Calibration of the commercial soil test for P on a red calcareous loam

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Location
Minnipa
Minnipa Ag Bureau
Rainfall
Av. Annual: 324 mm
Av. GSR: 241 mm
2019 Total: 235 mm
2019 GSR: 205 mm
Yield
Potential: 2.1 t/ha (W), 1.3 t/ha (C)
Actual: 1.7 t/ha (W), 0.25 t/ha (C)
Paddock history
2018: Wheat before canola, canola before wheat trial
2017: Pasture
2016: Pasture
2015: Pasture
Soil type
Red sandy clay loam
Soil test
$pH_{(H20)}$ 8.4, PBI 79, K 523 mg/kg
Plot size
20 m x 2 m x 4 reps x 25.5 cm row spacing
Trial design
Completely randomised design, 2 bays deep x 44 plots long x crop type (wheat or canola)
Yield limiting factors
Low rainfall, frost

Key messages

- **With low rainfall and poor growth at many sites, crops required little P to maximise grain yield.**
- **On a red sandy clay loam at Minnipa, wheat only needed a Colwell P value of 10-15 mg/kg to achieve maximum grain yield without P fertiliser.**
- **Canola appears to have a lower critical P level than wheat.**

Why do the trial?

Soil testing for N, P, K and S is a key strategy for monitoring soil fertility of cropping soils as well as for refining fertiliser application strategies for future crops. For this to be successful, the relationship between the soil test and likely response to applied nutrients needs to be well calibrated. Many of these calibrations were developed from fertiliser trials conducted over 20 years ago and have provided robust guidelines on many soil types, but mostly for cereals. Since these trials were conducted cropping systems have changed significantly and altered the face of soil fertility in the Australian grains industry. A detailed re-examination of those existing guidelines is needed to ensure they are still relevant in current farming systems.

As part of the GRDC funded MPCN2 (More Profit from Crop Nutrition) program, a review of data in the Better Fertilizer Decisions for Cropping (BFDC) database showed gaps exist for key crops, soils and regions. Most of these gaps relate to crops that are (i) new to cropping regions or are a low proportion of cropped area, i.e. break crops, (ii) emerging nutrient constraints that had previously been adequate in specific soil types and (iii) issues associated with changing nutrient profile distribution. This project (UQ00082) is closing gaps in the BFDC database using replicated trials. Trials have been established on sites selected for nutrient responses and run over multiple years to develop soil test-crop response relationships. By using wheat as a benchmark alongside a break crop, we should be able to extend the relevance of the guidelines beyond the conditions at the trial site.

How was it done?

A P deficient site on a red sandy clay loam was selected near Pildappa on upper Eyre Peninsula. Soil P status was very low at < 6 ppm Colwell P in the top 10 cm. On 7 May 2018, P fertiliser treatments were applied at 11 rates from 0 - 200 kg P/ha to create a range of soil P reserves.

Two identical trials were sown at the site in 2018, one with Mace wheat as the benchmarking crop and Stingray canola for comparison.

In 2019, 44T02 canola was seeded over the wheat trial and Mace wheat over the canola. Crops were inter-row seeded on the previous crop rows with no P fertiliser. Both crops received urea banded under the seed row @ 49 kg/ha and wheat received an extra 11 kg/ha of urea with the seed.

