MANAGING MANGANESE DEFICIENCY IN LUPINS

FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

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Solutions to manage manganese deficiency to reduce the incidence of split seed syndrome in high-yielding lupin

KEY POINTS

- Manganese deficiency and the resulting split seed syndrome cause lost production for growers
- Manganese sulfate was the most effective formulation to increase the concentration of manganese in the stem test when applied at budding at all three trial sites
- Manganese sulfate applied at 1000gai/ha (2x) rate was also the most effective treatment to increase seed nutrient concentrations of Mn at two of the three sites when applied at either timing
- Manganese oxide at the highest rate (2x) at the second timing was most effective in increasing the stem test concentration at Burma Road and Ogilvie
- There was no effect of any treatment on yield at all three sites. The very dry finish to the season affected yields more than Mn treatment or timing

A crop of narrow leaf lupin, flowering in August in the Geraldton region.

Introduction

Lupin is the highest-volume pulse crop grown in Western Australia, with WA production comprising about 80 per cent of the national lupin crop.

WA lupin crops are predominantly grown on lighter acid sands, which account for large areas of the grain belt. The crop's importance lies in providing a break to cereal cropping, fixing nitrogen in the soil for subsequent crops and providing feed within mixed farming enterprises.

Production is dominated by narrow leaf lupin species, which account for nearly 95 per cent of the annual crop. Although lupin is grown throughout the state, the Geraldton Port Zone accounts for the majority of production.

An increasing problem – manganese deficiency

Lupin crops require good nutritional levels of three key elements: phosphorus, potassium and manganese. The levels of these elements are managed by the application of fertilisers at the time of sowing; however, unless levels are well understood deficiencies can occur, particularly with manganese (Mn).

Manganese deficiency has become more evident in recent years in the northern agricultural region. It is especially evident in the high-yielding, higher-rainfall (+450mm) areas, where the lighter sandy soil types are predominant.

The release of higher-yielding lupin varieties combined with the plant's poor ability to translocate Mn from its leaves to the grain can result in higher demand for Mn during the growing season.

When Mn demand is not met, the results can be costly: low vigour seed and germination percentages, low Mn concentration in the seed, lower yields, split lupin seed at harvest, and reduced returns due to downgrading at receival points.

Mn deficiency is most likely to occur in lupin crops grown in soils with higher pH levels. Over the past 10 years there has been a strong emphasis on raising soil pH levels in the lighter soil types in the northern agricultural region. Higher pH soils restrict the levels of available Mn to lupin crops, leading to deficiencies.

Mn deficiency in lupin crops may not always be observable during the growing season. It may only become

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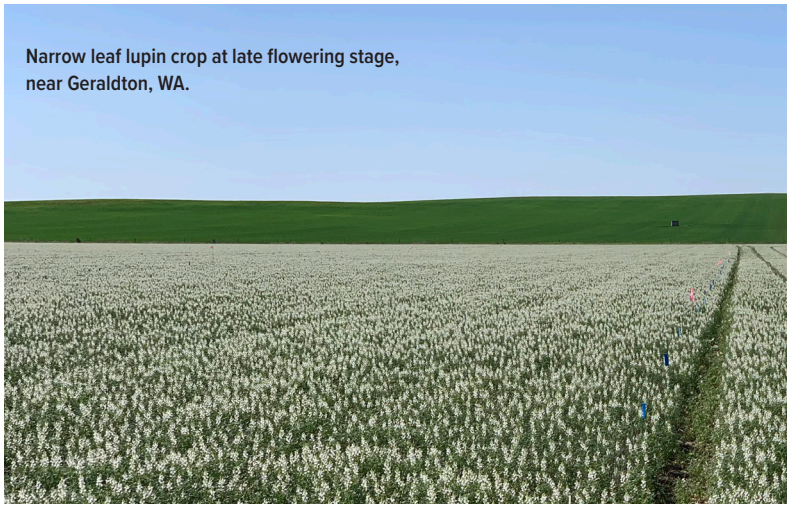

Narrow leaf lupin crop at late flowering stage, near Geraldton, WA.

TABLE 1 Manganese formulation types x cost/hectare.

Product	Rate (gai/ha)	Cost/ha	Rate (gai/ha)	Cost/ha
Manganese oxide	500	$10.25	1000	$20.50
Manganese chelate	500	$40.92	1000	$80.84
Manganese sulfate	500	$2.72	1000	$5.44
Manganese carbonate	500	$9.30	1000	$18.60

(gia/ha – grams of active ingredient per hectare)

apparent at harvest, when split seed syndrome becomes obvious.

Current practice to correct Mn deficiency

The current best practice is to do a soil test before seeding to understand the levels of Mn available in the soil. Levels between 1.5mg/kg and 4.5mg/kg are considered low and need to be amended before seeding. It is recommended that a suitable fertiliser with an adequate level of available Mn be used at seeding.

If Mn deficiency becomes evident in-crop during the growing season (observation, plant tissue testing – which is more accurate – or stem tissue testing), then foliar applications of Mn can be made. Timing is critical; the current recommendation is that foliar Mn applications be made when the pods on the main stem are 2 to 3cm in length and when the secondary stems have nearly completed flowering. The recommended application rate is 1kg/ha.

What we do not know about correcting Mn deficiency

With the incidence of split seed syndrome becoming more prevalent, there are three main factors that are not well understood by growers and agronomists:

- What is the most effective foliar Mn formulation for in-season applications?
- What is the most effective application rate?
- What is the most effective time of application (crop stage)?

All these factors have an influence on plant uptake and translocation of Mn into the plant and seed.

There are four types of Mn formulations available to growers: oxides, carbonates, chelates and sulfates. There is limited data available comparing these formulations and their efficacy in correcting Mn deficiencies in narrow leaf lupin crops.

These products also vary considerably in their cost per hectare, as shown in Table 1. Understanding the return on investment for each product is an important consideration in selection.

These products may also pose usability problems for growers (for example, how to mix and apply), but little is known about these issues.

Recent trial results

A series of trials was established in 2019 in the northern agricultural region in lupin crops that were being grown on soil types known to be low in Mn and responsive to applications of Mn. All sites were soil-tested before the research started and returned Mn levels lower than 3mg/kg.

Mn formulations were applied at equivalent rates of 500gai/ha and 1000gai/ha at two timings: budding on main stem (timing 1) and pods at 2 to 3cm on the primary inflorescence (timing 2).

To understand the uptake of Mn by the plant, tissue/stem testing was conducted at 10 days after application and at harvest, where seed was collected to test for Mn content.

The results varied between sites, formulations, rates and timing of application. However, there were no significant effects on yield or seed Mn content at harvest by any of the formulations when applied at the two rates and two timings. The 2019 season was especially dry in the northern agricultural region and this affected the results from the trials.

Although results were not conclusive and further investigation is required, there was some evidence to indicate that manganese sulfate may be superior for improving Mn concentrations in the stem and seed in responsive soils and deficient crops. Manganese sulfate is also the most economical form of Mn for the grower.

This trend needs further research to confirm and draw clear guidelines for applications.

GRDC RESEARCH CODE

Project – CRC1908-001SAX

FURTHER RESOURCES

GRDC, Lupin Grow Notes, Western region, 2017.
https://grdc.com.au/resources-and-publications/grownotes/crop-agronomy

Canola Agronomy Research in Western Australia booklet.
https://grdc.com.au/resources-and-publications/all-publications/publications/2018/canola-agronomy-research-in-western-australia

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