WEED CONTROL IN HIGH DENSITY DIRECT DRILLED FORAGE MAIZE

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Summary

Weed control in high density, direct drilled maize (*Zea mays*) was investigated using different rates of glyphosate applied at different times after final grazing. This was compared with paraquat either as a single or split application, with or without dicamba and/or an atrazine/alachlor mixture. Glyphosate applied at 1.08 kg/ha and a split application of paraquat (0.9 kg/ha total) resulted in similar maize dry matter yields (18-19 t DM/ha). Glyphosate was unaffected by the length of the regrowth period. Higher maize yields resulted when using a split versus a single application of paraquat. The addition of dicamba and/or an atrazine/alachlor mixture did not improve yields.

INTRODUCTION

Earlier work (Matthews 1973) suggested that when direct drilling high density forage maize in early December, a single application of paraquat (0.56 kg/ha) applied just prior to drilling gave a level of pasture suppression sufficient to ensure high DM yields of maize. However, recent work (Byford unpublished) would suggest that this rate and method of application of paraquat is marginal. Maize grown by this method yielded only 41% of that obtained from maize directly drilled into a weed-free seedbed.

The objective of this study was to investigate further minimum-cost methods of weed control for high density direct drilled maize. The study was in two parts;

1. To determine the effect on maize DM yields of various rates of glyphosate when applied at a range of times after the final grazing of the pasture.
2. To compare the effect of single and split applications of paraquat with or without dicamba and/or an atrazine/alachlor mixture.

METHOD

The trial was conducted between November 1978 and March 1979 at No. 2 Dairy, Ruakura on a Horotiu-Te Kowhai soil complex. The trial area had been cropped with direct drilled, green-feed maize the previous season following established pasture which was controlled by glyphosate applied at 1.08 kg/ha. Between maize crops Manawa ryegrass (*Lolium perenne* x *L. multiflorum*) and white clover (*Trifolium repens*) were sown on the area. The pasture composition of the site prior to the start of the 1978-79 trial was ryegrass 56%, *Poa* species 30% and white clover 13%.

The treatments were divided into two parts:

1. Glyphosate - three rates (0.36, 0.72 and 1.08 kg/ha) each applied after three durations of regrowth (3, 8 and 15 days between final

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2. grazing with dairy cows and spraying).
Paraquat - the treatments involving paraquat are listed below.

Abbreviation	Treatment
P	Single application paraquat (0.9 kg/ha)
(SP ₁) ₆	Split application paraquat (0.6+0.3 kg/ha); 6 days between applications.
(SP ₁) ₁₃	Split application paraquat (0.6+0.3 kg/ha); 13 days between applications.
(SP ₂) ₁₃	Split application paraquat (0.6+0.6 kg/ha); 13 days between applications.
(SP ₁) ₁₃ +D	(SP ₁) ₁₃ + dicamba (0.44 kg/ha)
(SP ₁) ₁₃ +A/A	(SP ₁) ₁₃ + atrazine/alachlor (1.5/3.5 kg/ha)
(SP ₁) ₁₃ +D+A/A	(SP ₁) ₁₃ + dicamba (0.44 kg/ha) + atrazine/alachlor (1.5/3.5 kg/ha).

The two parts were arranged in one trial layout, a split-plot design with six replicates. The periods of regrowth (which also gave the length of time between spraying) were the main plot treatments. The sub-plot size was 6 x 4 m.

All plots were sprayed on 23.11.78. The glyphosate and single paraquat plots received their single application and the split paraquat plots their second application on this date. Dicamba was applied with the first application of paraquat on 10.11.78 and the atrazine/alachlor mixture on 28.11.78. All herbicides were applied using a hand-held 2 m boom operating at 200 kPa pressure and delivering 250 litres/ha.

Greenfeed maize seed was sown on 24.11.78 at a rate of 250 kg/ha at 15 cm row spacings using a triple disc drill. Carbofuran insecticide (2.0 kg/ha) and 200 kg/ha of "Top-crop" starter fertiliser (6-6-5) were applied with the seed, while 100 kg/ha of muriate of potash and 250 kg/ha of sulphate of ammonia were broadcast on to the soil surface immediately after drilling.

Maize germination was estimated for each plot 17 days after sowing by counting the number of plants in three 2 m rows. On 4.1.79 all plots were visually assessed for the percentage control of ryegrass, clover and annual weeds, and maize vigour was assessed on a 0-10 scale; 0 = dead maize. On 20.3.79 the maize DM yield of each plot was estimated by harvesting to ground level the plants within a centrally sited 3 x 0.6 m quadrat. For each quadrat the total fresh weight and the number of plants present were recorded and a random selection of 10 plants was then chopped and a subsample dried at 90°C for 48 h for DM determination.

RESULTS

Maize germination was affected by the duration of the pasture regrowth periods; the 15 day regrowth treatment (54.1 plants/m²) differed significantly ($P<0.01$) from the 8 day regrowth treatment (46.3 plants/m²) while the 3 day regrowth treatment was intermediate (49.9 plants/m²). Germination was significantly greater ($P<0.05$) under a split (54.2 plants/m²) than a single (45.3 plants/m²) application of paraquat.

The results of the maize vigour scores and percentage control of ryegrass and white clover are given in Table 1. The assessment of annual weeds has been omitted because of their low incidence.

Since dicamba and atrazine/alachlor had no significant effects in the split paraquat treatments, only the mean has been presented. In a separate analysis a comparison of the best glyphosate treatment with the split paraquat treatments for the three parameters showed that for maize vigour and white clover control, split paraquat was significantly better ($P<0.01$; $P<0.05$ respectively). Ryegrass control was similar for both treatments.

