WEST MIDLANDS GROUP
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# Diagnostic strips, trials and tribulations

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## Key messages

Direct diagnosis of soil nutrient and compaction problems did not catch the imagination of growers in the WMG.

Despite the resultant lack of participation in the diagnostic projects. Considerable value was gained from opportunistic sampling and diagnostics associated with observed growth variations in paddocks from crops across windrows and from better growth patches.

## Aims

- To motivate growers to carry out direct problem diagnostics in their crops using:
    - nutrient and deep cultivation strips in crops, to compare with standard management;
    - follow-up work to find out why they have observable crop growth variations in a paddock and answer the "Why is it so?" questions.
- To develop a protocol for setting up strip tests and interpretation procedures for growers with different levels of commitment and time.

## Background

Two of the most common questions asked by growers are "Is this paddock performing up to potential, and if not, why not?"

These projects aimed to address these questions by persuading interested growers to apply test strips of various management practices (windrows, fertilisers, lime, wetting agents, cultivation) across their paddocks and soil types. The presence or absence of visual responses to these strips should stimulate further plant, tissue and soil sampling for analyses and the total results would be interpreted by experts. The project would also encourage the opportunistic use of observed better growth patches (such as windrows, old ash heaps and tree clearing) in paddocks to investigate why they are there and whether they can give insights into why the rest of the crop is performing at a lower level.

This paper reports the results of two small projects funded by COGGO and GRDC/RCSN, which looked at some of the things growers can do to see if their crops have constraints to growth, how to work out what some of those constraints might be and where they occur in a paddock and around the farm.

## Methods

A draft protocol on strip testing was sent out to 13 growers who had indicated they might become involved in the COGGO funded diagnostic nutrient strip project. Because farmers are a diverse group of individuals with a very wide range of motivations and desires to commit resources to investigations, the protocol was delivered at a series of levels of entry. The grower can choose the detail and level he/she is comfortable with. From simple to more complex, these levels and actions within each level were:

Level 1. – Simply question and follow up observed paddock differences

1. Look for growth differences in your sown crops (and pastures). If they are observable then the good is at least 15% better than the poor.
2. Find explanations for the differences (If linear and parallel to the workings, they may well be management related). Windrows, chaff trails and heaps, old root ash heaps, ripped lines, dead animals, fertilising and seeding mistakes can all give insights into possible crop growth constraints in your paddock. Are they soil type effects or related to old fence lines?
3. Compare and contrast growth stage/age, seeding depth, establishment density, colour etc. What is the nature of the observed growth difference (height, colour, tillers)?
4. Observe and note/map response differences along the strip.
5. If you cannot explain differences ask for help from an expert in this project (bbowden@agric.wa.gov.au) or from your agronomist contacts.
6. Take paired samples (equal length of row or equal plant number) across the boundary of good and poor growth and submit for the standard plant analyses.
7. Interpret the paired analyses as shown below or better; seek help from a trained agronomist. Use expertise from this project for free interpretations.

Level 2. – Leave a strip

1. When cropping a paddock leave and mark a run/round where you leave the fertiliser off.
2. If you are carrying out new management (e.g. deep cultivation, use of a new product, liming, composting, gypsum, biochar, bio solids, red mud, wetting agents) for the first time then leave and mark a strip where you do not use the new method.
3. Carry out the observational steps as for level 1 above.

Level 3. – Create a strip

1. Create windrows (when harvesting or with a rake when in a stubble phase) with 5 to 10 times the stubble load on the windrow (e.g. 10 metre cut onto a 1-2 metre windrow).

2. Ramp up the fertiliser rate to as high as possible for one round or run.

3. It is best to have a nil fertiliser control alongside a high fertiliser strip so do one round or run without fertiliser and double (or triple or maximise the rate) for the next round.
4. Simulate a windrow by finding the fertiliser with the highest levels and with as many nutrients as possible (e.g. Summit spud, CSBP potato manure E, WMF complete) and applying this in a run or round at as high a rate as possible.

