

SOME BROADLEAF HERBICIDES USED IN MIXTURES WITH GLYPHOSATE MAY HINDER THE GROWTH OF NARROW-LEAFED LUPIN

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ABSTRACT

In southern Chile, glyphosate is often complemented with broadleaf herbicides to improve the control of weeds like *Taraxacum officinale* Weber ex F. H. Wigg., *Hypochaeris radicata* L., *Plantago lanceolata* L., *Raphanus raphanistrum* L., *Veronica persica* Poiret, and *Trifolium repens* L. prior to sowing lupin or canola. The broadleaf herbicides may persist in the soil for unpredictable periods, depending on soil and climatic conditions.

Narrow-leafed lupin (*Lupinus angustifolius*) cv. Gungurru and canola (*Brassica napus*) cv. Coronet were sown 1, 8, 15, and 30 days after spraying herbicides. Treatments were (A) glyphosate alone (1080 g/ha), glyphosate in tank-mixture with (B) fluroxypyr (100 g/ha), (C) 2,4-D ester (350 g/ha), and (D) metsulfuron (3 g/ha) + picloram (24 g/ha), all with 200 L/ha of water. The soil was a silty loam andisol with 15.5% organic matter and pH 5.9. The plots (RCB design with 3 replications) were maintained weed-free. Plant stand (plants per square meter) was recorded at 21 and 31 days, plant height at 31 days, and aboveground and belowground dry biomass was measured 63 days after sowing.

Compared to glyphosate alone, treatments C and D significantly reduced plant height, aboveground and belowground dry biomass of lupins sown after 1 day. Only treatment D maintained that harmful effect on lupins sown 8, 15, and 30 days after herbicide spraying. Canola was less affected than lupin, but treatment D significantly reduced belowground and total dry biomass, compared to unaided glyphosate. Based on these results, the use of metsulfuron + picloram tank mixed with glyphosate in pre-seeding applications should be avoided.

KEY WORDS

Lupinus angustifolius, *Brassica napus*, canola

INTRODUCTION

Crops like lupin and canola are poor competitors in their earlier stages of development, and the choice of post emergence broadleaf herbicides is limited. Therefore, weed control prior to the sowing is crucial in order to minimise weed infestation level during the

growth of the crop. Glyphosate, the non-selective herbicide used widely in Chile (Espinoza y Díaz, 2005) and elsewhere (Baylis, 2000), is often complemented with broadleaf herbicides to improve the control of challenging weeds like *Taraxacum officinale*, *Hypochaeris radicata*, *Plantago lanceolata*, *Raphanus raphanistrum*, *Veronica persica*, and *Trifolium repens*, prior to sowing lupin or canola. The broadleaf herbicides commonly tank mixed with glyphosate include fluroxypyr, 2,4-D ester and metsulfuron + picloram. However, these herbicides may persist in the soil for variable periods, depending on application rate, soil and climatic conditions. Fluroxypyr has a relatively short half-life in soils (The Royal Society of Chemistry, 1990). The same is true for 2,4-D, which at usual rates disappears in 1-4 wk, but unlike fluroxypyr, it can be leached (Ross and Lembi, 1985). Metsulfuron has a moderate residual activity with a typical half-life of 30 d, but ranging from 1-6 wk (Ahrens, 1994). However, picloram has an average field half-life of 90 d, with a range of 20-300 d (Ahrens, 1994) or two to several seasons (Ross and Lembi, 1985).

Narrow-leafed lupin (*Lupinus angustifolius* L.) and canola rapeseed (*Brassica napus*) are sown in significant acreages in southern Chile. The objective of this work was to improve the establishment and growth of these crops by assessing the effect of the herbicides mentioned above.

