Dryland Legume Pasture Systems: Boron tolerant annual medics

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Location
Minnipa Agricultural Centre, paddock S8
Rainfall
Av. Annual: 324 mm
Av. GSR: 241 mm
2019 Total: 254 mm
2019 GSR: 234 mm
Paddock history
2018: Legume adaptation trial sown and established
2017: Scepter wheat
2016: Medic pasture
Soil type
Red sandy loam
Soil test
$pH_{(H20)}$ (0-10 cm) 8.4
Plot size
5 m x 1.5 m x 4 reps

Key messages

- **Annual medics are widely grown on neutral to alkaline soils that commonly contain high levels of boron in the subsoil that reduce plant growth.**
- **Boron tolerant barrel, strand and disc medic cultivars exist, but all spineless burr medic cultivars are intolerant of high boron levels.**
- **A cohort of boron tolerant spineless burr medics have been developed and entered field evaluation trials at Minnipa and Roseworthy in 2019.**

Why do the trial?

Annual medics are widely grown as ley pastures on neutral to alkaline soils and provide many benefits to mixed farms including providing high quality feed to livestock, fixing nitrogen; and reducing cereal disease levels. Mixed farms have reduced economic risk compared to livestock or cropping farms. High levels of boron in the subsoils is a widespread constraint in neutral to alkaline soils which can restrict dry matter production and seed set. Tolerant barrel, strand and disc medic cultivars exist, but this information is not always known by farmers and their advisors. All spineless burr medic cultivars are susceptible to high boron levels which may have restricted their adoption. We have developed a cohort of boron tolerant spineless burr medics and field evaluation was begun at Minnipa and Roseworthy in 2019.

How was it done?

Part 1: Medic cultivars were grown in soil with high boron levels in a glasshouse, leaf damage symptoms recorded and cultivars allocated to different tolerance groups (Howie 2012).

Part 2: The above identified that all spineless burr medic cultivars are susceptible to high boron levels. Screening wild accessions (supplied by the Australian Pasture Genebank) identified a burr medic accession with boron tolerance and vigorous growth. The boron tolerant accession was crossed with current spineless burr medic cultivars Scimitar and Cavalier. F2 plants with high early vigour were selected and a molecular marker used to identify homozygous boron tolerant plants. A single seed descent breeding method using speed breeding was used to obtain uniform lines. Lines were seed increased at Waite in 2018 and lines with the highest agronomic performance selected for 2019 field evaluation trials.

A cohort of 16 boron tolerant lines along with their parents and barrel medic cultivars that differ in boron tolerance, were sown at Roseworthy and Minnipa. The trials were managed as best practice first year annual medics to maximise dry matter and seed production. Best practice consists of a high sowing rate (10 kg/ha), controlling broadleaf and grass weeds, monitoring and controlling insects and no grazing. Dry matter production was assessed and pods collected. Seed yield will be determined by April 2020.

What happened?

Boron tolerance rating of annual medic cultivars is provided in Table 1. Tolerant cultivars exist for barrel, disc and strand medic but all spineless burr medic cultivars were found to be susceptible. Several cultivars have been released since this work was done which have not specifically had their boron tolerance tested, but they were developed by backcross breeding programs and likely to behave similar to their recurrent parents. Pristine Forage Technologies have developed the pod holding cultivars Jaguar (strand), Cheetah (barrel) and Lynx (barrel) which share close pedigrees with Herald, Caliph and Mogul respectively. Sultan-SU was bred to be tolerant of SU herbicide residues with its recurrent parent being Caliph and Sultan-SU carries the boron molecular marker of Caliph.

Table 1. Boron tolerance rating for annual medic cultivars (from Howie 2012).

Cultivar	Species	Boron response
Caliph	Barrel	Tolerant
Jester		Moderately susceptible
Mogul		Very susceptible
Parabinga		Moderately susceptible
Paraggio		Tolerant
Sephi		Tolerant
Toreador	Disc	Tolerant
Tornafield		Susceptible
Cavalier	Spineless burr	Susceptible
Circle Valley		Susceptible
Santiago		Susceptible
Scimitar		Susceptible
Serena		Susceptible
Angel	Strand	Tolerant
Harbinger		Tolerant
Herald		Tolerant

Evaluation of the boron tolerant spineless burr medic cohort is at an early stage, with more observations required before short-listing a line for release as a cultivar. However, the boron tolerant lines have so far produced dry matter similar to or better than cultivars Scimitar and Cavalier. Seed yields are yet to be determined and hence we have not determined the best performing lines in the establishment year. Hardseed studies and the performance of regenerating pastures is required before we can shortlist the superior lines.

What does this mean?

High levels of boron in sub soils is a widespread constraint to plant production in neutral to alkaline soils. Significant yield losses have been documented for cereals, pulses and pastures. Paull *et al* (1992) found medic shoot production under high boron solution culture was reduced by 27% (most tolerant) to 67% (most susceptible). Farmers and their advisors can take boron tolerance status into account when deciding on which cultivar to plant. High levels of boron can vary with topography, with high boron being more likely in the swales and less likely in the dunes. Burr medics are better adapted to loams and clays that occur in the swales and why we consider developing boron tolerant spineless burr medic cultivar is important.

Boron tolerance was not a breeding aim of any of the boron tolerant cultivars listed in Table 1. However, the fact that we have passively selected several boron tolerant cultivars suggest that high levels of boron was often a constraint in field evaluation and that boron tolerance enabled them to have higher yields. Many boron tolerant cereal and pulse cultivars exist and their performance may provide a useful guide to the significance of boron on individual farms. Benefits from boron tolerance will vary from season to season with tolerance more likely to provide benefit in dry years when subsoil water is more important. Climate change predictions are for a more variable climate with more dry years and it is likely that boron tolerance will become a more valued trait.

The breeding aim of the boron tolerant cohort is to combine the new trait of boron tolerance with improved agronomic performance. In 2019, field evaluation of the boron tolerant cohort was begun. While it is too early to tell if we have superior lines, most lines produced high dry matter in 2019. Seed yields, hardseed breakdown studies (December 2019 to April 2020) and regeneration performance in 2020 is required before we can short list lines.

High levels of boron in the subsoil are often associated with high salt levels. High salt levels can restrict plant growth including boron tolerant genotypes. The spineless burr medic cultivars Scimitar and Cavalier have useful salt tolerance. The lines that perform the best in the field in 2019 and 2020 will be screened for salt tolerance (and boron tolerance) and the final shortlist made. The final line chosen for cultivar release will have high agronomic performance combined with boron tolerance and possibly useful salt tolerance. Research is expected to be completed in 2022 which will be followed by a minimum of three years of seed build up and hence commercial seed is expected to be first available in 2025.

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