A field scale survey of soil-crop relationships on a water repellent sandy gravel soil

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Purpose: To quantify the main factors limiting grain yield in a water-repellent sandy gravel soil.

Location: Graham and Helen Lethlean

Soil Type: Sandy gravel

Soil Test Results:

0 to 10 cm	Lowest	Average	Highest
Organic carbon (%)	0.7	1.3	2.2
Soil pH ($CaCl_2$)	4.9	5.5	6.3
Colwell Phosphorus (mg/kg)	5.0	13	33
Colwell Potassium (mg/kg)	14	19	44
Sulfur (mg/kg)	6	11	16

Rotation: Canola 2014

Growing Season Rainfall (April- October 2015): 340 mm (Badgingarra Research Station)

BACKGROUND SUMMARY

Water repellent gravelly sands may require different management to water repellent sands to improve grain yield. An increase in gravel content can increase soil organic carbon, decrease the amount (kg/ha) of soil phosphorus and potassium and potentially increase leaching of nitrate. The sandy gravels of the Badgingarra area typically have gravelly soils in the higher parts of the landscape and deep sands in the valleys which may have different soil constraints for crop growth. This transect study has been completed to quantify which factors are most important for grain yield in a sandy gravel soil.

TRIAL DESIGN

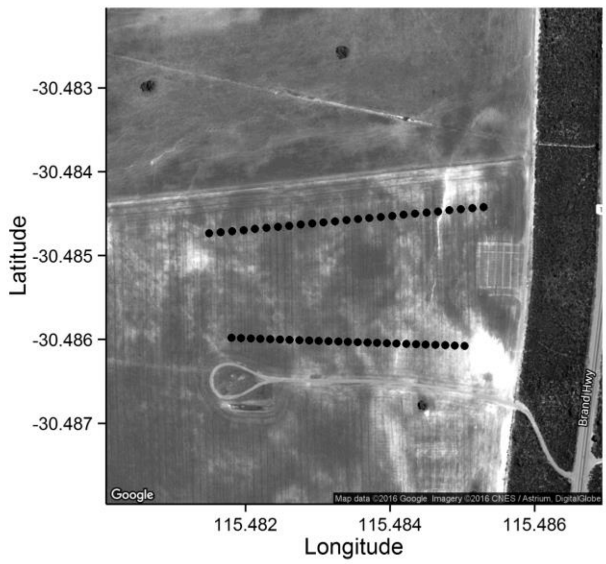
Transect design: 2 transects of 25 points (See trial layout)

Plot size: Paddock sown and managed by farmer.

Machinery use: Paired row RootBoot seeding points

Crop type and varieties used: Mace wheat

TRIAL LAYOUT

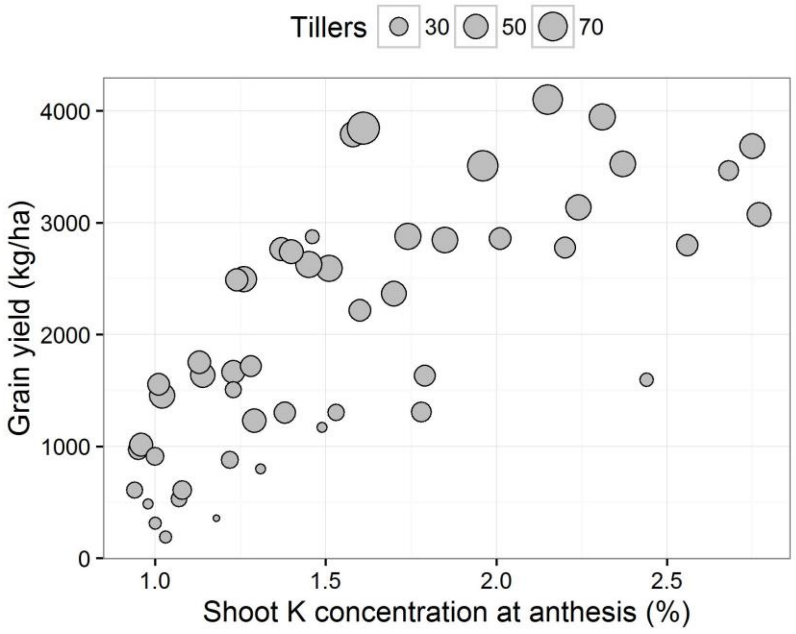


RESULTS

Grain yield ranged from 190 to 4101 kg/ha and the mean for the 50 sample points was 2037 kg ha. Grain yield was most highly correlated with tiller density (r=0.76), followed by shoot biomass at anthesis (r=0.73), shoot K concentration at anthesis (0.72), soil organic carbon 0-10 cm (r=0.71), ammonium nitrogen 0-10 cm (r=0.62) and total gamma counts (r=0.59). Grain yield had a slightly better correlation with gravel content at 10 to 20 cm (r=0.49) compared to gravel content at 0 to 10 cm (r=0.47).

