

## WEED COMPETITION IN MAIZE CROP UNDER DIFFERENT TIMINGS FOR POST-EMERGENCE WEED CONTROL

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### ABSTRACT

The effect of early weed competition was determined for a maize (*Zea mays*) crop grown in Waikato. Maize was established in three different environments, viz. weedy (no herbicide), grass weeds (pre-emergence atrazine) and broadleaf weeds (pre-emergence metolachlor). Surviving weeds were controlled with post-emergence nicosulfuron (60 g/ha) after different periods of competition and the plots kept weed free for the remainder of the trial. Weeds left completely uncontrolled for 4 weeks after emergence significantly reduced crop yields. When a pre-emergence herbicide was used, surviving weeds began to reduce maize yields after about 6 weeks with grasses having greater effect than broadleaf weeds. The actual period before the weeds started affecting crop growth and yield appeared to be related to the time taken by the weeds to achieve complete ground cover.

**Keywords:** maize, competition, weed control, ground cover, post-emergence.

### INTRODUCTION

Although maize (*Zea mays*) is a vigorous and tall growing plant, it is susceptible to competition from weeds, with losses greater than 30% commonly reported (Rahman 1985). For this reason many researchers have been modelling weed competition in this crop in an endeavour to predict thresholds and yield losses (McDonald and Riha 1999; Ngouajio *et al.* 1999). However, in Waikato region, where the weed seedbank is frequently very large (Rahman *et al.* 1996), it has been shown that competition from uncontrolled weeds will result in yield losses of up to 70% (Rahman and James 1992; James and Rahman 1994).

Cumberland *et al.* (1971) in studying the agronomic aspects of maize theorised on the existence of a "critical stage" in the life of a maize plant. This "critical stage" was between 4 and 6 weeks after emergence and competition at this stage had a major effect on potential yield. Others have found the critical period fell between 4 and 8 weeks after emergence, with the starting time of the period showing more variation than the end time (Hall *et al.* 1992). During this period weed interference reduced the overall maize leaf area by reducing the expanded leaf area of individual leaves and by accelerating senescence of lower leaves.

In New Zealand maize is usually planted in rows 75 cm apart with 13 – 20 cm between plants within rows. This crop differs from most others in its wide row spacing and very tall growth habit. Maize also has a large seed and shows strong and robust growth at emergence. Moisture is usually ample at planting, and competition for light is unlikely to have any effect until the weeds reach a certain size. The aim of the work presented here was to establish at what stage a maize crop was susceptible to competition from weeds and what the characteristics of the weed infestation were at that time.

### MATERIALS AND METHODS

The trial site was on a Brunwood silt loam soil (58% sand, 15% clay, 6.2% organic carbon, pH 5.8) at Rukuhia near Hamilton. Maize (cv. Pioneer 3527) was planted on 30 October 1998 using a Nodet Gougis precision vacuum planter. Row spacing was

75 cm and intra-row spacing was 13 cm, resulting in 102,600 seeds/ha. Three plots (21 x 40 m) were each given a different pre-emergence treatment on 2 November 1998 to promote different weed spectra. The first plot was sprayed with atrazine (Gesaprim) at 1.5 kg/ha to control broadleaf weeds and allow grass weeds to dominate. The second plot was sprayed with metolachlor (Dual) at 2.9 kg/ha to control grass weeds and allow broadleaf weeds to dominate. The third plot remained untreated, allowing the natural weed spectrum to establish. The herbicides were applied with a vehicle mounted boom sprayer at 200 kPa in 250 litres water/ha.

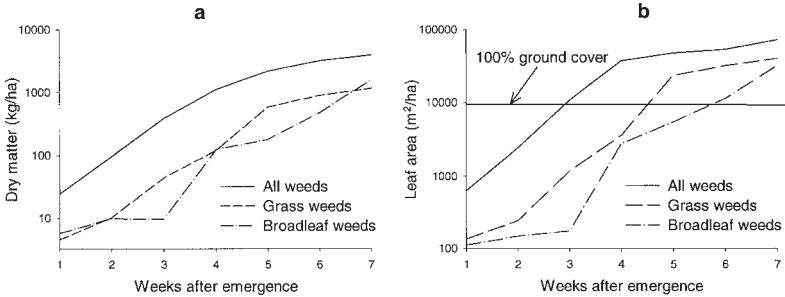
Each of the main plots was subdivided into 28 subplots (3 x 10 m) containing four planted rows to which seven treatments were applied in a complete randomised block design with four replicates. The seven treatments comprised an application of nicosulfuron (Amaze) at 60 g/ha plus a tallow amine ethoxylate adjuvant (Amaze Activator) at 0.5% v/v applied from 1 to 7 weeks after maize emergence. Any new weed growth that appeared in the plots after the initial treatment was controlled with a further application of nicosulfuron plus adjuvant 7 weeks after emergence to keep the plots weed free until harvest. The nicosulfuron was applied with a CO<sub>2</sub> powered backpack sprayer applying 300 litres/ha at 200 kPa. The nozzles (TeeJet 11004) were arranged to spray down the centre of each row thus minimising direct exposure of the maize plants.

