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CHEMICAL MANIPULATION OF PASTURE LEYS TO REGULATE COMPOSITION II.

THE EFFECTS ON CROP PRODUCTION

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INTRODUCTION

Annual grasses are a major component in annual Mediterranean pastures. Annual ryegrass (Lolium rigidum) has long been recognised as a serious weed in cereal crops (Levick, 1969). With the development of in crop herbicides capable of selectively controlling annual ryegrass, other grass; namely the brome (Bromus diandrus), barley (Hordeum leporinium) and Vulpia sp have become problem weeds in cereal crops as the method of tillage has shifted from a number or workings prior to seeding to the use of herbicides and a single cultivation at seeding. Dillon and Fonella (1984) stated that silvergrass (Vulpia sp) does not germinate when buried or subject to darkness, hence its ease of control using conventional tillage. In direct drilled crops it may, however, be a major weed as are the brome and barley grasses. No post-emergent in crop herbicides are available to control all three species.

By moving the grass control phase to the year prior to cropping, control of grasses may be achieved using selective herbicides, Thorn and Perry (1983).

The aim of this study was to determine the effect of chemically controlling annual grasses in the pasture phase two years prior to cropping on subsequent crop weed levels and grain yield. It was also designed to determine the advantages if any of post plant pre-emergent herbicides and post emergent herbicides in combination with pasture manipulation in a direct drilling tillage system.

MATERIALS AND METHODS

A pasture of Dwalganup subterranean clover (Trifolium subterraneum L) and a mixture of annual grasses (Lolium rigidum - annual ryegrass, Bromus diandrus - ripgut brome and Hordeum leporinium - barley grass) was selected at Moora, 31°S, 116°E, WA in 1980. The site had an average rainfall of 466 mm.

The soil was a red-brown sandy loam with an increasing gravel content to depth. The soil had a pH of 5.6 and an initial soil phosphorus level of 16 ppm. Prior to commencing the trial 90 kg/ha of superphosphate was topdressed across the site.

Experimental Design

The experiment comprised 4 main treatments of 2 stocking rates (4 and 8 weaner wethers/ha) and 2 pasture treatments (untreated and sprayed with propyzamide) replicated three times in a randomised block design. The plots were 150m x 83.3m and 150m x 41.6m in size for the 4 and 8/ha stocking rates respectively. Each plot was stocked with 5 animals.

Animal details were outlined by Thorn and Perry (1984). Following two years of continuous grazing, the site was cropped in the 1983 season. The main treatment plots were split into three crop herbicide treatments (Nil, diclofop-methyl, SSH0860) and 5 rates of nitrogen (0, 10, 20, 40 and 80 kg/ha) randomised within each sub-plot. The plots were 2.5m x 40m.

Sowing

The crop was sown using the sprayseed/direct drill technique. The site was sprayed with diquat and paraquat at 150g/ha and 250g/ha a.i respectively on the 13 June. All plots were seeded on the 15 June using a cone seeder. Eradu wheat was direct drilled at 50 kg/ha with 150 kg/ha of superphosphate. Nitrogen rates were topdressed at seeding at 0, 34, 68, 136, 272 kg/ha of Agran 34.0.

Herbicides

Pasture

Propyzamide (N-(1, 1 - dimethyl-propynl)-3, 5 dichlorobenzamide) applied as commercial 50% a.i. wettable powder formulation was applied to the pasture on 16 June 1981, two years prior to cropping at a rate of 0.75 kg/ha a.i. In 1982 the pastures were allowed to self regenerate.

Crop

Prior to cropping DDT was applied to the area at 1.0 l/ha.

On the 20 June 1983 SSH0860 (   ) was applied 5 days post planting and before emergence at 800 g/ha in 70 l of water/ha.

Diclofop-methyl was applied 30 days post sowing on the 15 July at 562 g/ha a.i. in 70 l/ha of water.

Measurements:

In crop weed counts were recorded on the 19 July on the control and SSH herbicide treated areas. In crop weed counts on the diclofop-methyl plots were recorded on 10 August 1983. At each time 5 quadrats of 0.1 m^{-2} were taken per plot. Crop density, grass weeds, subterranean clover, and broadleaf weeds were recorded.

