

# OCCURRENCE OF ROOT AND HYPOCOTYL DISEASES IN LUPIN CROPS IN THE NORTHERN WHEATBELT OF WESTERN AUSTRALIA

G.J. Thomas and W.J. MacLeod

Department of Agriculture and Food, Western Australia, Locked Bag No. 4, Bentley Delivery Centre, WA 6983, Australia.

Corresponding author's email: gthomas@agric.wa.gov.au

## ABSTRACT

Lupins are an important crop on sandy soils which comprise a significant proportion of the northern agricultural zone of Western Australia (WA), however root and hypocotyl rots have been demonstrated to reduce establishment and yield of lupin crops in this region. This study measured the severity and extent of pathogens currently causing root and hypocotyl rots of lupins in WA farming systems.

In the northern agricultural region of WA, a total of 120 narrow leaved lupin (*Lupinus angustifolius*) crops were sampled during 2004 and 2005. Crops were assessed for plant density and plants removed, washed and root rot, hypocotyl rot and seeding depth measured.

Over 95% of surveyed paddocks had root rot present with a median incidence of 8%. Hypocotyl rot was less prevalent occurring in 65% of paddocks with a median incidence of 1.6%.

*Rhizoctonia solani* and *Pleiochaeta setosa* were most commonly associated with root lesions, being isolated from lesions at more than 60% of sites respectively. *Fusarium* spp. and *Pythium* spp. were occasionally isolated from root lesions. *Rhizoctonia solani* was isolated from more than 80% of hypocotyl lesions.

This study indicates that root rot commonly occurs in lupin paddocks in the northern agricultural region of WA, but frequently only at low levels. The incidence of both root and hypocotyl rots within paddocks is lower than was observed in similar surveys carried out between 1983 and 1990. *Rhizoctonia solani* and *Pleiochaeta setosa* remain the major pathogens responsible for root damage.

## KEY WORDS

*Lupinus angustifolius*, root rot, hypocotyl rot, *Rhizoctonia solani*, *Pleiochaeta setosa*

## INTRODUCTION

Lupins form an important part of many farming systems on sandy soils in the northern agricultural zone of Western Australia. Historically they have been grown in close rotation with cereal crops, as a result root and

hypocotyl rots became a significant impediment to the successful establishment of lupin crops. Previous surveys of lupin root disease in 1983 (Sweetingham, 1989), 1986 (Sweetingham, 1987) and 1990 (Sweetingham, 1995) recorded that root rot was apparent in all lupin crops surveyed.

Fungal pathogens such as *Pleiochaeta setosa*, *Rhizoctonia solani*, thin binucleate *Rhizoctonia*, *Fusarium* spp. and *Pythium* spp. have been associated with root or hypocotyl disease in Western Australian lupins (MacLeod and Sweetingham 1997; MacNish 1985; Sweetingham 1984; Sweetingham 1989; Wood and McLean, 1982).

Farming systems have evolved since the previous root disease surveys with increased utilisation of minimum or zero tillage, greater stubble retention, greater reliance on herbicides and improved lupin varieties. These changes to lupin cropping practices may have impacted on the incidence, severity and causes of lupin root and hypocotyl rots.

The aim of this study was to determine the extent and nature of fungi currently causing root and hypocotyl rots of lupins in Western Australia and, consequently, the need for intervention to reduce the impact of root disease on crop yield.

## MATERIALS AND METHODS

One hundred and twenty narrow leaved lupin (*Lupinus angustifolius*) paddocks were sampled over 2 years (71 in 2004 and 49 in 2005) in the northern agricultural region of Western Australia. Sampling was conducted in May and June to achieve a target age of 3–6 weeks after sowing. Paddocks surveyed included a range of soil types, crop rotations, sowing systems and lupin varieties. Paddocks were selected to provide a representative sample of the paddocks sown to lupins.

Each paddock was sampled along a triangular transect, each side of which was about 150 metres. There were approximately 25 sampling points along the transect at which 4 to 6 plants were collected, resulting in approximately 120 plants collected in total. Samples were taken from representative parts of each paddock, avoiding areas where seeding density was higher. At ten sampling points along each transect, the number of lupins in a 0.5 m x 1.0 m quadrat were counted.

Plants were removed with a trowel and the soil immediately surrounding the roots retained, soil which was not adhered to the roots was allowed to fall away, without exposing root material. After collection, all plants from one transect were treated collectively as the site sample. All samples were kept refrigerated from sampling until assessment. Within 3 days of collection, the roots were washed free of soil and examined for the presence and severity of root and hypocotyl damage. A random sub-set of 20 plants were additionally assessed for the depth of sowing.

