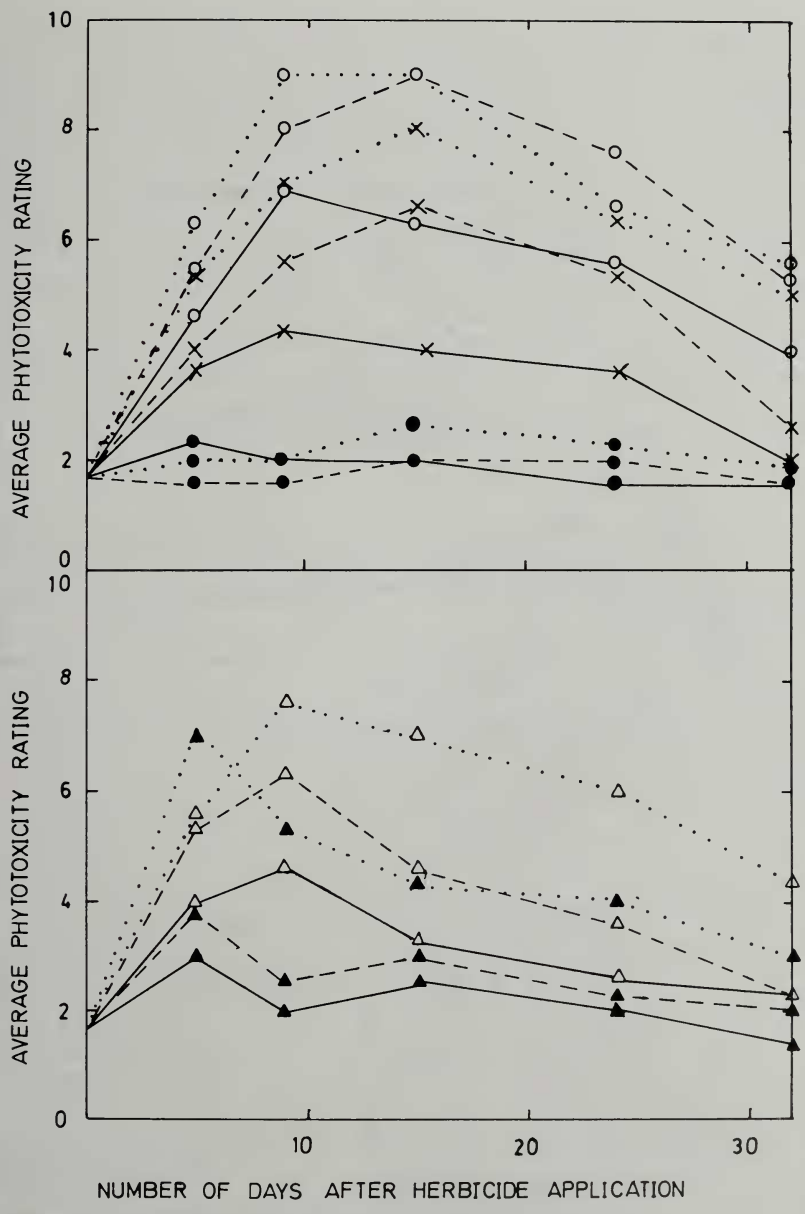

Fig. 1. Effects of herbicides on Tifgreen Bermuda grass.
Each herbicide was tested at four levels of concentration with 0 ml or 0 g/l as controls against which the effects of other treatments were compared. Herbicides were applied once at the start of the trial after which turf quality was monitored. This is expressed as phytotoxicity ratings on a scale of 1–10 where '1' means no phytotoxicity symptoms and '10' means complete killing of turf. Results presented are averages of three blocks/replicates. Herbicide concentrations are represented by the following symbols:-
(×————×), (×---------×), (×.....×) — metribuzin (Sencor WP 70) at 0.2, 0.6 and 1.2 g/l respectively; (o————o), (o---------o), (o.....o) — dicamba (Fez PE 400) at 1.0, 2.0 and 3.0 ml/l; (●————●), (●---------●), (●.....●) — bentazon (Basagran 39.6%) at 2.0, 6.0 and 10.0 ml/l; (△————△), (△--------△), (△.....△) — 2,4-D (2,4-D amine 720) at 2.0, 4.0 and 8.0 ml/l; (▲————▲), (▲---------▲), (▲.....▲) — MSMA (MSMA 500) at 2.0, 6.0 and 10.0 ml/l.