Anthesis dry matter of the crop was recorded on the 6 October 1983. Four quadrats of 0.25 m^{-2} per plot were cut. The material was oven dried at 80°C in a force draught oven for 48 hours then weighed. The material was then ground to 1 mm size and submitted to Government Chemical Laboratories to determine the nitrogen content by the Kjedahl method.

Grain yield was recorded on 30/11/83. Each plot was harvested using a small plot Wintersteiger harvester. Grain samples were collected and weighed then sub sampled to provide a sample for grain protein analysis.

RESULTS

Climatic conditions:

The 1983 season opened with 20 mm in early May which subsequently proved to be a false break. The main opening rains followed in early June. The growing season rainfall (May-October) was 379 mm which was below the average of 421. The October rainfall in particular was well below average, 7 mm compared to the average of 26 mm. Although October rainfall was below average the crop finished the season on stored moisture.

Previous Pasture History:

The pastures were set stocked at two stocking rates during the 1981 and 1982 seasons. Propyzamide application to pastures in 1981 resulted in excellent control of annual grasses. These effects were carried through into the 1982 and 1983 seasons. At the low stocking rate of 4 ha^{-1} some ryegrass was observed in the propyzamide plots, this was thought to be residual dark dormant seeds regenerating. In spring 1982 the untreated pastures had 15% grass in the pasture when stocked at 4 ha^{-1} and 23% at 8 ha^{-1}. The propyzamide treated pasture had 2% grass at 4 ha^{-1} and $< 1\%$ at 8 ha^{-1}. Grass germination in early May reflected the previous pasture treatments (Table 1).

Table 1: Grass density following early May break - 1983

Stocking rate	Pasture treatment	Grass density (plants/m²)
4	Untreated	447
	Propyzamide	252
8	Untreated	334
	Propyzamide	9

Soil Nitrogen Build Up:

Prior to commencing the trial in 1981 the top 10 cm contained 0.072% total soil nitrogen. By March 1983 the level had increased to 0.108%. There was no significant effect of treatment on either total soil nitrogen, pH, organic carbon or total mineral nitrogen in 1983. The mean pH was 5.5, while mineral nitrogen levels were a mean of 16.5 ppm and organic carbon % of 1.25.

On the 21/4/83 prior to cropping the residual dry pasture contained 26 and 32 kg/ha of nitrogen for the untreated and propyzamide treated pastures respectively at 4 ha^{-1} and 15 and 19 kg/ha at 8 ha^{-1}.

Grass Weeds in the Crop:

There was a significant ($p < 0.05$) stocking rate x pasture treatment interaction on in crop grass weeds. At the low stocking of 4 ha^{-1} there was no difference between the grass counts in the crop for the two pastures treatments. However, at 8 ha^{-1}, the grass weed levels were significantly lower on the propyzamide treated pasture (Table 2a). There was also a significant ($p < 0.001$) interaction between pasture treatment and herbicide. There was no difference between the control and diclofop-methyl treated crop in terms of grass numbers under the crop, however, SSH 0860 reduced the grass levels markedly in both the untreated and propyzamide treated pasture. The propyzamide treated pasture also resulted in significantly less grass weeds under the crop, regardless of the in crop herbicide used. (Table 2b).

Table 2: In crop grass weed levels (log (x +1)) for:

a) pasture treatments and stocking rate
b) pasture treatments and in crop herbicide

Grass Weed Counts in the Crop Transformed (log (x + 1))		
Pasture Treatment	Untreated	Propyzamide
a) Stocking Rate		
4	3.61	3.20
8	2.37	0.33
Se ± 0.43		
b) In Crop Herbicide		
Control	3.58	2.06
diclofop-methyl	3.68	1.72
SSH 0860	1.71	1.51
Se ± 0.37		
Se ± 0.26 when comparing herbicides at the same level of pasture treatment.		

Anthesis Dry Matter

There was a significant effect of stocking rate ($p < 0.05$), herbicide ($p < 0.001$) and nitrogen ($p < 0.001$) on anthesis dry matter production. Anthesis dry matter was 693 kg/ha higher for pastures stocked at 8/ha than 4/ha. Anthesis dry matter was higher in the diclofop-methyl and SSH 0860 treatments compared to the control, while SSH 0860 was higher than diclofop-methyl. There was a significant quadratic response to nitrogen (Figure 1).