Immediately prior to the application of the post-emergence treatments the following data were collected from each plot: maize height and number of leaf tips (average of ten plants), maize leaf area and maize dry matter (average of four plants), weed dry matter (duplicate 0.1 m<sup>2</sup> quadrats placed adjacent to a maize row) and weed leaf area (from a subsample of weeds harvested for dry matter determination). In the main plot where no pre-emergence herbicide was used (allowing all weeds) the grass and broadleaf weeds were separated before measurement. Leaf area of the maize was determined by video imaging on a moving belt while that for the weeds was by image analysis (ImageTool ver 2.0, UTHSCSA) of a digitised (scanned) image of the leaves which had been placed on clear acetate sheets. At the end of the season maize yields were determined by harvesting 50 cobs from the two centre rows of each plot. The cobs were shelled and moisture content determined by the capacitance method. Grain yields were adjusted to 14% moisture content and ANOVA (Minitab) used to separate the means.

## RESULTS AND DISCUSSION

The atrazine treatment controlled all the broadleaf weeds except for a few atrazine-resistant fathen (*Chenopodium album*) plants. The predominant weeds remaining were smooth witchgrass (*Panicum dichotomiflorum*) and summer grass (*Digitaria sanguinalis*). However, the atrazine apparently had some effect on these grasses, as they did not establish as quickly as those in the untreated plot (Fig. 1). Similarly the metolachlor treatment provided excellent control of the grass weeds but the remaining broadleaf weeds were slower to establish than those on the untreated plot. The predominant weeds in this treatment were willow weed (*Polygonum persicaria*), fathen, redroot (*Amaranthus* spp.) and apple of Peru (*Nicandra physalodes*). Where no pre-emergence herbicide was used the same weeds were found. For the first four weeks grass and broadleaf weeds contributed equally to the total weed mass but after this time the dry weight of the broadleaf weeds was roughly twice that of the grasses.

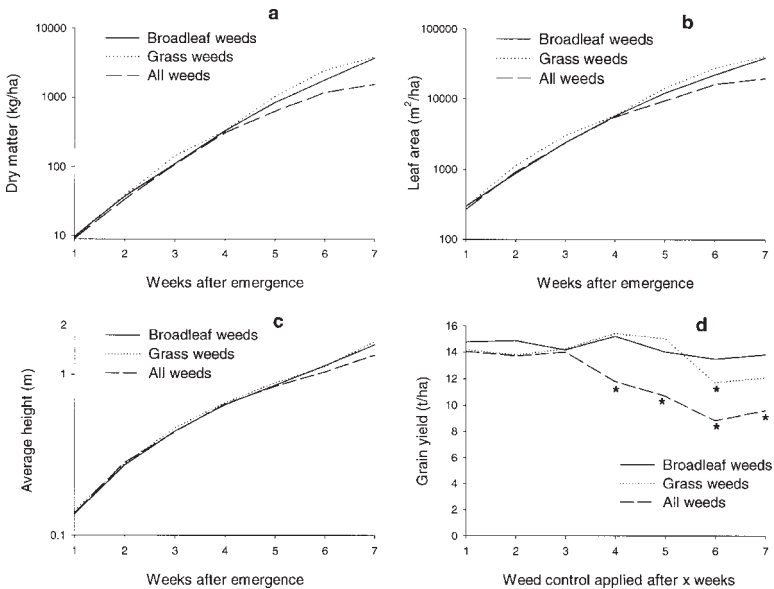
The early season weed control achieved with nicosulfuron was excellent. Being a broad spectrum herbicide (James and Rahman 1997), nicosulfuron controlled all the broadleaf and grass weeds present in the trial. In weeks 1-4 the weeds stopped growing immediately after spraying and their residues shrivelled and rotted within 2 weeks. However, when the weeds were larger at the time of treatment (weeks 5-7) they took longer to brown off and disappear although it was clear that their growth stopped when treated. Plots treated on weeks 1-3 required a further application of nicosulfuron at 7 weeks after emergence to keep them completely weed free. Treatment of the weeds in weeks 6-7 was very difficult as both the maize and weeds were quite large (Fig. 2c) and it would not have been possible in a grower's normal operation.