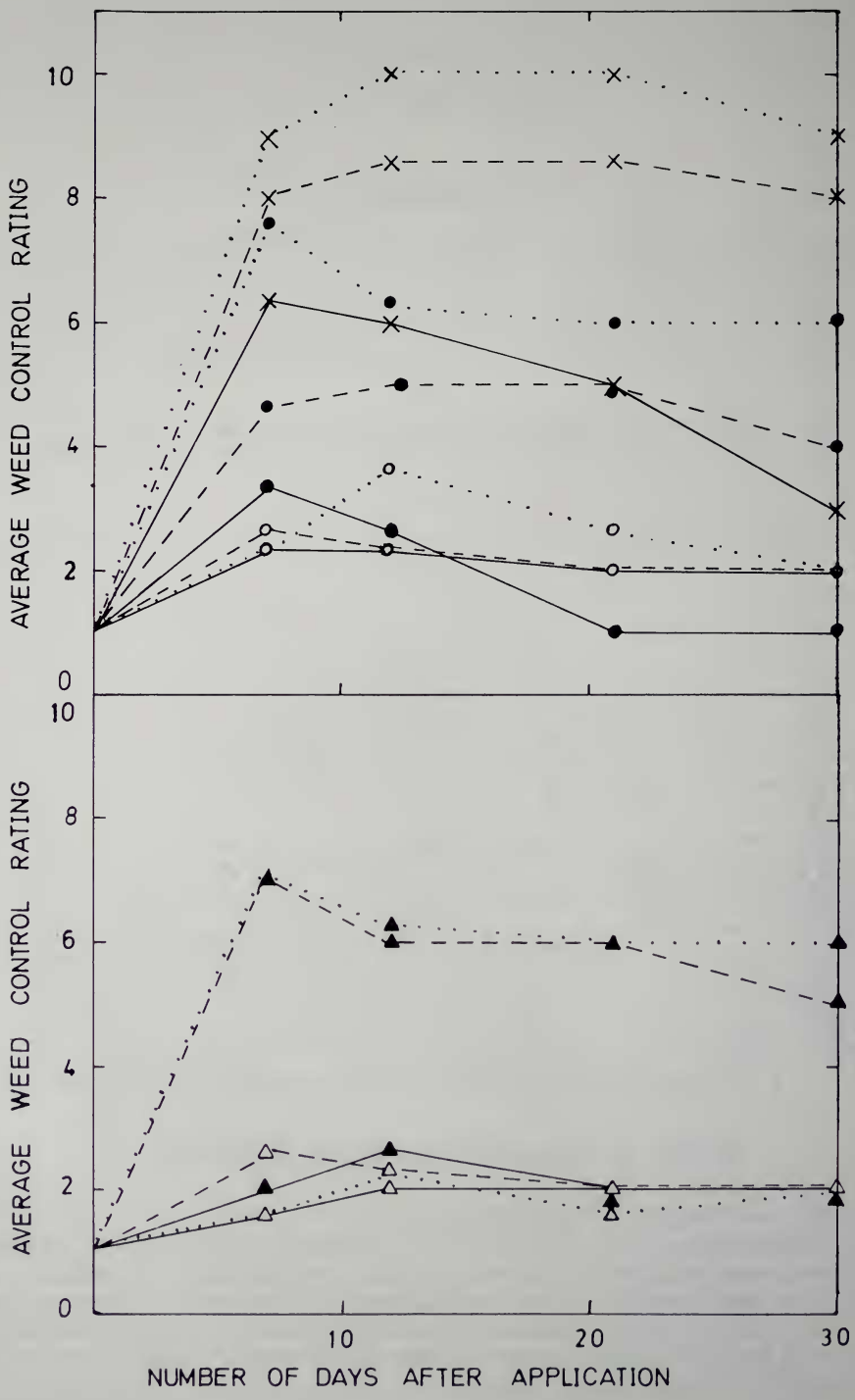

Fig. 2. Effects of herbicides on *Cyperus kyllingia*.
The procedure for this trial and symbols for herbicides and concentrations are as found in Fig. 1. Weed control was expressed as weed control ratings of 1–10, with '1' meaning no control and '10' meaning total killing of weeds. Results presented are averages of three blocks/replicates.

the fact that even when most of the turf within a treatment plot was killed, turf surrounding it continued to grow, sending new shoots into the damaged plot. Thus recovery from herbicide burn of ratings '7' and above, under trial conditions, should not be taken to mean that the same will be expected to occur if large areas of turf were blanket sprayed with overdoses of herbicides. Spot spraying appears to be the safer method of application and if blanket spraying is to be carried out then lower dosages of herbicide should be used, repeating the application when necessary.

Results shown in Fig. 1 are summarised in Table 1 which shows herbicide concentrations that produced phytotoxicity ratings of '4' and below in Bermuda grass. The rating of '4' was chosen as the upper limit for acceptable turf because the visual appearance of grass with this rating and below was reasonably good and recovery from the effects of herbicide was rapid. With this as the criterion it is seen that metribuzin WP70 at 0.2 g/l, bentazon 39.6% at 2.0, 6.0 and 10.0 ml/l, and MSMA 500 at 2.0 and 6.0 ml/l could be 'safely' sprayed on Tifgreen Bermuda grass.

