Break crops being sown onto unsuitable soils, unsuspectingly.

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Key messages

The findings of the Profitable Crop and Pasture Sequences project (AKA Focus Paddocks) soil acidity measurements agree with those of Gazey, Andrew and Griffin (2013). A high proportion of sampled paddocks, 39%, have sub-surface pH below minimum target of pH_{Ca} 4.8.

37% of sampled paddocks have pH_{Ca} in the surface greater than 5.5. Of these paddocks 40% have pH_{ca} of less than 4.8 at 10–30cm. This has negative implications for legume break crops field pea and chickpea, and also legume pastures sown into these paddocks.

We found 22% of paddocks sown to canola had adequate surface pH_{Ca} 5.5 and below target subsurface pH_{Ca} 4.8 in 2013.

Background

The Profitable Break Crop and Pasture Sequence project, also known as the Focus Paddocks project, is now into its fourth season. The project is collecting field data from the same 184 paddocks, for five consecutive years. Working with the project are Yuna Farm Improvement Group, Mingenew Irwin Group, West Midlands Group, Liebe, WANTFA, Facey, Holt Rock Group, Fitzgerald Biosphere Group and North Stirlings Pallinup NRM. The project aims to deepen our understanding of the implications of crop and pasture rotation on the farming system. This paper discusses the results and potential implications from the subsurface soil pH testing.

Between pH_{Ca} 5.5 and pH_{Ca} 8 is the ideal pH range for plants (Gazey and Davies 2009). Soil pH targets, as set by DAFWA and industry are 5.5 in the topsoil, 0–10cm, and >4.8 in the subsurface soil, 10cm and below. At pH_{ca} of 4.8, or lower, levels of aluminium in the soil increase to toxic levels. Free aluminium has a large impact on crop yield. It reduces root growth in turn reducing the depth of soil the plant has access to.

In terms of lime movement through the soil, a pH level of 5.5 is required in the top 0-10cm of soil before lime can influence any soil below this level. Lime applied to the surface will be worked in with the traffic of the seeding implement. This creates a layer where the pH is ameliorated to the depth of the seeding point but no further. Lime must be in contact with the soil of low pH in order to react. This layering effect has an impact on yield potential of rotation crops and pastures. An ameliorated surface, above pH_{ca} 5.5, and subsurface with pH_{ca} below 4.8 reduces the yield potential of rotation crops and the efficacy of N fixation. In spite of a lime application the subsurface pH remains unchanged until the lime is able to leach through the profile.

There is potential for incorrect decisions to be made without full knowledge of the soil pH to depth. This is particularly true when the crop is susceptible to low pH or aluminium toxicity, as are break crops chickpea, field pea and canola. Poor yields of these rotation crops may be the result of low pH at depth, in spite of good pH at the surface. A surface soil pH_{ca} of 5.5, suitable for pulse crops, may conceal low pH in the subsurface unsuitable for pulse crops.

Current recommendations for both field pea and chickpea may lead to inappropriate sowing. It is recommended that field pea be grown on a wide range of soil types, but

prefer sandy loams or heavier, and pH_{Ca} 5.0 and above. Chickpeas are recommended for soils with a surface pH_{ca} of 5.0 if sub-soil pH rises to above 5.5 within 10 to 15cm of the surface (Loss et al 1998, White et al 2005). The optimum pH range for canola is between pH_{Ca} 5 and 8. Outside of this range yield potential is reduced. Canola suffers significant yield loss below pH_{Ca} 4.6 (Miller et al 2002). If the subsurface has not been tested and growers are using these recommendations it is likely that the resulting break crops are not as high yielding as expected.

The Profitable Break Crop and Pasture Sequence project has collected data that enables numerous hypotheses to be tested. One such hypothesis is that growers are planting break crops onto soils that have surface soil above target at pH_{Ca}5.5 but have subsurface below target pH_{Ca}4.8.

