Crop nutrition and the response to clay amendment of sands

Richard W. Bell[1], David Hall[2], Stan Sochacki[1] and Steve Davies[3]
[1]School of Veterinary and Life Sciences, Murdoch University, Murdoch WA 6150 R.Bell@murdoch.edu.au, S.Sochacki@murdoch.edu.au
[2]Department of Primary Industries and Regional Development (DPIRD), Esperance West Australia
[3]Department of Primary Industries and Regional Development, Geraldton West Australia

Introduction

Clay amendment of sands using clay-rich subsoils has occurred on over 160,000 ha in southern Australia, primarily to ameliorate water repellence. The implications of clay amendment for crop nutrition have not been examined, nor has there been much consideration given to the variation in subsoil properties and their effects on crop nutrition.

Methodology

Seven existing claying trial sites were assessed:

- Clay rates by incorporation experiment at Dalyup, Esperance. Established by WANTFA in 1999 with ongoing monitoring by DPIRD. Clay was applied at rates of 50, 100, 200 and 300 t/ha.
- Long-term claying site at Esperance Downs Research Station (EDRS- E1). Established in 1998. Clay-rich subsoil was spread at 0, 50, 100 and 150 t/ha and incorporated with a scarifier.
- Clay by depth of incorporation at EDRS (EDRS-W7). In this experiment established by DPIRD in 20112, clay was spread at 175 t/ha and incorporated either shallow (15cm) or deep (35cm) using a rotary spader.
- Clay rate by incorporation method at Bolgart. Established by WANTFA and Wheatbelt NRM in 2010. Clay was applied at three rates 0, 260 and 520 t/ha. Incorporation tools included offset discs, rotary hoe and rotary spader. .
- Clay delving and spading demonstration, Bolgart. Established as a replicated experiment by landholder and WANTFA in 2013. The treatments were: no-till (the current system); spading alone; delving followed by spading.
- Clay rates by incorporation demonstration, Badgingarra Research Station (BRS-1). Established by DPIRD and West Midlands Group in 2009. Clay applied at 5 rates, 0, 50, 100, 360 and 450 t/ha and incorporated with either a rotary spader or shallow working (10 cm) offset discs.
- Water repellent soil amelioration experiment, BRS (BRS-2). Established by DPIRD in 2009, soil amendment treatments were nil amendment, lime at 3 t/ha and clay at 150 t/ha. Across these strips a range of tillage and incorporation treatments were applied, including offset discs, deep ripping and rotary spading.

Results

Bolgart

Clay addition (520 t of subsoil/ha) in the Bolgart experiment increased yields in 2010 and 2011, but not at 260 t/ha or in any of the following four years. Indeed in 2014, there was negative effect of clay addition on yield of lupin. At the Bolgart clay experiment, there was no obvious benefit of clay amendment for K concentrations in sands or in crops. Indeed in 2014, clay treatment appeared to decrease the concentrations of K in lupin leaves. The subsoil added at Bolgart contained 32-63 mg Colwell K/kg and apparently contributed negligible plant available K. Even after 5 years, with annual K fertiliser applications of 13 kg K/ha, there was no indication that clayed soils either contained more plant available K or supplied more to crops.

Badgingarra

In five crops harvested since the BRS-1 experiment (started in 2009, clay addition had no significant effect on crop yields. The subsoil used at BRS-1 was low in K (26-36 mg Colwell K/kg). However, the sand to which clay was added in the clay rates experiment had more than adequate extractable K. Hence, in that experiment there was little influence of clay addition on crop K nutrition.

At BRS-2, clay had positive effects on yield in 2013 and 2014. Even through the same subsoil material was used as the clay rates experiment, the soil test values at the experiment were lower in Colwell P and K than the clay rates experiment. With addition of clay, Colwell K was increased from 39 mg/kg, which is considered deficient for cereal crops, to 52 mg/kg which is adequate. Hence the alleviation of K deficiency may explain the increase in crop yields with clay addition, but soil P levels remained deficient. The increase in yield with clay addition was consistent with an increase in flag leaf K from deficient to adequate concentrations.

Two of the three experimental sites resulted in significant yield increases as a result of clay addition. When averaged across all years, the addition of clay resulted in yield increases of 50% (Dalyup- 15 years), 42% (EDRS-E1 4 years), and 0% (EDRS-W7 5+ years) when compared to the control treatments. In many seasons, emergence was not affected by clay addition yet grain yield increases still occurred and may be attributed to increased nutrient levels and nutrient retention (CEC) as well as improved water retention found in clay amended soils (Hall *et al.* 2010). The site (EDRS-W7) that did not show any grain yield increase to the addition of clay had 3.6% clay without amendment, was not highly water repellent (MED 1.6) and had soil K levels exceeding 130 mg/kg.

Clay amended soils had increased N levels in the soil at the long term Dalyup trial site and in plant tissue analysis at EDRS (E1) trial in 2014. Nitrogen levels at the other sites were unaffected by clay addition.

Soil P levels were increased as a result of clay addition at both long-term trial sites at Dalyup and EDRS (W7). The higher PRI/PBI values found associated with subsoil clays also indicates that P is more likely to be adsorbed and may even be less available as a result of clay amendment. The consequence of this for crop nutrition will depend on whether soil P levels are above, near or below the critical Colwell P values.

At the Dalyup site, the addition of subsoil at rates of 200 and 300 t/ha resulted in soil K levels exceeding the minimum threshold (40 mg/kg). K levels in the clays used at the Dalyup and EDRS (E1) ranged from 350 to 1000 mg/kg.

The effect of clay amendment on S nutrition was not conclusive. It is likely that low inherent levels, leaching and sorption by added clay determine plant access to S.

Conclusions

Based on 7 field sites where sands were clay amended, there appears to be a positive effect of K in subsoils on crop yield if the topsoil has low initial Colwell K, but not if the initial topsoil has adequate K. On soils that already have above 60 mg Colwell K/kg, there were no responses to clay addition.

To maximise the returns on investment, soil testing of the subsoil and the topsoil to be treated is highly advisable before undertaking claying. The key subsoil tests are clay%, EC, Colwell K, PBI/PRI and boron. Subsoil testing can lead to more profitable decisions on which subsoils to select for treatment, and the fields to treat or not treat. In addition, better fertiliser decisions can be made for clay-amended sands, in particular for K nutrition.

Key words: Clay, Colwell K, subsoil, topsoil

Acknowledgments

The research undertaken as part of GRDC project UMU00041 was made possible by the contributions of growers through trial cooperation, collaboration with other GRDC projects (DAW00204, DAW00244) and Department of Primary Industry and Regional Development.

References

Hall DJM, Jones HR, Crabtree WL. and Daniels TL (2010) Claying and deep ripping can increase crop yields and profits on water repellent sands with marginal fertility in southern Western Australia. *Soil Research* 48,178-187.