Sub-samples of diseased root and hypocotyl pieces from each site were washed in sterile water, air dried and plated onto three agar media for isolation of root pathogens: water agar containing 25 ppm aureomycin HCl (WAA); water agar containing 50 ppm gentamycin, 10 ppm metalaxyl and 0.4 ppm carbendazim (WAGRB); corn meal agar containing 400 ppm pimaricin, 200 ppm vancomycin, and 160 ppm pentachloronitrobenzene (P10VP). Pectic zymogram groups of a representative sample of *Rhizoctonia* isolates were identified using the method of Sweetingham *et al.* (1986).

## RESULTS AND DISCUSSION

### ROOT ROT

Incidence of root and hypocotyl rots and observations on crop establishment were similar over the two years of the survey. Root rot was detected in 95% of paddocks sampled. Approximately 60% of these sites had less than 10% of plants with root rot symptoms (Fig. 1a). Very high levels of root damage occurred in several paddocks, incidence ranged from 0% to 41% with a median of 8%.

*R. solani* and *P. setosa* were isolated from root lesions from 63% and 71% of sites respectively (Table 1). The majority of paddocks sampled had previous lupin history, favouring the presence of the lupin specific pathogen, *P. setosa* (Sweetingham, 1989).

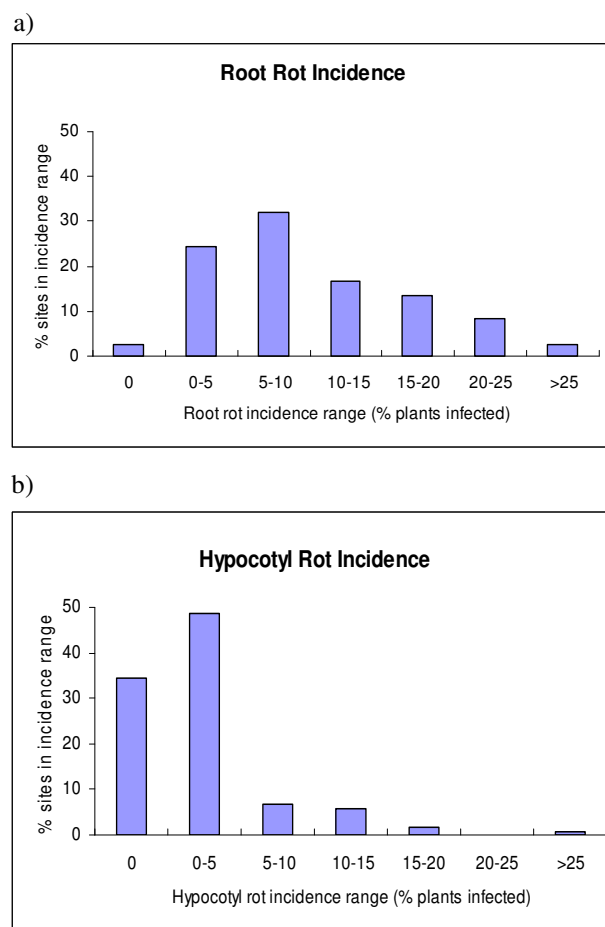
*Pythium* spp. and less frequently *Fusarium* spp. were also isolated from root lesions, often in conjunction with either *R. Solani* or *P. setosa*. Sweetingham (1989) suggests that these fungi are generally not significant primary pathogens of lupins and our results support this view.

The thin binucleate *Rhizoctonia* which causes Eradu patch, is difficult to isolate from lesions, therefore this disease was identified from root symptoms as described by MacLeod and Sweetingham (1987). Lesions characteristic of Eradu patch, stripping of cortical tissue from tap roots and trimming lateral roots, were confirmed at 8% of sites, however a further 5% of sites had symptoms suggestive of Eradu patch. Crop stunting typical of Eradu patch is not usually evident until 6–8 weeks after sowing (MacLeod and Sweetingham, 1987) and so this survey may have underestimated the scale of this disease.

Abiotic factors also contributed to root damage in some crops, for example the paddock with greatest incidence of root damage had suffered significant sulfonylurea herbicide toxicity as the primary contributor to root damage.

### HYPOCOTYL ROT

Hypocotyl rot was less common than root rot, occurring in 65% of paddocks, but generally at low levels. Incidence within paddocks ranged from 0–29% with a median of 1.6%. Over 90% of infected sites had less than 10% of plants with hypocotyl rot symptoms (Fig. 1b).



**Fig. 1.** Distribution of incidence of a) root rot (median incidence = 8.3%, incidence range = 0–41%) and b) hypocotyl rot (median incidence = 1.6%, incidence range = 0–29%) in lupins sampled from 120 individual paddocks in the northern agricultural region of Western Australia in 2004 and 2005.

*R. solani* was the most common pathogen isolated from infected hypocotyls (81% infected sites). *P. setosa* is not usually associated with hypocotyl rot and in this survey was only occasionally isolated from hypocotyl lesions. Several paddocks where *Rhizoctonia* hypocotyl rot was higher than the median had contained legume based pasture (e.g. Serradella) in the previous 3–4 years. Pasture legumes are also hosts of the strains of *R. solani*

that attack lupin hypocotyls. In at least one case, lupins sown into a paddock that had no previous lupin history, but a long pasture history, had almost 10% plants affected by hypocotyl rot.