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TABLE 1. Effect of rate of glyphosate, period of regrowth, and single versus split application of paraquat on maize vigour (0 = dead maize) and percent control of ryegrass and white clover.

		Maize vigour	Ryegrass control (%)	White clover control (%)
Rate of glyphosate (kg/ha)	0.36	5.8 bB	55 C	31 C
	0.72	6.9 aAB	90 B	57 B
	1.08	7.8 aA	98 A	89 A
Period of regrowth (days)	3	6.4 a	91 aA	67 a
	8	6.9 a	84 bAB	59 a
	15	6.9 a	81 bB	61 a
Split paraquat		9.0 A	100 a	99 A
Single paraquat		6.3 B	99 a	65 B
CV (%)		15	15	20

The maize yield data are presented in Table 2. For the glyphosate treatments no significant differences occurred due to the apparently anomalous result of the 8 day regrowth treatment. No explanation for this can be offered. If this result is disregarded then the remaining data show a response in DM yield to an increased rate of glyphosate, but no difference in yield between the 3 and 15 day regrowth periods.

TABLE 2. Maize DM yields (t/ha)

i) Glyphosate		Rate (kg/ha)			mean
		0.36	0.72	1.08	
Regrowth period (days)	3	14.0	16.1	18.2	16.1
	8	16.7	14.7	14.9	15.4
	15	14.6	16.2	17.8	16.2
	mean	15.1	15.7	17.0	15.9
ii) Paraquat		P	(SP ₁) ₆	(SP ₁) ₁₃	(SP ₂) ₁₃
		16.1	18.7	19.7	18.3
+ dicamba + atrazine/alachlor				17.8	
Pooled EMS = 6.08; CV = 14%; LSD 5% = 3.0					

Within the paraquat treatments there was a significant improvement ($P < 0.05$) from the split application. Higher levels of paraquat or additions of dicamba and/or the atrazine/alachlor mixture did not affect yields.

None of the paraquat treatments affected plant population. The mean of these treatments was 36.3 plants/m². Increasing rates of glyphosate, however, significantly reduced ($P < 0.05$) plant populations (table 3).

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TABLE 3. Plant populations at harvest (No. plants/m²)

Rate of glyphosate (kg/ha)		
0.36	0.72	1.08
42.2	38.3	36.6

CV = 15%; LSD 5% = 6.6

DISCUSSION

Maize yields were generally high in this trial and the best yields of 18-19 t DM/ha obtained would be approaching the maximum expected for a growing period of 116 days when using this high density, direct drilling method. The high yield from the single application of paraquat reflects the low level of weed competition present in this trial. Summer grass (*Digitaria sanguinalis*) and broad-leaf annuals were infrequent and the white clover component of the sward was only in its first season. In a trial conducted in 1977-78 using a lower rate of paraquat (0.56 kg/ha) and where summer grass levels were high and red clover (*Trifolium pratense*) was the main clover component, a single application of paraquat resulted in a 59% reduction in maize yield compared with that from weed-free treatments (Byford unpublished). Care must therefore be taken when extrapolating results of this present study to areas with higher weed populations and more established clover/ryegrass swards.

Interpretation of the glyphosate treatment effects on maize yield is difficult because of the anomalous result from the 8 day regrowth treatments. If these results are disregarded the remaining data suggest that the effectiveness of glyphosate under the conditions of this trial was not altered by the pasture regrowth period. This is reflected in the final maize DM yields and also in the ryegrass and white clover control assessments. If anything the results suggest a greater control of existing pasture after the 3-day regrowth period.

The significantly lower germination counts from the 8 day regrowth period were not reflected in the plant populations at harvest so it is unlikely that they have any practical importance. The decline in plant population associated with an increase rate of glyphosate was possibly the result of plant death being greater the higher the DM yield (cf. plant population and DM yield of split paraquat treatment).

Disregarding the 8 day regrowth treatment the data suggest that rates of glyphosate approaching 1.08 kg/ha are needed to give maximum maize DM yields. In the previous season (Byford and Stratton unpublished) maximum maize yields were obtained using 0.9-1.08 kg/ha to control permanent ryegrass/white clover pasture.

Despite high maize yields obtained when using a single application of paraquat, significantly higher yields were obtained when that same amount of paraquat was applied as a split application either 6 or 13 days apart. This advantage appeared to be the result of better control of the white clover when using a split application (65% v 98%). The lack of response to the addition of atrazine/alachlor mixture reflects the generally low levels of summer grass and broad-leaf weeds which were present.

Maize vigour 41 days after sowing was lower when using glyphosate than with a split application of paraquat, even when the plots were relatively weed-free. Glyphosate, which results in a slower kill of the existing herbage, may immobilise nitrogen for longer, resulting in a nitrogen deficiency.

In this trial 1.08 kg/ha of glyphosate resulted in a similar yield to

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that obtained using 0.9 kg/ha of paraquat in a split application. The product and application costs for these two methods are \$71.57 and \$45.40/ha respectively. This suggests that when growing direct drilled high density forage maize in pasture where ryegrass and white clover are the main components, paraquat is more economical than glyphosate.

ACKNOWLEDGEMENTS

To the staff of the Agronomy Section, No. 2 Dairy and Ms S. Fox for their field work and record keeping. To Mr C. B. Dyson for advice on the design of the trial and analysis of the data.

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