Nitrogen % in tops and nitrogen uptake

There was a significant herbicide effect ($p < 0.001$) and nitrogen effect ($p < 0.001$) on N% and nitrogen uptake (Table 3 a, b).

In terms of nitrogen uptake there was also a significant stocking rate effect ($p < 0.05$). An extra 9 kg/ha of nitrogen was taken up at 8/ha than at 4/ha, with 4/ha taking up 52 kg and 8/ha taking up 61 kg/ha. More nitrogen was taken up by diclofop-methyl and SSH 0860 than the control (Table 3a, b). Nitrogen uptake increased as the amount of applied nitrogen increased (Table 3a, b).

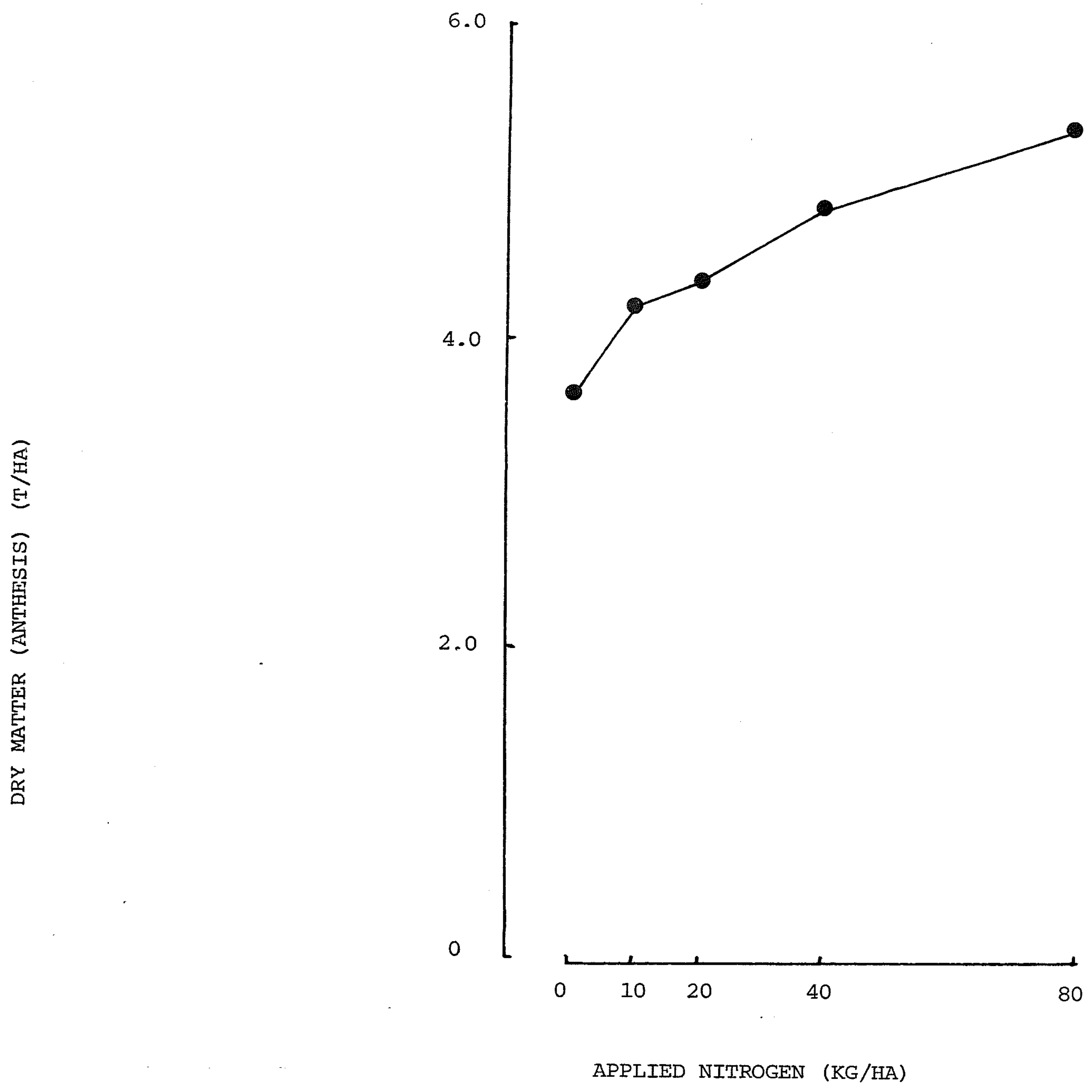

Figure 1: The effect of applied nitrogen on anthesis dry matter production.

