SUCCESSFUL LUPIN ESTABLISHMENT IN WESTERN AUSTRALIA – A REVIEW

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ABSTRACT

Establishing lupins has been a problem in Western Australia in the past. Using good quality, large seed, retaining previous crop stubble, loosening the soil below the seed, placing fertiliser away from the seed, leaving a water harvesting soil profile above the seed and placing loose soil above the seed has negated most establishment problems.

KEYWORDS

lupin, establishment, sowing, germination, stubble, fertiliser placement

INTRODUCTION

In Western Australian dryland agriculture significant improvements to crop establishment, weed and disease control and yield have resulted from seedbed management techniques involving stubble retention, appropriate soil disturbance and placement of seed and fertiliser in relation to soil moisture (Sweetingham and Jarvis, 1993) (Nelson and Delane, 1991).

The development of herbicide resistance in annual ryegrass (*Lolium rigidum*) and wild radish (*Raphanus raphanistrum*) has added a major challenge for lupin producers in Western Australia. Its impact has been felt first and most severely by producers who have used a continuous wheat-lupin rotation. In managing resistance successful establishment is the key and will determine the viability of lupin in a crop rotation. Agronomic practices after establishment are also needed to combat herbicide resistant weeds. For example, French and Maiolo (2008) suggest lupin crop competition at plant densities higher than 40 plants/m^2 reduces annual ryegrass growth and seed set.

The purpose of this paper is to summarise the important factors that has lead to successful lupin field establishment in Western Australia where field establishment rate was often lower than the laboratory tested germination rate. The techniques discussed in this paper will help ensure field establishment rates are high.

SEED QUALITY

Seed with low germination percentage as indicated in a standard laboratory test can also have poor seedling vigour. Causes of poor germination include rain on a mature crop waiting for harvest and mechanical damage from harvesters (Blanchard, 1990). Blanchard (1990)also suggested harvester drum or rotor peripheral speed should not be higher than 12 m/s for acceptable laboratory seed germination.

McCarthy and Delane (1992) suggested lupin seed weight should be above 145 mg/seed for the best establishment and vigour. Bwye *et al.* (1994) also suggested the seed should have less than 0.5 per cent cucumber mosaic virus infected seed, however in years of high risk (summer rain) or for certified seed a zero test was recommended.

Low levels of phosphorus (P) and manganese (Mn) is also an indicator of poor seed quality. Seeds with less than 0.25 per cent P have recorded up to 25 per cent yield reductions (Bolland *et al.* 1989). Similarly, germination and subsequent growth of lupin seedlings is reduced if seeds contain less than 13 mg/kg Mn (Brennan and Longnecker, 2001). Applying P or Mn fertiliser can not compensate for low levels of these nutrients in the seed.

STUBBLE RETENTION

Retaining stubble effectively reduces soil borne Brown Spot spores from splashing up onto the lupin plant (Sweetingham and Jarvis, 1993). This is most important for protecting young seedlings from Brown Spot disease. Further, seed should be treated with a fungicide to reduce the incidence of root rot caused by Brown Spot (*Pleiochaeta setosa*) spores (Sweetingham, 1993). Sowing with tines or discs to leave some stubble cover is most important. Stubble length may have to be reduced for tine sowing equipment to avoid stubble blockages. Blockages will result in uneven and poor crop establishment. To avoid blockages when retaining stubble for good establishment Leonard (1993) suggested the maximum stubble length should be one half the clearance distance between tines in any direction for stubble levels up to 3 t/ha and one third the clearance distance for stubble levels from 3 to 5 t/ha.

LOOSE SOIL BELOW THE SEED

The young root system of the lupin needs to move quickly down into the soil to stay in moist soil if the soil surface dries out. Loosening the soil below the seed,

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such as with a deep narrow blade on tine drills, aids this root development. Bligh (1991) found disc drills with a single angled disc can compact the soil immediately below the depth of the disc, which is not desirable for lupins. In this instance the problem was associated with medium clay soils.

FERTILISER SOWN AWAY FROM THE SEED

Fertiliser placed next to the seed can be toxic to the seed due to the salt effect in drying soil. Riethmuller and Jarvis (1991) found the toxic effect of 17.7 kg/ha P fertiliser with the seed reduced field emergence by 22 per cent compared to placing the fertiliser 7 cm below the seed in 38 cm wide rows. Mason *et al.* (1996) suggested the maximum rate of P to be 16 kg/ha in 18 cm wide rows if placed with the seed. Jarvis (1992) reported work of R. Brennan at Badgingarra showing that manganese (Mn) placed below the seed improved yields by 15 per cent over placing with the seed. Jarvis (1992) reported lupins responded to phosphorus (P) placed below the seed on soils that had a low P at depth.

WATER HARVESTING SOIL PROFILE ABOVE THE SEED

Having a 'V' soil profile directly above the seed effectively harvests rainfall onto the seed from runoff from the sides of the 'V'. This is important for good lupin emergence on a non-wetting soil. Riethmuller (2003) found this to be important for canola sowing as well, which gave the most reliable establishment with up to 59 per cent more seedlings established. A disadvantage with this technique is that pre-emergent herbicides, such as simazine, can be thrown into the inter-row leaving no herbicide in the row for weed control. A post-sowing top-up spray of simazine (no more than 0.5 L/ha, 500 g/L a.i.) may reduce this problem if there are no signs of simazine pre-emergent damage to the lupins.

LOOSE SOIL ABOVE THE SEED

Amjad and Riethmuller (2001) found pressing the lupin seed with a press wheel with no soil cover, then followed by a depth controlled rotary harrow to move some loose soil over the seed, not only improved lupin plant establishment by 11 per cent but reduced ryegrass (*Lolium rigidum*) weed seed set by 58 per cent (Fig. 1). The reduced ryegrass numbers may have been due to the loose soil drying out, which acted as a dry mulch to reduce deeper soil moisture loss (aiding lupin establishment) as well as impeding ryegrass germination due to the drier top soil. The loose soil may also have brought some simazine back into the row.

Riethmuller (2006) found that a ring harrow is more suitable to fit to air-drills to bring loose soil back over the row but does not have the control of the rotary harrow that has depth gauge wheels (Fig. 2).

Fig. 1. Lupin seed pressed into the soil (top photo) before covering with loose soil by a rotary harrow with depth gauge wheels on the ends (bottom photo).

Fig. 2. A ring harrow following press wheels to bring loose soil over the seed.

CONCLUSIONS

Successful lupin establishment in Western Australia can be achieved through attention to five key areas: good quality seed, stubble retention, loosened soil below the seed, fertiliser away from, preferably below, the seed, a water harvesting 'V' soil profile above the seed and loose soil over the seed.

Future work needs to investigate improvements to chemical and physical weed control in the row. A ring harrow following press wheels is a compromise between depth control and practicality and a better technique is needed for all soil types. Also lupin competition against weeds needs further work as precision placed lupin plants along the row may compete better against weeds. As with many lupin emergence issues the solution must always be practical for a broadscale system.

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