Table 1
Herbicide concentrations that could be 'safely' used on Tifgreen Bermuda grass.

Herbicide		Tifgreen Bermuda grass
Metribuzin (Sencor WP 70) g/l	0.2	x
	0.6	
	1.2	
Dicamba (Fez PE 400) ml/l	1.0	
	2.0	
	3.0	
Bentazon (Basagran 39.6%) ml/l	2.0	x
	6.0	x
	10.0	x
2,4-D (2,4-D amine 720) ml/l	2.0	
	4.0	
	8.0	
MSMA (MSMA 500) ml/l	2.0	x
	6.0	x
	10.0	

Concentrations of herbicides that caused burn up to a upper limit of phytotoxicity rating '4' are marked (X); these are considered 'safe' for use on the turf under the experimental conditions employed. Results shown here are extracted from data in Fig. 1. Plots of turf showing phytotoxicity ratings of '4' and below were not excessively unsightly and recovered from burn rapidly.

Figures 2-4 show the effects of herbicides on *Cyperus kyllingia, Euphorbia thymifolia* and *Axonopus compressus* respectively. Weeds that were controlled at ratings of '1-5' were found to recover quickly from the effects of the herbicides. Increasingly effective control was noted with ratings of '6-8' while in cases where ratings of '9-10' were achieved, excessive damage to Bermuda grass also occurred. Herbicide concentrations that resulted in control ratings of '7' were therefore considered potentially useful for selective weed control.