Table 3: The effect of nitrogen rate and in crop herbicide on nitrogen % in the tops and nitrogen uptake (k/ha) at anthesis.

Rate of Nitrogen (kg/ha)	Nitrogen in tops (%)	Nitrogen uptake (kg/ha)
a) Nitrogen rate		
0	1.22	44.6
10	1.23	51.9
20	1.22	53.3
40	1.26	60.6
80	1.33	71.1
Se ±	0.02	2.2
b) Herbicide		
Control	1.21	49.1
diclofop-methyl	1.33	57.2
SSH 0860	1.22	62.6
Se ±	0.02	2.9

Grain Yield

There was a significant ($p < 0.01$) stocking rate x herbicide interaction on grain yield. At 4 ha^{-1} crop yield was significantly higher in the diclofop-methyl and SSH 0860 treatments. At 8 ha^{-1} the control and diclofop-methyl treatments weren't different while the SSH 0860 treatment was significantly better.

There was a significant quadratic grain yield response to nitrogen ($p < 0.001$). There was a significant herbicide x nitrogen interaction ($p < 0.05$), with SSH 0860 yielding more than diclofop-methyl and diclofop-methyl yielding more than the control at all rates of nitrogen (Figure 2). In the control treatment there was no difference between 10 and 20 kg/ha of applied N; in the diclofop-methyl treatment there was a significant effect of nitrogen rate on yield; in the SSH 0860 treatment there was no difference between 0 and 10 kg/ha of N. There was also a significant ($p < 0.01$) stocking rate x pasture treatment x nitrogen interaction. At 4 ha^{-1} the yield on the propyzamide treated areas were higher than the untreated at all rates of nitrogen except 100 kg/ha. At 8 ha^{-1} the yield on the propyzamide treated areas were similar to the untreated at all nitrogen rates except 40 kg/ha (Figure 3).

Regression analysis of the data indicated that the linear component of the quadratic equation relating yield and nitrogen was significantly different for the three herbicide treatments.

Grain yield as a function of nitrogen for the three herbicide treatments were:

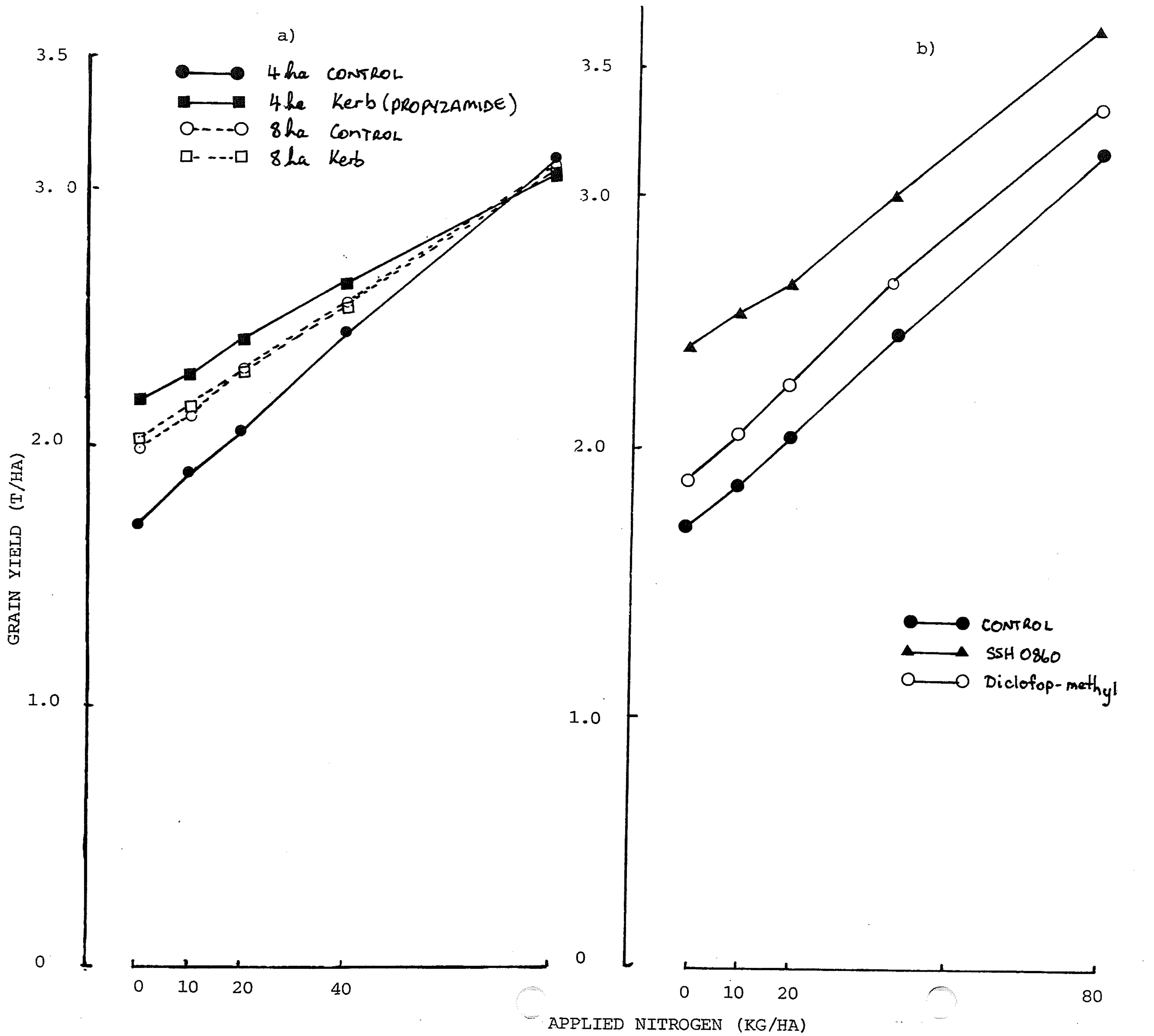

Figure 2A. The effect of previous pasture treatments and N rate on grain yield.

Figure 2B: The effect of in crop herbicides on grain yield.

control:	$GY = 1710 + 15.2N - 0.08N^2$
diclofop-methyl:	$GY = 1892 + 15.1N - 0.08N^2$
SSH 0860:	$GY = 2404 + 11.9N - 0.08N^2$

Regression analysis of the nitrogen x stocking rate x pasture treatment interaction showed that the fitted curves for the yield/nitrogen relationship for each pasture and stocking rate treatment were:

Stocking Rate	Pasture Treatment	Equation
4	Untreated	$GY = 1729 + 18.0N - 0.08N^2$
4	Propyzamide	$GY = 2206 + 11.2N - 0.08N^2$
8	Untreated	$GY = 2029 + 14.0N - 0.08N^2$
8	Propyzamide	$GY = 2046 + 13.0N - 0.08N^2$

There was a significant difference between the intercepts and the slopes of the linear component of the relationship.

There was also a significant effect of herbicides x stocking rate interaction on grain yield. In the absence of any in crop herbicide grain yield was higher at the higher stocking rate, and lower at the high stocking rate when SSH 0860 was used. When diclofop-methyl was used there was no difference between the stocking rates (Table 4).

Grain yield was re-analysed taking grass weeds out as a covariate. The significant interactions were unchanged as was the shape of the relation between yield and nitrogen for each significant set of treatments.

Table 4: Grain yield (kg/ha) for stocking rate and in crop herbicide treatments

Stocking Rate/ha Herbicide	Grain Yield (kg/ha) Control	diclofop-methyl	SSH 0860
4	1882	2226	2717
8	2192	2202	2514

Se $\pm$ 258
Se $\pm$ 104 when comparing herbicides at same stocking rate.