**FIGURE 1: Weed dry matter (a) and leaf area (b) measured at the time weeds were controlled in a maize crop.**

There was a close relationship between weed dry matter and weed leaf area (Fig. 1). The grass weeds in the atrazine treated plots and the broadleaf weeds in the metolachlor treated plots grew at similar rates but in both cases had been adversely affected by the herbicides. The combined weights of grass and broadleaf weeds were less than when they were growing together in the untreated plot. In Fig. 1b a line has been drawn to indicate the hypothetical 100% ground cover (assuming no overlap of weed leaves). This shows that 100% cover was attained after about 18 days in the untreated plot and after about 31 and 42 days in the grass and broadleaf plots respectively, again showing the effects of the pre-emergence herbicides on the surviving weeds

The responses of the maize crop to various weed pressures are shown in Fig. 2. From about the fourth week after emergence the maize in the untreated plot produced less dry matter (Fig. 2a) and less leaf area (Fig. 2b) than plants in the other two main



**FIGURE 2: Maize dry matter (a), leaf area (b) and height (c) measured at the time weeds were controlled and grain yield (d) measured at the end of the season. The \* indicates a grain yield significantly different to the yield from the week 1 weed control treatment.**

plot treatments. Maize height was less affected (Fig. 2c). Another aspect of the weed competition from week four onwards in the untreated plot, was that the weeds, although only about three-quarters the height of the maize, shaded the lower leaves and held the upper maize leaves in an upright position, lessening their exposure to sunlight.

Final maize grain yields are presented in Fig. 2d. These show that uncontrolled weeds had no effect on crop yield for the first 3 weeks after emergence. However, when no pre-emergence herbicide was used and weeds were allowed to grow unchecked after that date, yields were significantly lower than those from the week 1 weed control plots. In the atrazine treated plot the grass weeds that established caused a significant yield loss only when allowed to grow unchecked for 6 weeks. In the metolachlor treated plots the surviving broadleaf weeds had no effect on grain yields when allowed to grow unchecked for the first 7 weeks after emergence. This reflects in part the high level of suppression of the broadleaf weeds by the metolachlor.

In this trial, the time from which maize yields were affected by the weeds appeared to be related to the time when the weeds attained 100% ground cover. In the untreated plot where the weeds grew with the greatest vigour, theoretical complete ground cover was achieved about 18 days after emergence and the yield losses were significant from 28 days onwards. In the atrazine plot theoretical complete ground cover occurred about 31 days after emergence and a significant yield reduction resulted from the weeds that remained unchecked up to day 42. In the metolachlor treated plot, theoretical complete ground cover was only achieved a week before the final weed control date (7 weeks after emergence) and no significant yield losses were observed.

In a practical situation where the weeds are growing unchecked because no pre-emergence herbicide was used in the maize crop, final grain yields will not be affected as long as the weeds are controlled within 3 weeks of crop emergence. If pre-emergence weed control measures were used then the allowable post-emergence window could be extended to 5 or 6 weeks. These results support the theory of Cumberland *et al.* (1971) that there is a critical stage for weed competition in a maize crop. However, the actual period before the weeds begin to affect the crop appears to be related to the time taken by the weeds to achieve complete ground cover and this could possibly be used as a guide for the timing and necessity of post-emergence weed control in maize.

## REFERENCES

- Cumberland, G.L.B., Honore, E.N. and Farrel, C.A., 1971. The importance of weeds, and the correct timing of weed control measures, in maize. *Proc. 24th N. Z. Weed and Pest Control Conf.*: 115-120.
- Hall, M.R., Swanton, C.J. and Anderson, G.M., 1992. The critical period of weed control in grain corn (*Zea mays* L.). *Weed Sci.* 40:441-447.
- James, T.K. and Rahman, A., 1994. Effect of adjuvants and stage of growth on the efficacy of three sulfonylurea herbicides to grass weeds. *Proc. 47th N. Z. Plant Prot. Conf.*: 11-16.
- James, T.K. and Rahman, A., 1997. Control of couch (*Elytrigia repens*) and Mercer grass (*Paspalum distichum*) in maize with nicosulfuron. *Proc. 50th N. Z. Plant Prot. Conf.*: 467-471.
- McDonald, A.J. and Riha, S.J., 1999. Model of crop:weed competition applied to maize:*Abutilon theophrasti* interactions. *Weed Res.* 39: 355-369.
- Ngouajio, M., Lemieux, C. and Leroux, G.D., 1999. Prediction of corn (*Zea mays*) yield loss from early observations of the relative leaf area and relative leaf cover of weeds. *Weed Sci.* 47:297-304.
- Rahman, A., 1985. Weed control in maize in New Zealand. Pp 37-45 In: Maize – Management to Market, H.A. Eagles and G.S. Wratt (Eds); Agron. Soc. N.Z., Special pub. No. 4, Palmerston North, New Zealand.
- Rahman, A. and James, T.K., 1992. Weed control and soil persistence studies with dimethanamid in maize. *Proc. 45th N.Z. Plant Prot. Conf.*: 84-88.
- Rahman, A., James, T.K., Grbavac, N. and Mellsop, J., 1996. Spatial distribution of weed seedbank in maize cropping fields. *Proc. 49th N.Z. Plant Prot. Conf.*: 291-295.