Our results suggest that crop establishment and potassium and nitrogen availability were the most important agronomic factors affecting grain yield. The combined effect of tiller density and shoot potassium concentration on grain yield is shown in Figure 1; sites where shoot K concentration was low and tiller density was low had the lowest grain yield. Low tiller density was also associated with low organic carbon; tiller densities of less than 30 tillers per square meter occurred where organic carbon was less than about 1.3%. Organic carbon affects crop growth via soil nitrogen supply, soil structural stability (furrow infill) and water repellence. At this site, nitrogen supply seems to be the dominant effect; there was no relationship between seedling density and organic carbon and water repellence was lower where soil organic carbon was less than 1.3%. Tiller density was more correlated with organic carbon 0 to 10 cm (r=0.44) and ammonium N 0 to 10 cm (r=0.37) and a poorly correlated with seedling density (r=0.29).

Figure 1: Relationship between grain yield (hand cuts) and shoot K concentration at anthesis. The size of the dot shows the number of tillers per square metre on 24 July

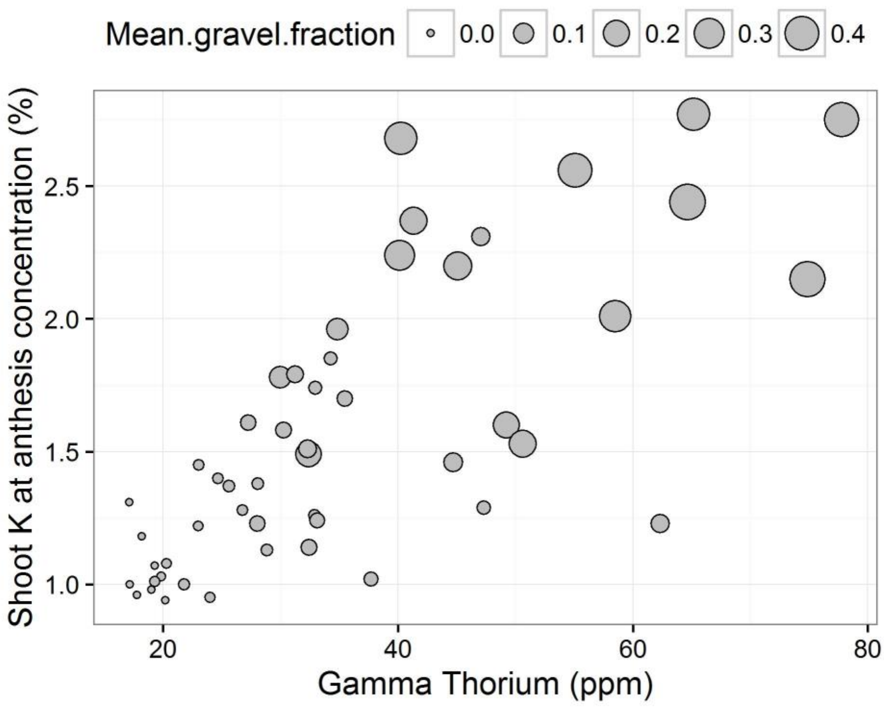


DISCUSSION

Crop establishment and nutrient supply had a greater effect on crop growth than soil water repellence at this site. Interestingly, grain yield showed a weak, slightly positive relationship with our measurements of water repellence e.g. grain yield was highest at points that had higher levels of water repellence (data not shown here). The positive relationship between soil water repellence reflects the role of soil water repellent organic matter and soil nitrogen supply. Our results suggest nitrogen supply was a major limitation to growth therefore it is reasonable that higher grain yields occurred where soil organic carbon (soil nitrogen supply) was high. Water repellence may have had a minor effect because it was not severe at this site; the MED values ranged from 0.1 (Low water repellence, King 1981) to 2.1 (Moderate water repellence) and the average was 1.0 (Moderate water repellence). However, the samples for MED measurement were taken in winter when the expression of soil water repellence is lowest.

Gamma thorium provided a reasonable prediction of shoot K concentration and gravel content and provides a feasible method for delineating K management zones on sandy gravels in the Badgingarra area. Figure 2 shows that high shoot K concentration is associated with gravel content and vice versa. The critical shoot K concentration for wheat at anthesis is 1.5%; based on the data shown in Figure 2 the areas where gamma Thorium is less than 40 ppm would be responsive to potassium fertilizer application.

Figure 2: Relationship between shoot K concentration at anthesis and gamma thorium. The size of the dot shows the mean gravel fraction by weight for the 0 to 20 cm soil depth



The gravel measurements separated into 2 clusters; non-gravelly soil where the fraction of gravel was less than 15% by weight and gravel soil where the fraction was greater than 15%. The mean Colwell K 0 to 10 cm was 17 mg kg which is well below the critical range of 51 to 57 for high yield potential on deep grey sands. Based on current prices and a wheat yield potential of 2t/ha, the DAFWA K calculator shows profit would be maximized with 40 kg K/ha applied. However, the efficacy of topdressed K on this sand may be low. The mean Colwell K for the gravel soil was 24 mg / kg which is also well below critical levels but shoot K concentration was adequate. This suggests that the crop is accessing K from the subsoil and that tissue testing may be an important component of assessing nutrient supply from different parts of the sandy gravel landscape.

ACKNOWLEDGEMENTS

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