**Table 1.** Isolation of *Pleiochaeta setosa* and *Rhizoctonia solani* from root and hypocotyl lesions in lupins sampled from 120 sites in the Northern Agricultural region of Western Australia in 2004 and 2005.

Pathogen incidence	Root	Hypocotyl
Sites with <i>R. solani</i> isolated	63%	81%
Sites with <i>P. setosa</i> isolated	73%	6%
Sites with Eradu-Patch	8%	–

#### RHIZOCTONIA STRAINS

Pectic zymograms from a representative sample of *Rhizoctonia* isolates from hypocotyls revealed that majority of isolates belonged to ZG3 (83%) and a few belonged to ZG4 (10%) pectic zymogram groups. Whereas, isolates associated with root rot were from the ZG1 (24%) and ZG3 (70%) groups. The ZG1 group has a wide host range and is present in many agricultural soils. It contributes to root disease as a primary pathogen causing rhizoctonia root rot and with severe infection is visible in paddocks as rhizoctonia bare patch. The ZG3 group is a primary pathogen of lupin hypocotyls rather than roots (Sweetingham, 1989) but the frequency of isolation from roots in this survey indicates that it is common in lupin producing soils and is involved in interactions or secondary infection with other causes of root damage. Additionally ZG6 was also found to be associated with both root and hypocotyl lesions at low frequency (< 5%) (Table 2).

**Table 2.** Percentage of *R. Solani* isolates within common zymogram groups (ZG), identified from hypocotyl or root lesions in 2004–05.

	ZG1	ZG3	ZG4	ZG6
Hypocotyl (41*)	5	83	10	2
Root (25*)	24	72	0	4

\* Number of isolates tested.

#### AGRONOMIC OBSERVATIONS

Sowing depth varied between sites but was generally consistent within a site. Median sowing depth in both years was 3.0 and 3.3 cm with ~90% of sites having a median sowing depth less than 5 cm, which is recommended for optimum establishment (Garlinge, 2005). Average plant density was 50 plants/m<sup>2</sup>, with nearly three quarters of sites having more than 40 plants/m<sup>2</sup>. Seeding rates of approximately 100 kg/ha are recommended for narrow leafed lupin (Garlinge, 2005), this seeding rate should achieve plant densities around 50 plants/m<sup>2</sup>. These plant densities should provide some protection from reduced seedling establishment from root or hypocotyl infection.

#### HISTORICAL SURVEY COMPARISONS

This current survey was carried out in a similar manner to previous surveys of lupin crops across the northern agricultural region in 1983 (Sweetingham, 1989), 1986 (Sweetingham, 1987) and 1990 (Sweetingham, 1995). In all surveys, root rot was more common than hypocotyl rot. Root rot occurred at more than 95% of sites in each survey, however the median incidence of root rot decreased over time from 30% in 1985–86 to 8% in 2005–06. In previous surveys, a greater proportion of paddocks had very high and potentially yield limiting levels of root rot incidence (Table 3). Hypocotyl rot incidence varied between surveys. Incidence of infected paddocks and percentage paddocks with > 10% incidence was greatest in the 1990 survey. Similar to the root rot results, hypocotyl rot incidence was lowest in the 2004–05 survey (Table 3).

Reduced incidence of root disease does not seem to be related to a change in the pathogens present in cropping paddocks and current varieties do not differ significantly from older varieties in susceptibility to root pathogens. The reduction in overall root disease is more likely related to changes in farming systems, paddock selection, crop rotation, crop establishment techniques and understanding of disease risks. Lupins have become an established part of farming systems and poorly performing or high disease potential paddocks are less likely to be sown to lupin. Root damage from herbicide and fertiliser toxicities still occur but occur less frequently with improved cropping techniques. Current seeding rates and crop establishment techniques (including seed placement and sowing depth control) are resulting in better seedling establishment than recorded in previous surveys. This helps to reduce the impact of seedling mortality, associated with root or hypocotyl rots on final stand density and subsequent grain yield.

This series of surveys indicate that the incidence of root and hypocotyl rots in commercial lupin paddocks in Western Australia has decreased dramatically over the past 20 years, however current lupin growers can still expect some level of root rot in their paddocks and in occasional paddocks the potential for high levels of disease and significant crop losses still exist.

**Table 3.** Incidence of root and hypocotyl rot in three surveys of commercial lupin crops in 1985–86, 1990 and 2004–05.

Survey year	Root	Hypocotyl
2004/05		
Paddocks infected	97%	65%
Paddocks > 10% incidence	40%	9%
1990		
Paddocks infected	100%	98%
Paddocks > 10% incidence	83%	51%
1985–86		
Paddocks infected	100%	86%
Paddocks > 10% incidence	91%	12%

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