INTERACTION OF BROWN LEAF SPOT WITH POST-EMERGENT HERBICIDES IN NARROW LEAFED LUPINS

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ABSTRACT

Inoculation with *P. setosa conidia*, the infected plants had significantly lower dry weight compared to the same spray treatments in the un-inoculated set except metribuzin 225 g/ha (double the label rate) and diflufenican 100 g mixtures with tepraloxydim 60 g + Hasten® 1% or quizalofop 75 g/ha + BS 1000® 0.2 %. Further, application of herbicides to the brown leaf spot infected plants did not increase disease severity (except diflufenican + tepraloxydim + Hasten®), reduce plant height and dry weight compared to disease only treatment. These results indicate that there is no in the routine screenings on tolerance of new lupin varieties to herbicides, the testing is conducted under disease and weed free conditions. Not much information is available on the impact of foliar diseases like brown leaf spot on tolerance of lupins to herbicides. Thus a glasshouse experiment was conducted in 2008 at Northam, Western Australia to investigate the impact of brown leaf spot (*Pleiochaeta setosa*) infection of lupins on the plants' tolerance to post-emergent herbicides. The results reinforced that application of herbicides at the registered rates to healthy lupin plants (not inoculated with *P. setosa conidia*) are not injurious to plant growth. Under moderate to high disease pressure, produced by the negative interaction between brown leaf spot and post-emergent herbicides, at the registered rates, on lupins. Thus application of post-emergent herbicides, according to label recommendations, to the brown leaf spot infected crops can be expected to achieve effective weed control without increased negative impact on growth and development of lupins.

KEYWORDS

lupins, brown leaf spot, post-emergent herbicides, weeds, herbicide tolerance

INTRODUCTION

Brown leaf spot is a very serious fungal disease of lupins in Australia. It is caused by the fungus *Pleiochaeta setosa*, and the cotyledons of the infected plants develop dark brown spots, then rapidly die and drop off. Leaves also develop dark brown spots, often net-like in appearance, and often become distorted and reduced in size before prematurely dropping off. Small brown flecks may also be evident on the stems and these occasionally develop into large cankers (Sweetingham, 1999). In Western Australia (WA), the commonly grown narrow leafed lupin variety Mandelup, is moderately susceptible to this disease. Broadleaf weeds are also a major problem in lupin production in WA and are commonly controlled by post-emergent application of herbicides. Pathan *et al.* (2005) reported that competition from 3 to 24 wild radish plants m^{-2} can reduce lupin yield by 27 to 66%. A range of herbicides are registered for control of both grass and broadleaf weeds in lupins. Under disease free conditions, most of the registered herbicides at the label rates have been reported to not reduce the growth or yield significantly of narrow leafed lupins cv. Mandelup (Dhammu *et al.* 2004, Dhammu and Nicholson, 2005 and 2006). However, only anecdotal information is available on crop safety of these herbicides applied to lupin crops infected with brown leaf spot. The aim of this experiment was to study the interaction of brown leaf spot infection on the tolerance of lupins to post-emergent herbicides.

MATERIALS AND METHODS

Fifteen seeds of narrow leafed lupins (cv. Mandelup) were sown 3-4 cm deep in 5-litre pots filled with river sand on 28 February 2008 in a glasshouse at Northam, WA. The lupin seeds were soaked in the tap water overnight before seeding in the pots. At the 4 fully expanded leaf stage of the plants, half of the pots (56) selected randomly, were sprayed to the point of run-off with a conidiospore suspension of *Pleiochaeta setosa* (13 x 10^3 spores/mL) using a hand sprayer. The inoculated pots were placed on a separate table in the glasshouse, individually bagged in polythene bags and incubated for 48 hrs at 23°C ± 2°C. The remaining pots (un-inoculated) were also individually bagged for the incubation period. After the incubation, the plants (both inoculated and un-inoculated) were watered thoroughly and the herbicide treatments (Table 1) were applied 18 hrs later using an overhead, compressed air, glasshouse boom sprayer calibrated to deliver 100 L/ha at 200 kPa pressure. After application of herbicide treatments, the inoculated and un-inoculated pots were

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again put on separate tables in the glasshouse. The pots were watered daily and fertilised every week with Thrive®. There were 4 replications of each treatment. Pots were thinned to each contain 10 uniform looking plants, 6 days after the treatments application.

