INTERACTIONS BETWEEN MANAGEMENT PRACTICES AND SOIL BIOTA IN NORTHERN FARMING SYSTEMS: IMPLICATIONS FOR PRODUCTIVITY

Mike Bell
Plant Science/Delivery, QDPI&F, Kingaroy, QLD

Nikki Seymour
Plant Science/Delivery, QDPI&F, Toowoomba QLD

Graham Stirling
Biological Crop Protection, Indooroopilly QLD

Lukas van Zwiet
NSW Department of Primary Industries, Wollongbar, NSW

Take home message

Soil biota hold the key to sustainable crop production via impacts on processes like suppression of disease outbreaks and the cycling of essential nutrients. Management decisions have major impacts on soil biota, and a key to long-term sustainability is understanding the trade-offs associated with these decisions. Evidence gathered in this project suggests there is significant room to improve soil health in soils throughout the region, but one of the key limitations is the amount, frequency and type of carbon inputs. This paper summarises data quantifying the impacts of everyday management decisions on soil biota in the broadacre rainfed cropping systems in northern NSW and southern Qld, and provides evidence of tentative links between soil biota and crop performance.

Key Words

soil biota, soil health, crop yields, management, organic matter.

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Key findings from recent soil biology research

Efficient use of scarce water resources is an essential component of profitable grains cropping systems, especially in the northern grains region. The predominance of cropping on heavy clay soils with high water storage

capacities (150-250mm) has led to the development of cropping systems that rely heavily on water stored in the profiles during pre-cropping fallows to sustain the crop during dry periods. Widespread adoption of reduced till/direct drill management practices has greatly enhanced the productivity of this system by increasing the fallowing efficiency (% incident rainfall stored in the soil profile) through increased infiltration and reduced soil evaporation. At the same time, a combination of commodity prices that have favoured cropping over grazing, combined with the long (unproductive) fallow periods needed to rebuild soil moisture reserves after pasture leys, have meant that cropping is the primary land use in most cropped areas. Perhaps just as importantly, a lack of broadly adapted, profitable non-grain crop rotation options has meant that this cropped land is largely sown to summer and winter cereals, with summer sorghum assuming an increasingly dominant position in the crop rotation.

This combination of circumstances has had significant impacts on the soil biological community in cropping soils in the region. Key findings from the recently completed soil biology initiative in the north have been that –

- There is evidence of widespread cereal-specific biotic constraints in soils from across the region. This is in addition to known major pathogens like lesion nematodes (*Pratylenchus* sp.) and Crown rot (*Fusarium pseudograminearum*), and is perhaps not surprising given the dominance of cereal grains in the rotation. A key finding from the project is that *Pythium* spp may be problematic for sorghum in particular.

- Biological activity in cropped soils across the region is low and largely concentrated at or near the soil surface, especially under DD. This biological activity clearly decreases with increasing length of fallow and falling residue inputs, with commonly less than half the biological activity after a 15-18 month long fallow than a 6 month short fallow.

- Nematode assemblages suggest that the biological community in surface soils, especially under DD, is fungal dominant, although confirmation by other measures is still pending. This fungal dominance appears to decrease further down the profile.

- The widespread use of artificial fertilisers (especially N and P) seems to have had a minimal impact on the size and activity of the microbial community, probably as result of balancing any short term negative impacts of the fertilisers themselves with increased crop growth and residue input. The only components of the community shown to be negatively impacted were some omnivorous nematode species with relatively long life cycles, but the implications of these changes are unknown.

- There is evidence of significant biological suppression of *Pratylenchus* spp. in some cropped soils and not others, although the mechanism is not well understood. Suppression is clearly enhanced in soils under pasture and decreased in some crop situations – especially after long bare fallows.

- There are clear indications of confounding of soil biota and moisture availability impacts on crop productivity. Management strategies that seek to minimise cropping risk by maximising profile moisture storage (eg. long fallows) or controlling the rate of exploitation of stored soil water (eg. wide row spacings, skip row planting) have clearly detrimental impacts on soil biota. Conversely, management strategies that enhance soil biological activity at the expense of some stored soil water (eg. short duration millet crops grown as green manures or for grain during a long bare fallow) have been shown to increase subsequent wheat yields by up to 25% through enhanced water use efficiency. This is despite maintaining populations of key pathogens like lesion nematodes, and suggests beneficial impacts of improved background biology on crop growth and pathogen multiplication. There is a clear need to explore the interactions between moisture availability and biological activity on crop yields in these environments.

Implications for future farming systems

The clear message coming from this work is that despite changes to the tillage system and retention of residues, there is a clear need to increase soil C inputs (especially below ground plant roots) if soil biological status is to improve. An increase adoption of pasture leys/mixed cropping would have a positive impact, although there are clear practical limits to where this can occur successfully. Alternative strategies such as short term green manure cropping during fallows and use of organic wastes like feedlot manure offer some promise, while the development of broadly adapted non-grain rotation crops would have a significant impact on the type of C input as well as pathogen dynamics. The data on suppression of lesion nematode populations suggest that achieving better background soil biology could have a major impact on yield losses from known pathogens, while the improved water use efficiency in wheat after green manure millet suggests that improved soil biology offers the potential to improve water use efficiency in the farming system.

Contact details:

Bjelke Petersen Research Station, PO Box 23,Kingaroy 4610.
Tel: (07) 41600730 Fax: (07) 41623238
e-mail: mike.bell@dpi.qld.gov.au