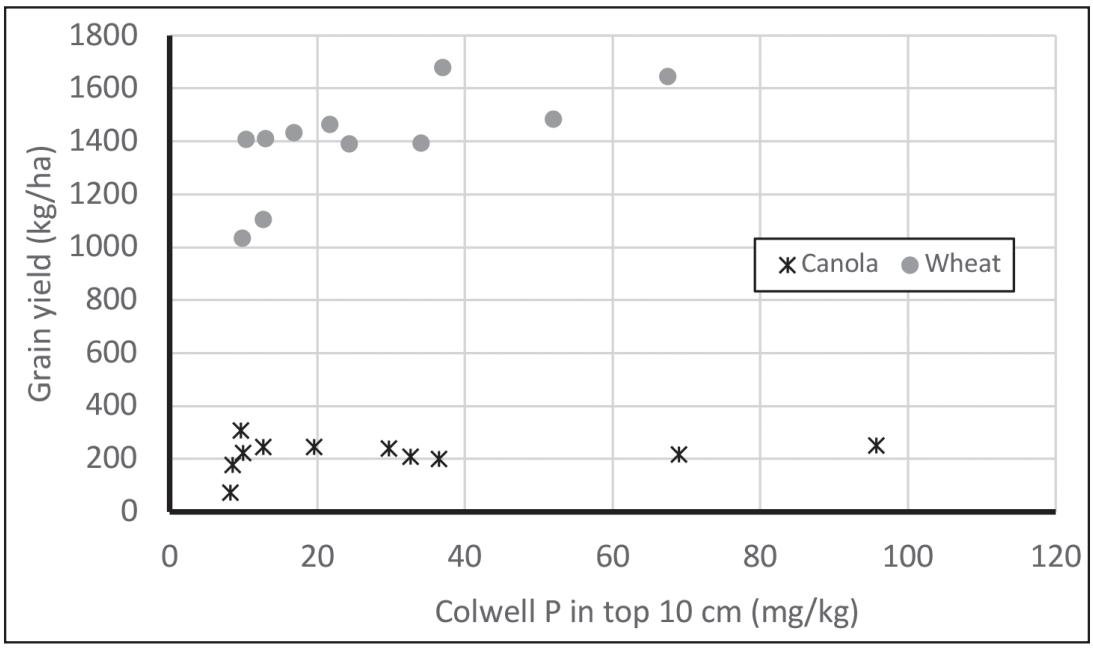

Figure 1. Grain yield of wheat and canola with increasing Colwell P in the topsoil at Pildappa, SA in 2019.

What happened?

Despite periods of very severe water stress during the season, both crops grew substantially better where soil tests were high for P (above 15 mg/kg in the top 10 cm for wheat, and above 10 mg/kg for canola). Canola appeared to be more stressed than wheat during the dry periods and the grain yield of canola was very poor, especially relative to wheat. Maximum grain yields for wheat were 1.6 t/ha compared with 0.3 t/ha for canola. Wheat grain yields were reduced by more than 30% (or nearly 0.5 t/ha) by P deficiency, for canola the reduction was more than 70% (or about 0.15 t/ha) (Figure 1).

Colwell P values in 2019 were approximately half of those recorded in 2018 but most were still much higher than untreated levels. This shows that while P is strongly fixed in this red calcareous sandy loam, applications of P in one year can still have benefits at least into the year after application.

What does this mean?

The minimum Colwell P soil test for wheat in 2018 was about 11 mg/kg. Below this value, wheat would suffer substantial yield penalties if grown without P fertiliser. The same figure estimated from the 2019 wheat crop is about 15 mg/kg. Both of these critical levels are substantially lower than the current standard of 20-25 mg/kg for mallee-type soils. These values are probably low due to the very low production levels experienced in both seasons. Under these conditions, crops require very little P to maximise growth.

The canola was not harvested in 2018 so its sensitivity to low soil P levels could not be compared to wheat in that year, but in 2019 its critical level was lower than wheat (approximately 10 mg/kg compared to 15 mg/kg for wheat). This suggests that canola can grow without the need for P fertiliser at lower soil P reserves than wheat. However, it does not necessarily mean that canola should be grown with lower rates of P than wheat because the optimum rate for P fertiliser is determined by many factors such as value of the commodity and the long term goal for soil P reserves, not just crop sensitivity.

For this project, 2020 will be a critical year because it is the last growing season for the project and so far our data set for calibrating soil tests in current farming systems consists entirely of seasons drier than average and in many cases extremely dry. 2020 is our last chance to estimate soil critical levels for N, P, K and S under wetter conditions and thus have a more balanced data set.

Acknowledgements

Mike Bell (The University of Queensland) who leads the UQ00082 project funded by GRDC. Thank you to Neil King, Katrina Brands, Steve Jeffs and Bradley Hutchings for undertaking the field work and processing samples.

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