The data was recorded on disease reaction 1, 2 and 3 weeks after herbicide sprays (WAS) using 0-5 scale (where 0 = healthy leaf, with no or with one or two spots on one or two leaflets; 5 = leaf defoliated, all leaflets have dropped). The disease ratings were conducted on five randomly selected plants per pot for the first time, those plants were tagged and rated again for the subsequent disease assessments. On each plant the first six leaves were assessed for disease, as these leaves were exposed to inoculation spray. As there was no secondary infection in the glasshouse, the new plant growth was unaffected. Two and three WAS, herbicide phytotoxicity was assessed on a 0-100% scale (where 0 = no discolouration or damage evident, 100 = total discolouration or 100% leaf area necrotic) and the height of the five tagged plants in each pot was measured from ground level to the base of last fully opened leaf on the main stem. Three WAS, all plants (alive and dead) were cut at ground level, their leaves and stem were separated and dry weight (g per pot) recorded. The data were statistically analysed (ANOVA) using a completely randomised design in Genstat program Edition 11 for windows to compare the treatment means.

RESULTS AND DISCUSSION

Diflufenican and metribuzin are contact type of herbicides with a limited translocation. As a result these herbicides produce symptoms on the leaves exposed to the spray and generally new plant growth is unaffected. Two WAS, diflufenican alone and in mixture other herbicides caused visible spotting or bleaching (10%) on the first six leaves which were exposed to spray (Table 1). The intensity of these symptoms increased to double or more when diflufenican was applied in a mixture with tepraloxydim or metribuzin on both inoculated and uninoculated plants.

Metribuzin caused necrosis on leaves (10%). The intensity of symptoms increased (4.5 to 10 fold) when the rate of metribuzin was increased from 112.5 to 225 g/ha and the symptoms were more pronounced at the higher rate on un-inoculated plants compared with brown spot inoculated plants (Table 1). On the latter, the symptoms were less as the first two to four leaves which displayed most of the herbicide symptoms in the un-inoculated plants, had dropped off.

Metribuzin at double the label rate (225 g/ha) also caused significant reduction in plant dry weight of un-inoculated plants as compared to its label rate (112.5 g/ha) and the absolute control. Diflufenican + simazine also resulted in 10% leaf necrosis, whereas Hasten® 1 L/ha caused leaf spotting and yellowing in both the inoculated and un-inoculated sets (Table 1). Observations taken three WAS followed more or less a similar trend (data not shown).

The herbicide symptoms observed in this experiment are in line with the symptoms reported from the field trials (Dhammu and Nicholson, 2005 and 2006). In this experiment, metribuzin at double the label rate (225 g/ha) caused significant biomass reduction in un-inoculated plants (Table 1). This damage may translate into yield loss as in one out of six field trials conducted from 2003 to 2005, a higher than label rate (188 g/ha) also caused significant reduction in grain yield of Mandelup lupins (Dhammu *et al.* 2004; Dhammu and Nicholson, 2005 and 2006).

Inoculation with *P. setosa* produced moderate to high disease pressure on the leaves exposed to inoculum. The disease severity increased over time irrespective of herbicide treatments. One WAS, metribuzin 225 g/ha resulted in significantly higher disease severity than disease only treatment.

Leaf burning or scorching by metribuzin might have contributed to early leaflet or whole leaf drop off and thus there was higher disease score. At the later time of disease assessments, this treatment was at par with disease only treatment. Three WAS, diflufenican + tepraloxydim + Hasten® had significantly higher disease severity than disease only treatment (Table 1). The *P. setosa* infection alone or in conjunction with herbicide treatments had no significant negative effect on height of the lupin plants (data not shown).

Under the moderate to high disease pressure in this experiment, the infected plants had lower total dry weight compared to the same spray treatment in the un-inoculated set, except metribuzin 225 g/ha and diflufenican mixtures with tepraloxydim or quizalofop. Generally, lower leaf dry weight under the treatments (compared to absolute control) contributed more to this negative effect than the stem weight. However, application of herbicides or herbicide mixtures to infected plants did not result into further reduction in stem, leaf or total dry weight of plants as compared to disease only treatment (except metribuzin 225 g/ha which reduced leaf dry weight significantly).

This indicates that there was no significant negative interaction between brown leaf spot and commonly used registered herbicides on lupins. These results need to be validated under field conditions. It is quite likely that under low disease pressure situation, herbicides like metribuzin or simazine either alone in mixture with other herbicides, may increase the disease severity, reduce the plant growth and ultimately grain yield.