MATERIALS AND METHODS

The experiment was carried out in a silty loam andisol with 15.5% organic matter and pH 5.9. Four treatments were evaluated: glyphosate (1080 g/ha), glyphosate (1080 g/ha) + fluroxypyr (100 g/ha), glyphosate (1080 g/ha) + 2,4-D ester (350 g/ha), and glyphosate (1080 g/ha) + metsulfuron (3 g/ha) + picloram (24 g/ha). Metsulfuron and picloram were evaluated jointly as they are active ingredients of a single commercial product. All mixes were blended in the tank of a MAT-OSU bike-type sprayer with Tee-jet 8001 flat nozzles, calibrated to apply 200 L/ha of water at 30 lb per square inch of pressure. All herbicides were applied on 8 September, 2003 on soft, moist soil without presence of weeds or crop residues; with 12°C mean air temperature and 82% relative humidity. Narrow-leafed lupin cv. Gungurru and canola

cv. Coronet were sown 1, 8, 15 and 30 d after the herbicides were sprayed (9, 16, 23, September and 8 October). Plots consisted of 10 rows 2 m long, 20 cm apart, and were arranged in a randomised block design with three replications. Fertilizer (in kg/ha), was 10 N, 90 P₂O₅, 80 K₂O, 54 S, 220 CaO, for lupin, and 200 N, 300 P₂O₅, 150 K₂O, 54 S, 220 CaO, for canola. Plots were maintained weed-free and were watered by sprinklers in order to keep the soil humid. Stand was recorded at 21 and 31 days, plant height at 31 days, and aboveground and belowground dry biomass was measured 63 days after sowing. The sampling area was 0.2 m², each sample comprising two inner rows, 50 cm long.

RESULTS AND DISCUSSION

The effects of the herbicide mixtures were compared to that of glyphosate alone, since at the dose applied (1080 g/ha), it is generally considered that glyphosate has very short or nil residual activity in the soil, and so does not affect subsequent crops.

In the case of narrow leafed lupin, plant height, aboveground, belowground, and total dry biomass was reduced when glyphosate was mixed with metsulfuron + picloram (Table 1). This effect was more dramatic when lupins were sown 1 d after the herbicide treatment and decreased as the time to sowing increased, but it was significant even up to 30 d. For glyphosate mixed with

2,4-D ester, a negative effect—namely a reduction in aboveground, belowground, and total dry biomass was observed only when lupins were sown 1 d after spraying the herbicides, but no significant effect was detected with longer gaps. Plant growth was not affected by glyphosate + fluroxypyr, not even if lupin was sown only 1 d after herbicide spraying. However, for these two mixtures (glyphosate + 2,4-D ester and glyphosate + fluroxypyr) the data suggest that sowing lupins soon after spraying may be risky and at least a 15 day moratorium period after spraying should be abided to avoid any damage.

In the case of canola, only the mix of glyphosate with metsulfuron + picloram significantly decreased belowground and total dry biomass when the crop was sown 1, 15 and 30 d after the herbicide treatment (Table 2). No significant effect for these variables was detected when sowing was 8 d after herbicide treatment, but this was most probably due to a failure in the experimental precision. As the period between the herbicide treatment and crop sowing decreased, the negative effect increased. When canola was sown 1 d after herbicide treatment, the aboveground dry biomass was also significantly affected. The root systems of the canola seemed to be more harmed than the aerial parts. However, canola appeared to be more tolerant than narrow-leafed lupins to the herbicide mixtures evaluated.

Table 1. Stand at 21 and 31 days after sowing (das), plant height, aboveground, belowground, and total plant dry biomass for narrow-leafed lupin.

Treatments	Stand 21 das (plants/m ²)	Stand 31 das (plants/m ²)	Plant height (cm)	Above-ground biomass (g/m ²)	Below-ground biomass (g/m ²)	Total dry biomass (g/m ²)
1 d period between herbicide spraying and crop sowing						
Glyphosate (G)	56.7 a	56.7 a	9.3 a	86.7 a	13.7 a	100.4 a
G + fluroxypyr	58.3 a	58.3 a	9.4 a	67.5 ab	11.3 ab	78.8 ab
G + 2,4-D ester	31.7 a	45.0 ab	8.0 b	46.3 b	7.8 b	54.1 b
G + metsulfuron+picloram	28.3 a	33.3 b	2.8 c	6.1 c	2.4 c	8.5 c
8 d period between herbicide spraying and crop sowing						
Glyphosate (G)	61.7 a	66.7 a	9.6 a	167.3 a	23.7 a	191.0 a
G + fluroxypyr	55.0 a	61.7 a	9.0 ab	129.4 a	20.1 a	149.5 a
G + 2,4-D ester	53.3 a	55.0 a	8.7 b	135.9 a	22.9 a	158.8 a
G + metsulfuron+picloram	26.7 b	50.0 a	5.7 c	24.4 b	5.4 b	29.8 b
15 d period between herbicide spraying and crop sowing						
Glyphosate (G)	60.0 a	60.0 a	14.2 a	173.9 a	25.0 a	198.9 a
G + fluroxypyr	51.7 b	56.7 a	13.6 a	168.2 a	25.0 a	193.2 a
G + 2,4-D ester	56.7 ab	56.7 a	14.0 a	180.8 a	23.5 a	204.3 a
G + metsulfuron+picloram	56.7 ab	58.3 a	10.8 b	64.8 b	9.3 b	74.1 b
30 d period between herbicide spraying and crop sowing						
Glyphosate (G)	60.0 a	61.7 a	18.4 a	278.1 a	30.9 a	309.0 a
G + fluroxypyr	61.7 a	60.0 a	18.4 a	280.7 a	30.0 a	310.7 a
G + 2,4-D ester	65.0 a	65.0 a	17.6 a	298.4 a	37.0 a	335.4 a
G + metsulfuron+picloram	58.3 a	58.3 a	14.7 b	154.8 b	18.9 b	173.7 b

