FINAL REPORT

GRDC
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DAS00111

DNA Tests for nematode community analysis

PROJECT DETAILS

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PROJECT TITLE:	DNA TESTS FOR NEMATODE COMMUNITY ANALYSIS
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Summary

Free living nematodes (FLN) can be used to measure the status of biological soil health to help growers monitor impacts of soil management practices. FLN communities were characterised in soils across cereal regions in a range of soil types and seasons. Statistical analysis identified five key management practices associated with changes in FLN communities. Twenty FLN taxa were identified as good indicators of those overall changes. Fifteen DNA tests, covering the key FLN taxa, were developed to allow routine FLN quantification. A method is being developed to report DNA test results to be delivered as part of the PreDicta B soil testing service to provide information on biological soil health.

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Conclusions

FLN tests could be used by growers and agronomists to look at how a management change in a paddock changes its biological soil health. Alternatively, these tests could be used to benchmark a farm or paddock against the baseline for their region. As part of the PreDicta B suite, FLN tests will assist growers to think about biological soil health. An issue with using pathogen diagnostic tests is that growers lose sight of the fact that many beneficial organisms also occur in soil. The advantage of tests that measure pathogens and beneficial organisms is that they encourage growers to think holistically about their soil biological community, which might lead them to consider adopting practices that will improve the health of their soils.

Recommendations

FLN tests are currently offered through the SA Research and Development Institute (SARDI) Root Disease Testing service as 'tests under evaluation' for research use. Researchers and grower groups can use these tests to further validate the tests and to refine the biological soil health ratings based on them. For example, the tests could be utilised for research projects to monitor the effects of chemical (herbicide and pesticide) applications and their non-target impacts, and the effects of chemical and fertiliser application methods (banding, liquid, granular) on nematode communities. The high throughput ability of this technology enables studies that monitor seasonal and spatial variations within nematode communities, something that has previously been unable to be performed.

The ability of quantitative polymerase chain reaction (qPCR) tests to distinguish between management and environmental changes could be improved: 1) by developing tests for the six remaining FLN taxa identified as indicators and 2) by designing individual tests for *Aporcellaimus*, *Discolaimidae*, *Dorylaimellus*, *Dorylaimus*, *Eudorylaimus* and *Mesodorylaimus*, all identified as indicator taxa but currently not distinguished within the single DNA assay available for the *Dorylamida* order.

Outcomes

Tests for analysis of FLN communities available to growers and agronomists in the cropping industry and linked to National Soil Quality Monitoring Framework. The success of the project will be measured by the integration of FLN community analysis into the soil quality monitoring system and the uptake of this system nationally by growers.

Economic
The ability to monitor biological soil health will allow growers to gain knowledge on the health of their soils and to monitor soil health status with changing management practices. The ability to monitor and change practices to improve biological soil health will produce more sustainable and thus more productive soils. Higher productivity of crops will ultimately equal an economic benefit to growers and the industry. In addition, 'healthier' soils could lead to reduced nutrient and chemical applications, lowering input costs at the farm level.

Environmental
The monitoring of soil health will enable growers to maintain more balanced soil food webs and to suppress parasitic pathogens that cause damage to cereal crops. Well balanced soil food webs will promote better nutrient turnover and transfer and thus decrease the rates of applied fertilisers.

Social
This project developed new scientific capacity in nematology by training a skilled nematologist and developed a capability for farming systems groups to monitor changes in nematode communities in their soils.

Achievements/Benefits

Results on how farming managements impact FLN communities and soil health in different regions were presented during a GRDC Soil Biology Initiative (SBI) Theme I workshop in October 2014 and key messages to be communicated to growers have been developed. The project team also attended an SBI-wide workshop (February 2015) to refine key extension messages and communicate plans to further develop the FLN DNA tests to measure and report soil biological health. Data collated at these workshops contributed to the Soil Biology in Australian Grain Production Technical Report.

Knowledge exchange activities with growers and agronomists were carried out to assess the value and interpretation of the FLN DNA test results in monitoring cereal soil biological health. A number of grower-friendly articles outlining the key results and extension messages have been released to highlight these new tests and the importance of monitoring and improving soil biology. Following the Soil Biology Symposium in May 2014, a GRDC media release was issued. Articles were published in GRDC Ground Cover, Adviser Newsletters and Driving Agronomy podcasts. Another GRDC media release issued in October 2014 was published in Ground Cover and several regional newspapers and resulted in an interview on ABC Country Hour.

A summary of the key results was presented at grower field days on Eyre Peninsula and in the Mallee in South Australia (SA) and at a Victoria (VIC) Mallee GRDC grower update. Feedback was sought from attendees on the predicted uptake and usefulness of FLN tests in their farming decisions. In addition, a questionnaire was sent to the PreDicta B advisory group (DAS00137) of 12 leading agronomists representing major cereal regions to seek feedback on the value of test information, presentation format and potential uptake by growers in their regions. These agronomists passed this information on to their networks of growers. The agronomist and grower feedback recommended that soil health ratings be reported using a traffic light system, not FLN numbers. This would be similar to the disease and yield loss risk categories reported for soil borne pathogens. Feedback indicated the tests would not be useful without recommendations on management changes required to improve soil biology. Respondents indicated that low test uptake would result unless there were clear yield benefits associated with the changes made to improve soil health, as evidenced in case studies or demonstration trials in each region. The agronomists suggested that growers already using the PreDicta B crop research disease tests panel would be most likely to add the additional soil health tests, but only if the additional cost was small.

A concept for simplified reporting of FLN DNA test results has been developed in response to this feedback. The reporting method, developed in consultation with statisticians, will incorporate the nematode DNA test results and environmental and management data to provide an overall soil biology rating. Management practices to improve the biology would be recommended based on the status of the nematode community.

Soil type and rainfall have been shown to be key drivers influencing nematode communities in the existing dataset, so the biological health ratings will need to be reported at a regional level. Further data collection and analysis are required to determine whether or not reporting will need to be at the lower level of soil type. There are generally 4-6 key 'clusters' of FLN within a region, with the clusters based on management practices. Those clusters can be assigned preliminary soil biology ratings based on their community structures. Within each region, one cluster will be defined as the baseline for that region. The remaining clusters generally either have better or poorer 'soil biological health' than the baseline cluster. A modelling approach is proposed that compares an individual soil's biology against the baseline biology for that region. Knowing where

the nematode community in a particular soil sits within the range of possible communities, in terms of soil health, would enable recommendations to be made on management practices that could be implemented to improve the biology.

To achieve this requires an expanded dataset for each region. This will be achieved by utilising the new GRDC national paddock survey (NPS) project (BWD00025), in which soil from two paddock zones in 250 paddocks over four seasons will be collected in the northern, southern and western cropping regions. Soil water and chemical analysis, crop data including yield and disease data will be utilised to identify the key nematode community structures in each region. Once the communities in each region have been identified, this knowledge can be used with the paddock management history data to develop a model to predict the probability of specific management practices changing community structures to impact either positively or negatively on biological soil health. This will allow a biological health rating to be accompanied by associated management recommendations on how to improve biological soil health in that specific soil type. The NPS project is valuable because it will enable monitoring of the same paddocks (same soil types and average rainfalls) for multiple seasons; providing data of the type needed to analyse the probability of specific management combinations impacting on FLN communities. The model to predict the probable impact of specific management practices on nematode communities will be developed in collaboration with a statistician or programmer with data mining and predictive modelling expertise. FLN community analysis of the 500 samples collected in 2015 has been completed and further soil, disease and management data are awaited to allow further analysis.