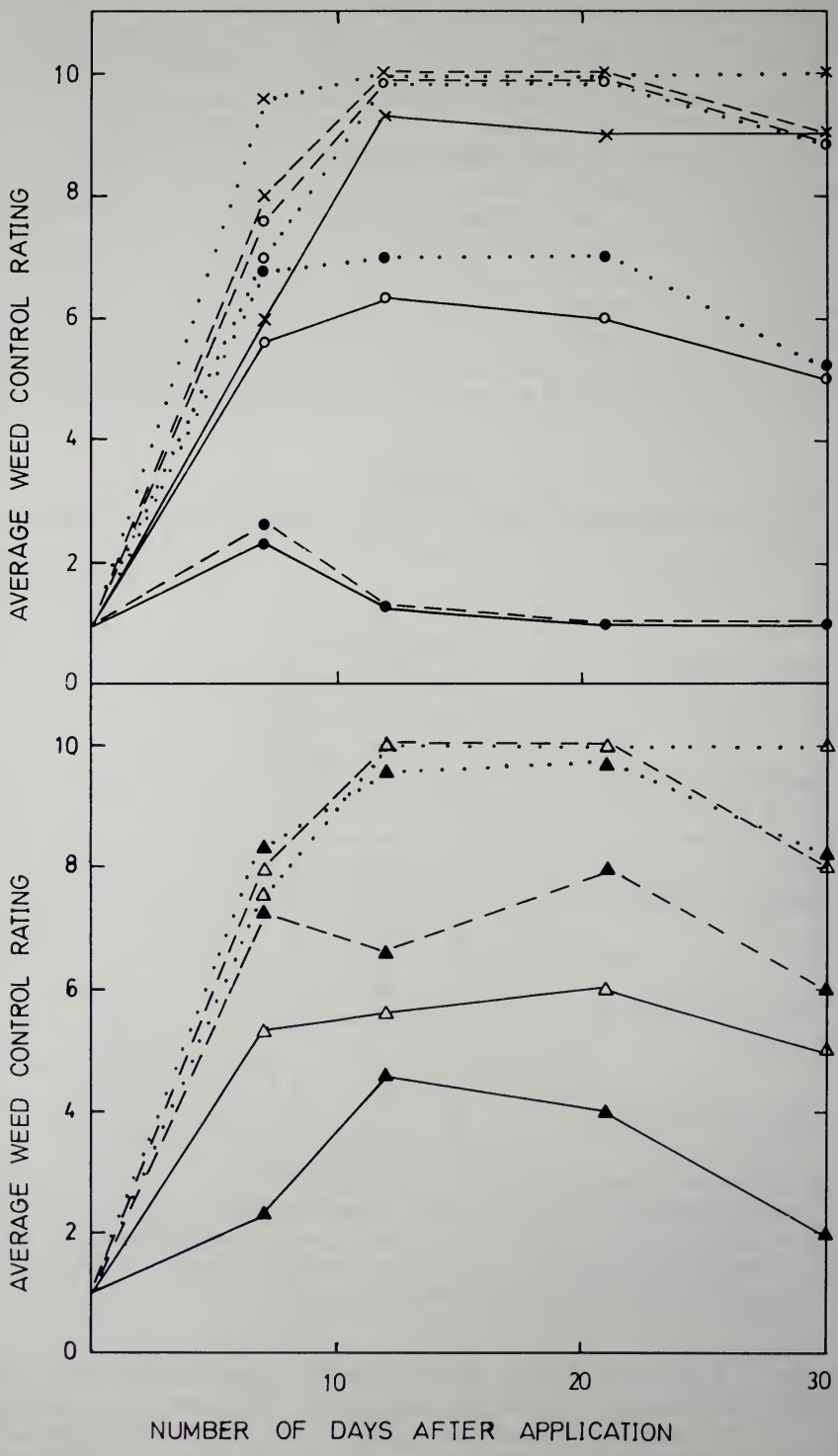

Fig. 3. Effects of herbicides on *Euphorbia thymifolia*.
The explanation for this figure follows that in Fig. 2.