Method

The same 184 paddocks were surveyed over a 4 year period, 2010 to 2013. The survey was conducted within the cropping zone of south western WA (Figure 1).

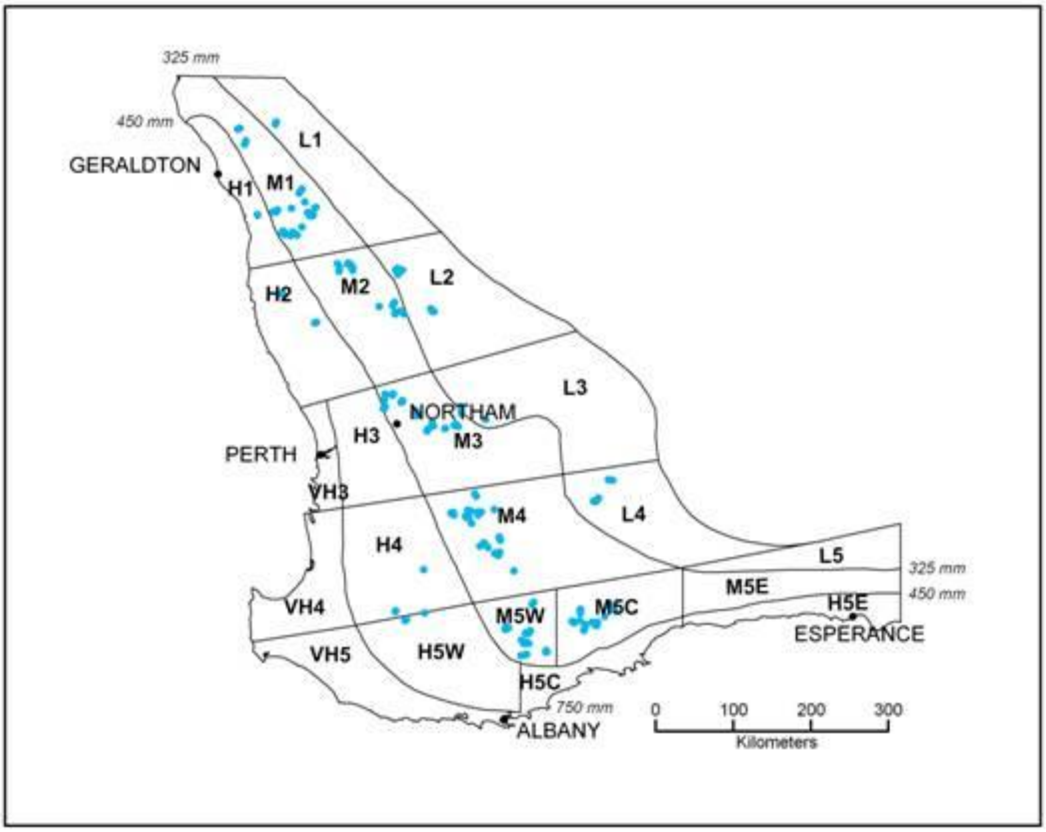

Figure 1 Paddocks locations within the wheatbelt of south west Australia where a four year survey was taken to measure the dynamics of soil pH and crop rotation.

Paddock selection

Paddocks were selected to encompass a range of crop and pasture sequences representative of the wider industry. This was achieved by selecting across a large geographical area encompassing several agro-ecological zones and common soil types. It was anticipated that farmers may view the survey as an opportunity to investigate poor performing paddocks. To ensure this did not bias the sample site selection stipulated ‘productive paddocks’ be nominated. In order to establish a common sequence starting point paddocks were required to be sown to wheat in the first year of monitoring.

Sampling methods

Sampling sites were defined as one hectare areas with average paddock production, as advised by the farmer. The hectare area began at least 30m from the edge of the paddock to avoid edge effects. The hectare area was divided into 4 pseudo replicates to ensure sampling across the entire hectare area. This hectare was revisited each year.