DISCUSSION

Propyzamide resulted in excellent control of the annual grasses in the pasture and this effect was carried through in the two subsequent regenerations. Heavy stocking also resulted in grass control. Ryegrass was observed to be the only grass regenerating on the propyzamide plots, this was thought to be due to the dormancy characteristics of ryegrass. Those regenerating were most likely to be dark dormant seeds from previous years (Gramshaw 1974).

The use of the sprayseed/direct drilling technique resulted in an excellent weed kill prior to seeding, however, ryegrass and some subterranean clover was observed to germinate after the crop had emerged, suggesting that the single spray and cultivation at seeding is on its own unable to give a weed free crop. The use of SSH 0860, post plant, pre-emergent resulted in excellent grass weed control as well as excellent broadleaf weed control. Diclofop-methyl did not give the same degree of grass control. Ryegrass germination following diclofop-methyl application may be the reason for the poor grass control gained with this herbicide. Depth of burial, degree of dormancy may extend the germination of ryegrass Gramshaw (1974). The use of SSH 0860 prior to weed germination means that the germinating seedlings are controlled early and do not compete with the crop, while diclofop-methyl was applied 30 days post seeding and the grasses were competing with the crop.

There were significant effects of stocking rate, herbicide treatment and nitrogen on both anthesis dry matter and nitrogen uptake. The stocking rate effect was thought to be linked to the lower grass levels in the crop at the higher stocking rate. This illustrates the importance of grazing for weed control. This concept has been well understood in the past, however, with the increased push towards greater percentages of farms in crop and the rundown of livestock numbers, producers often do not have sufficient stock to control grasses in spring when grass growth and seed production is most rapid. For this reason there is a greater reliance on in crop herbicides for weed control. The significant herbicide effect on dry matter production and nitrogen uptake was related to the degree of grass control, with higher dry matter and nitrogen uptake on the treatments giving best weed control. The crop responded to applied nitrogen with highest nitrogen uptake at the highest nitrogen rate applied. Soil nitrogen levels of 0.108% total soil nitrogen are considered to be nitrogen deficient and probably explain the response. Soil nitrogen levels were built up from 0.072% to 0.108% over the two pasture years prior to cropping, however there was no significant effect of pasture treatments or stocking rate on soil nitrogen, organic carbon, available NH_4^+ and NO_3^- levels and pH.

In the absence of applied nitrogen propyzamide treated pasture yielded 477 kg/ha more grain than the untreated pasture treatment when stocked at 4/ha, at 8/ha the difference was only 17 kg/ha. The treatments responded differently to applied nitrogen with the slope of the linear part of the response curve being greater in the untreated than the propyzamide treatment at both stocking rates. The quadratic term of the nitrogen response curves were not significantly different.

Grain yield in the absence of applied nitrogen was 182 kg/ha higher for the diclofop-methyl than the control and 694 kg/ha higher for the SSH 0860 treatment. The slope of the linear component of the nitrogen x herbicide response curves were similar for both the control and diclofop-methyl treatments and less for the SSH 0860 treatment. There was no significant change in the quadratic component of the response curves.

Grain yields were re-analysed taking grass weeds as a covariate, however, this did not alter any of the significant interactions indicating that weeds were not influencing the main treatment effects. Although soil tests could not statistically discern any significant difference between the treatments the crop yield results show that propyzamide increased grain yield by increasing soil nitrogen.

CONCLUSIONS

These results indicate the importance of grazing pressure on pastures to control grass weeds, and failing that, the excellent grass control that can be achieved with selective herbicides on pastures. The increased push to more crop and less sheep may mean an increased reliance on herbicides to regulate pasture composition, particularly when the paddock is to be cropped the following year.

These results also highlight the fact that the single spray and cultivation at seeding (sprayseed/direct drill tillage system) does not always give a weed free crop, where ryegrass is a problem weed. The use of post-plant pre-emergent herbicides may provide one way of controlling problem weeds and may even achieve good results without the preliminary sprayseed application prior to seeding. The advantage of this type of herbicide is in the early removal of weed competition, whereas, post emergent herbicides often are sprayed too late and the crop suffers from weed competition. Late spraying of post-emergent herbicides is most common in wet years when it is difficult to get a suitable day to get onto the land.

The use of selective herbicides to reduce grass or problem weed numbers prior to cropping offers producers alternatives to grazing pressure as a control measure.