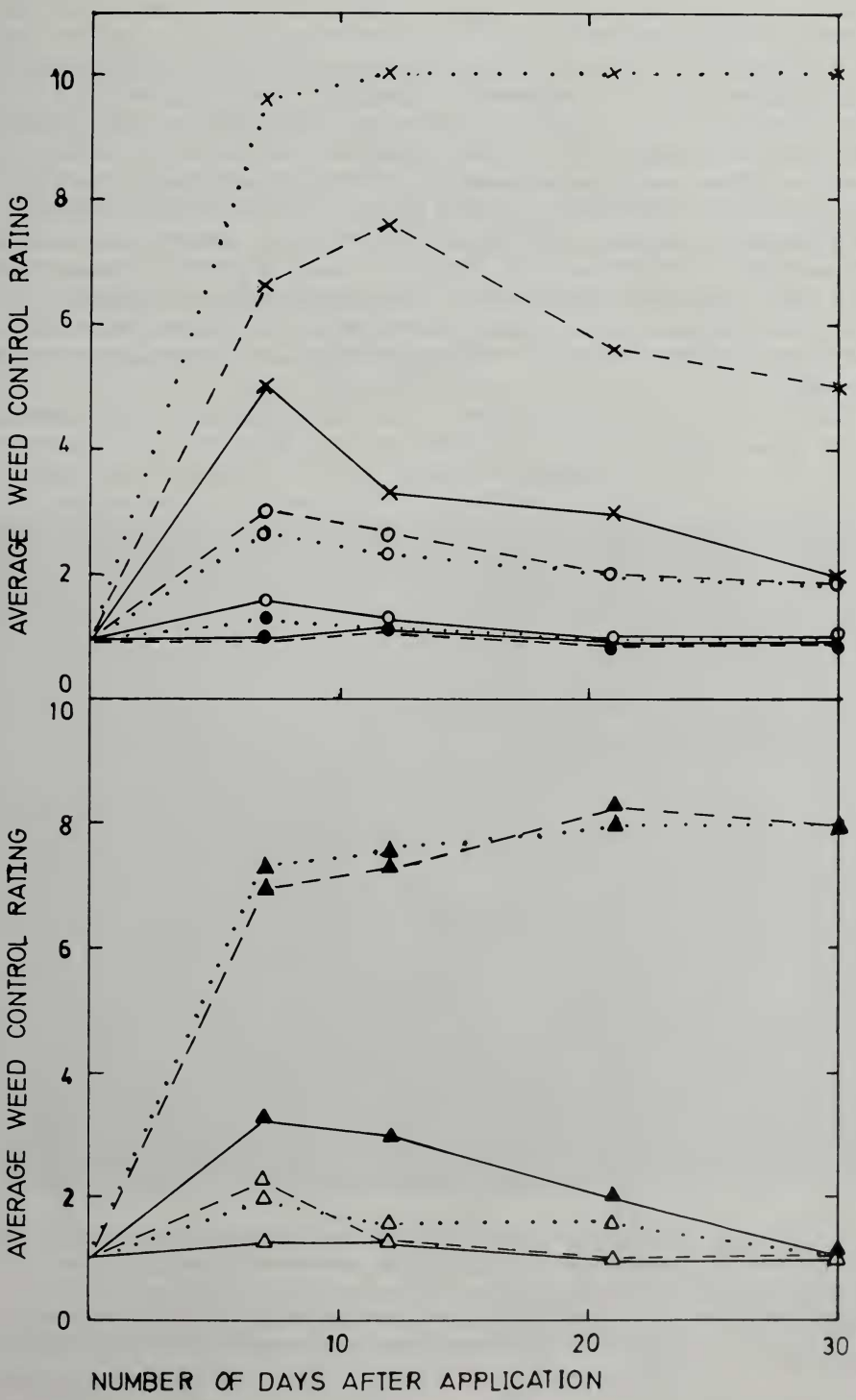

Fig. 4. Effects of herbicides on *Axonopus compressus*.
The explanation for this figure follows that in Fig. 2.

Table 2 summarises herbicide concentrations that affect weeds by at least a minimum control rating of '7'.

For the sake of convenience, it would be useful to have a herbicide which will control all three weeds (*A. compressus, E. thymifolia, C. kyllingia*) at the same time. Using the rating of '7' as the criterion, it is seen that herbicides like dicamba and 2,4-D could only control *E. thymifolia* but not the other two weeds. Similarly, bentazon at its highest concentration tested controlled *C. kyllingia* and *E. thymifolia* but not *A. compressus*. Dicamba, 2,4-D and bentazon were each not versatile enough for the purpose of providing control of all three weeds. Only applications of metribuzin at 0.6 or 1.2 g/l, or MSMA at 6.0 or 10.0 ml/l could be expected to control all three weeds at the same time. Results in Fig. 1 however show that metribuzin at 0.6 and 1.2 g/l, and MSMA at 10 ml/l caused excessive burn in Tifgreen Bermuda grass. This left only MSMA at 6 ml/l as the potential for use in universal control of all three weeds.