4 soil samples of 0-10cm were taken from 44 points within the hectare using the 10cm pogo sampler. Using a pneumatic soil corer 4 in situ samples, to a depth of 1m where possible, were taken for soil classification and nutrient testing at 10cm intervals. Samples were taken annually prior to sowing. 182 paddocks were sampled in this way during 2013.

Results

The pH results from 2013 testing are shown here.

Table 1 Percentage of paddocks within specific pH_{ca} ranges. Samples taken from 3 depths.

Depth of sample (cm)	pH_{ca} Range			
	< =4.8	4.8 – 5.0	5.0 - 5.5	>=5.5
0-10	19	19	25	37
10-20	39	9	11	41
20-30	24	5	11	60

Of the 182 tested paddocks 67 paddocks have a pH_{ca} of 5.5 or greater in the top 10cm of soil. This number nearly doubles to 127 paddocks at a surface pH_{ca} of 5.0.

In our sample 37 % (Table 1) of all paddocks had satisfactory surface pH_{ca} of 5.5 or above. Of these 40 % (Table 2) had subsurface below target, less than pH_{Ca} 4.8. Hence overall 15% of the 182 paddocks had a satisfactory surface soil and unsatisfactory sub surface.

Table 2 Number, percent and relative percent, of paddocks within specific pH_{ca} ranges at 0-10 and 10-20cm.

Soil depth (cm)	pH_{ca} Range		
0-10	>=5.5	>=5.5	>=5.0
10-20	<=4.8	<=5.0	<=4.8
Number of paddocks	27	31	53
Percentage of all sampled paddocks (182)	15	17	30
Relative Percentage of paddocks with pH >5.5 at 0-10cm	40	46	
Relative Percentage of paddocks with >5.0 at 0-10cm			42

Tallying plantings we found 22% of paddocks sown to canola had adequate surface pH and below target subsurface pH in 2013. In 2012 these soil conditions occurred in 17% of paddocks sown to canola.

Discussion

Since the late nineties there has been a steady decline in the area sown to break crops. In particular chickpea and field pea. During this period disease, weeds and crop architecture were attributed as the cause of this decline in break crop area. Many of these aspects have been overcome through breeding and improved agronomic practices. In spite of this the area sown to break crop has not increased. This research, along with that of Gazey and Andrew, has highlighted the large proportion of paddocks with poor pH levels in the subsurface.

We are not able to partition the influence of low subsurface pH on the break crop decline. It is known that poor soil pH decreases the crops competitive ability over weeds, increases susceptibility to disease, and decreases yield. An improvement of subsurface pH will serve to reverse these and improve yield potential of the break crop, potentially leading to increased area sown in future seasons.

Our concern is these crops could have been misplaced in paddocks with unmeasured subsurface pH below critical levels. Growers sowing break crops into paddocks with a surface pH of 5.5 with sub surface pH less than 4.8 may have unwillingly limited the yield potential.

Our data indicates that 15% of paddocks have surface pH_{Ca} of 5.5 and subsurface pH_{Ca} of less than 4.8. Additionally if growers followed the recommendation and planted pea or chickpea crops into soils with a pH_{Ca} minimum of 5.0 on the surface then 42% of these paddocks would be unsuitable for either chickpea, field pea, legume pasture and, to a lesser extent, barley and canola due to a declining pH in the sub surface.

The hypothesis that break crops were suffering yield loss to low subsurface pH was unable to be tested for chickpea, field pea as the number of Focus Paddocks sown to these crops was not sufficient.

For canola there were enough paddocks to assess the hypothesis. Potentially 1 in 5 canola paddocks will have yield limited by poor subsurface pH in spite of adequate surface pH. The area sown to canola is increasing throughout the state. Therefore the likelihood of canola being sown into poorer soils also increases.

Conclusion

A high proportion of paddocks monitored within the focus paddock project have pH profiles that will limit productivity of break crops.

It is necessary to measure subsurface pH to mitigate the risk of unsuitable land use.

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Key words

Soil acidity, sub surface pH, break crops, yield reduction,

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