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Table 1. Effect of treatments on disease development, lupin plant growth and dry weight per pot (% of absolute control).

No	Herbicides (rate/ha)	Disease	Disease ratings			Herbicide phytotoxicity (%) on leaves (2 WAS)		Dry weight (3 WAS)		
			1 WAS	2WAS	3 WAS	Spotting	Necrosis	Stem	Leaves	Total weight
T1	Untreated control (no herbicides and disease)	Absent	0	0	0	0	0	100 (1.33 g)	100 (3.14 g)	100 (4.47 g)
T2	Diflufenican (DFF) 100 g	"	0	0	0	10	0	131	112	118
T3	Mertibuzin (Metri.) 112.5 g	"	0	0	0	0	10	111	94	99
T4	Mertibuzin (Metri.) 225 g	"	0	0	0	0	45	**72**	**68**	**69**
T5	Tepraloxydim (Tepra.) 60 g + Hasten® 1%	"	0	0	0	0	0	135	112	118
T6	Quizalofop (Quizal.) 75 g + BS 1000® 0.2%	"	0	0	0	0	0	125	108	113
T7	DFF 100 g + Tepra. 60 g + Hasten® 1%	"	0	0	0	30	0	116	95	102
T8	DFF 100 g + Quizal. 75 g + BS 1000® 0.2%	"	0	0	0	20	0	115	97	102
T9	DFF 50 g + Metri. 112.5 g	"	0	0	0	20	0	111	92	98
T10	DFF 50 g + Metosulam 4.3 g	"	0	0	0	10	0	124	108	112
T11	DFF 50 g + Simazine (Sima.) 250 g	"	0	0	0	10	10	131	112	118
T12	DFF 50 g + Metri. 75 g + Sima. 250 g	"	0	0	0	10	0	102	95	97
T13	Hasten® 1 L	"	0	0	0	20	0	119	105	109
T14	BS 1000® 200 mL	"	0	0	0	0	0	111	106	107
T15	Disease only (no herbicides)	Present	2.6	3.3	3.5	0	0	**76**	**73**	**77**
T16	DFF 100 g	"	2.7	3.2	3.5	10	0	88	**66**	**71**
T17	Metri. 112.5 g	"	2.6	3.3	3.5	0	0	93	**71**	**66**
T18	Metri. 225 g	"	**2.9**	3.5	3.8	0	10	**72**	**50***	**62**
T19	Tepra. 60 g + Hasten® 1%	"	2.8	3.2	3.5	0	0	90	**70**	**74**
T20	Quizal. 75 g + BS 1000® 0.2%	"	2.5	2.9	3.3	0	0	99	83	88
T21	DFF 100 g + Tepra. 60 g + Hasten® 1%	"	2.6	3.4	**3.9**	30	0	82	**80**	85
T22	DFF 100 g + Quizal. 75 g + BS 1000® 0.2%	"	2.5	3.2	3.5	10	0	82	**74**	85
T23	DFF 50 g + Metri. 112.5 g	"	2.6	3.2	3.6	20	0	86	**75**	**78**
T24	DFF 50 g + Metosulam 4.3 g	"	2.9	3.2	3.6	10	0	89	**71**	**76**
T25	DFF 50 g + Sima. 250 g	"	2.8	3.4	3.7	20	10	87	**73**	82
T26	DFF 50 g + Metri. 75 g + Sima. 250 g	"	2.9	3.4	3.8	10	0	**74**	**58**	**61**
T27	Hasten® 1 L	"	2.7	3.1	3.6	10	0	89	**72**	81
T28	BS 1000® 200 mL	"	2.9	3.3	3.5	0	0	**72**	**67**	**69**
LSD (0.05)			0.3	0.3	0.4			23	19	19
CV (%)			8.6	7.2	7.0			16	16	15

NOTES FOR TABLE 1

WAS = weeks after treatment spraying.

For disease rating 0-5 scale used; 0 = healthy leaf, with no or with one or two spots on one or two leaflets; 5 = the leaf defoliated, all leaflets dropped.

For herbicide phyototoxicity rating 0-100 scale used; 0 = no discolouration or damage evident, 100 = total discolouration or 100% leaf area necrotic.

Figures in **bold** are significantly different from absolute control.

Figures underlined are significantly different from their respective disease free treatments.

Figures with * are significantly lower than disease only treatment (T15).

Hasten® = Ethylated vegetable oil with non-ionic emulsifier.

BS 1000® = Non-ionic wetter.

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