MSMA (6 ml/l) was sprayed on 3 m × 1 m plots at the rate of 55 ml spray solution per square metre using CP15 Knapsack sprayers. Plots were either sprayed only once at the start of the experiment or once a week for 3 weeks in succession. Since metribuzin at 0.6 g/l could control all three weeds but was too phytotoxic for Tifgreen Bermuda grass, it was decided to test metribuzin at 0.2 g/l to determine if repeated spraying could bring about the same effects as found for the higher concentration. Results show that repeated weekly spraying of MSMA for 3 weeks resulted in selective control of *A. compressus, C. kyllingia* and another weed *Brachiara distachya*;

Table 2
Herbicide concentrations that effectively controlled *C. kyllingia, E. thymifolia* and *A. compressus*.

Herbicide		*Cyperus kyllingia*	*Euphorbia thymifolia*	*Axonopus compressus*
Metribuzin	0.2		x	
(Sencor WP 70)	0.6	x	x	x
g/l	1.2	x	x	x
Dicamba	1.0			
(Fez PE 400)	2.0		x	
ml/l	3.0		x	
Bentazon	2.0			
(Basagran 39.6%)	6.0			
ml/l	10.0	x	x	
2,4-D	2.0			
(2,4-D amine 720)	4.0		x	
ml/l	8.0		x	
MSMA	2.0			
(MSMA 500)	6.0	x	x	x
ml/l	10.0	x	x	x

Concentrations of herbicides that controlled the 3 weeds by at least a control rating of '7' are marked (X); these are considered effective for control of the respective weeds. Results shown here were extracted from Figs. 2–4.

E. thymifolia were weak in growth, ceased spreading but were not totally killed. *Cyperus radians*, a coarse, tufted sedge with wiry leaves and inflorescence stalks (Wong 1986) was affected by MSMA to the extent that tips of leaves and inflorescences were burnt but the tuft remained alive; growth was impeded although total killing of the weed did not occur. Metribuzin when sprayed at 0.2 g/l weekly for 2 weeks in succession resulted in total control of *E. thymifolia* but had no effect on *A. compressus*, *B. distachya* or *C. kyllingia* even after 3 applications (weekly) in succession. To confirm the selectiveness of MSMA at 6 ml/l, it was sprayed repeatedly at weekly intervals for 5 weeks on a 9 m × 2 m plot (55 ml spray solution per square metre). *A. compressus*, *C. kyllingia*, *B. distachya* were all controlled while the Tifgreen Bermuda grass began to grow, spreading itself to cover areas formerly covered with weeds. The entire plot looked darker green than the surrounding areas (Plate 1) by virtue of the cover eventually provided by Tifgreen Bermuda grass within the plot; surrounding areas were lighter green because they were still infested with weeds that gave the lawn a lighter green color.

Plate 1. Weed control and the accompanying growth of Tifgreen Bermuda grass in MSMA-treated plots. The darker green plot of turf in the figure resulted from the eradication of weeds like *C. kyllingia*, *A. compressus* and *B. distachya* accompanied by active growth of Bermuda grass which was not affected by the herbicide and was also darker green in colour than the weeds. MSMA 500 (6 ml/l) was sprayed at weekly intervals for 5 weeks in succession.

Conclusion

Chemical control of weeds by selective herbicides is possible. Care must however be taken to ensure the application of correct dosages. MSMA, a pentavalent arsenical herbicide considered to be of a low order of toxicity to man and animals, and which is inactivated upon contact with soil (Anderson 1977), was found to be highly selective in this trial. It controlled *A. compressus, B. distachya, C. kyllingia* and to a lesser extent *E. thymifolia* without damaging Tifgreen Bermuda grass. Metribuzin, an asymmetrical-triazine herbicide which is detoxified by microbial action in the soil (Anderson 1977), was more effective on *E. thymifolia.*

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