In each column and within each period, means followed by the same letter are not significantly different according to Tukey HSD test at $P \leq 0.05$.

Table 2. Stand at 21 and 31 days after sowing (das), plant height, aboveground, belowground, and total plant dry biomass for canola rapeseed.

Treatments	Stand 21 das (plants/m ²)	Stand 31 das (plants/m ²)	Plant height (cm)	Above- ground biomass (g/m ²)	Under- ground biomass (g/m ²)	Total dry biomass (g/m ²)
1 d period between herbicide spraying and crop sowing						
Glyphosate (G)	223.3 a	226.7 a	17.4 a	331.0 a	87.7 a	418.7 a
G + fluroxypyr	170.0 a	165.0 a	16.6 a	308.6 a	63.4 a	372.0 a
G + 2,4-D ester	211.7 a	205.0 a	16.6 a	266.7 ab	64.6 a	331.3 ab
G + metsulfuron+picloram	171.7 a	176.7 a	9.9 b	201.4 b	28.2 b	229.6 b
8 d period between herbicide spraying and crop sowing						
Glyphosate (G)	333.3 a	331.7 a	16.2 a	355.5 a	108.5 a	464.0 a
G + fluroxypyr	268.3 a	288.3 a	15.3 a	410.5 a	113.0 a	523.5 a
G + 2,4-D ester	293.3 a	281.7 a	16.3 a	425.0 a	115.8 a	540.8 a
G + metsulfuron+picloram	305.0 a	305.0 a	12.6 b	334.0 a	85.4 a	419.4 a
15 d period between herbicide spraying and crop sowing						
Glyphosate (G)	248.3 a	248.3 a	22.6 a	379.0 a	104.3 b	483.3 ab
G + fluroxypyr	248.3 a	238.3 a	23.1 a	417.5 a	129.5 a	547.0 a
G + 2,4-D ester	240.0 a	243.3 a	22.1 a	385.7 a	113.3 ab	499.0 ab
G + metsulfuron+picloram	226.7 a	223.3 a	21.9 a	352.1 a	101.8 b	453.3 b
30 d period between herbicide spraying and crop sowing						
Glyphosate (G)	278.3 ab	280.0 ab	28.1 a	436.9 a	157.4 ab	594.3 ab
G + fluroxypyr	283.3 a	305.0 a	28.4 a	450.9 a	159.3 ab	610.2 ab
G + 2,4-D ester	280.0 a	330.0 a	28.5 a	471.1 a	182.9 a	654.0 a
G + metsulfuron+picloram	223.0 b	225.0 b	27.8 a	390.5 a	139.5 b	530.0 b

In each column and within each period, means followed by the same letter are not significantly different according to Tukey HSD test at $P \leq 0.05$.

LITERATURE CITED

- In conclusion, the mix of metsulfuron + picloram with glyphosate in order to enhance weed control prior to the sowing of narrow-leafed lupin or canola should be avoided. Nevertheless, the negative effect observed may be due to picloram only, which has a known long persistence in the soil. The mix of glyphosate with either 2,4-D ester or fluroxypyr, at the doses evaluated, appeared safe for narrow-leafed lupins provided the crop is sown after a minimum period of 15 d from the herbicide treatment.
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