Level 4. – Pseudo (un-replicated) tests or demonstrations of several treatments. Possible layouts are:-

1. Treatment 1 (T1), control strip (C),T2, C, T3, C, T4 C or more efficiently for space, C,T1, T2, C, T3, T4, C, where each strip/treatment has a boundary for paired sampling comparisons with an untreated control or perhaps a paddock management area
2. Tartan cross plotter where you run a broad treatment comparison in one direction, cross it with another treatment comparison and then for subsequent treatments you centre your new run on the boundary for the other runs. This results in a factorial combination of treatments and is ideal for multi-nutrient comparisons top-dressed on to pasture. A bit more thought is required for using this method for cropping. You can get replication by repeating this arrangement but would need a biometrician to help with the statistical evaluation of such a trial.

Level 5. – Replicated, farmer trials

1. A DAFWA “Test as You Grow” hand book and kit was developed to help with this. Here you run experimental treatments in strips as you sow (parallel to workings), with crossovers into the next run to get replication.
2. Best of all for trial work is replicated treatment plots run at right angles to the normal workings (across the main management variations in the paddock.

The WMG also received GRDC/RCSN funds for a diagnostic deep cultivation strip project.

On 11 co-operating farms, a total of 21 strips, (2.4 metres wide) were ripped on Wednesday 28 and Thursday 29 April 2015, using DAFWA’s experimental ripper towed by a Fastrac tractor provided by AFGRI Moora. The 16 strips which were cropped in 2015 were inspected during the year to see if there were observable responses and if so, paired on and off strip, plant samples were taken to determine the relative nutritional status.

**Results and Discussion**

None of the 13 growers who had agreed to do nutritional strip work (entry levels 2 and 3) and were given a draft protocol prior to seeding, put out strips of any sort. This was a disappointment to us. One grower reported that his seeder had run out of fertiliser leaving an obvious strip which was tissue sampled and which could be seen in subsequent satellite imagery.

In lieu of nil or extra fertiliser strips, I reverted to entry level 1 and carried out a telephone survey to see if any growers had seen any obvious variable growth patterns in sown crops (including windrow effects). This and my own fence hopping, resulted in about 10 sites where paired sampling and diagnostic analyses could be carried out.

At most sites, K deficiency was diagnosed. At several **windrow** sites, the effects were complicated by establishment effects. There was better established crop density on the windrows than off with better growth resulting. The windrow had apparently acted as a mulch with poorer and shallower and in some cases, later, establishment in the inter windrow zone where soils were drier. The table below uses a few examples to illustrate some points of interpretation.

**Some example diagnostic windrow, strip and patch, paired sampling results - 2015 season**

| farmer | site | on/off | mgm/plant | N% | P% | K% | Cu ppm | Zn ppm | Mn ppm |
|---|---|---|---|---|---|---|---|---|---|
| 3 | west | on wr | 521 | 5.5 | 0.41 | 6.2 | 8.9 | 39 | 24 |
| 3 | | off wr | 295 | 5.8 | 0.50 | 3.7 | 10.6 | 52 | 80 |
| | | off/on | 0.57 | 1.05 | 1.22 | **0.60** | 1.19 | 1.33 | 3.33 |
| 4 | north | on wr | 515 | 4.4 | 0.50 | 4.0 | 7.5 | 31 | 37 |
| 4 | | off wr | 139 | 5.0 | 0.47 | 2.2 | 8.2 | 33 | 42 |
| | | off/on | 0.27 | 1.14 | 0.94 | **0.54** | 1.09 | 1.06 | 1.14 |
| 4 | south | on wr | 1744 | 2.3 | 0.27 | 2.8 | 3.7 | 18 | 42 |
| 4 | | off wr | 1500 | 2.8 | 0.24 | 1.4 | 2.8 | 15 | 28 |
| | | off/on | 0.86 | 1.22 | 0.89 | **0.48** | **0.76** | 0.83 | **0.67** |
| 5 | | on wr | 2400 | 2.4 | 0.22 | 3.3 | 4.8 | 26 | 90 |
| 5 | | off wr | 457 | 3.0 | 0.28 | 3.6 | 7.9 | 34 | 137 |
| | | off/on | 0.19 | 1.23 | 1.27 | 1.11 | 1.65 | 1.31 | 1.52 |
| 6 | | on wr | 12400 | 1.1 | 0.15 | 1.7 | 1.6 | 11 | 27 |
| 6 | | off wr | 4880 | 1.2 | 0.18 | 1.8 | 1.4 | 13 | 19 |
| | | off/on | 0.39 | 1.02 | 1.20 | 1.06 | 0.90 | 1.17 | **0.70** |
| 10 | | on patch | 9610 | 1.1 | 0.13 | 1.4 | 1.8 | 9 | 25 |
| 10 | | off patch | 6667 | 0.9 | 0.22 | 0.7 | 2.8 | 14 | 43 |
| | | off/on | 0.69 | **0.77** | 1.69 | **0.52** | 1.55 | 1.52 | 1.72 |
| | | | | | | | | | |
| farmer | | **soil tests** | pH | OC% | P mg/kg | K mg/kg | Cu* | Zn* | Mn* |
| 10 | | on patch | 5.4 | 1.83 | 6 | 39 | 0.66 | 1.6 | 3.4 |
| 10 | | off patch | 5.4 | 1.14 | 5 | <15 | 0.53 | 1.2 | 2.4 |
| | * DTPA extractable mg/kg | | | | | | | | |

Points to note from the table above:-

- The biomass levels vary markedly due to differences in the sampling and seeding times. Also whole top nutrient levels usually trend downwards with time so the important issue is the relative value of the paired samples
- The off/on ratio is a good indicator of which nutrients are deficient when it goes below about 0.8 (bold and boxed cells in the table). Usually you will see that the ratio goes above unity for the other nutrients if there is one dominant limiting nutrient because the reduced growth on the bulk (off) areas has less demand for those nutrients which then are in luxury supply as seen for farmers 3, 4 and 6.For farmer 4 south, several nutrient levels are much lower off the windrow. This often means that there is a soil based constraint to root growth (acidity. Herbicide residues, root disease) which has an effect on the uptake. However this site gave twice the yield of the north site on a sandier soil so the constraints could not have been too bad in this dry season. The northern windrow analysis showed unambiguous K deficiency. Yield component analyses on these two farmer 4 sites (see accompanying paper) showed the value of potassium ("the poor man's irrigation") in improving harvest index and reducing screenings.

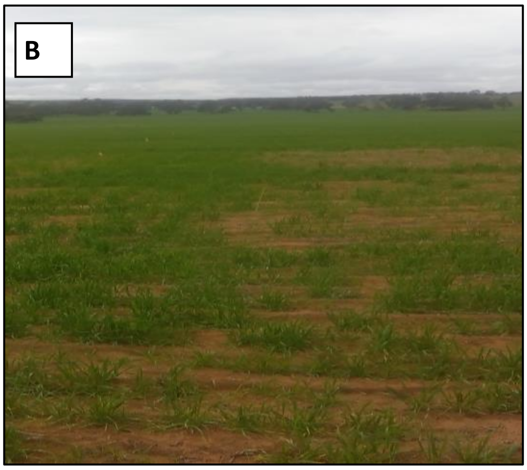
- The farmer 6 results were from a two year old windrow on a gravelly fine textured soil, showed obvious Mn deficiency. Fine textured gravelly soils which carry powder barked wandoo, are known for having Mn deficiency in cereals particularly in dry years.
- The results for farmer 5 are very interesting. This was where the seeder ran out of fertiliser for a distance of 2-300 metres in the crop with a marked effect on crop biomass. This effect was visible in a late spring satellite image of the crop where the low biomass, nil fertiliser strip had delayed maturity and was greener than the bulk crop. Surprisingly, no nutrient showed up as deficient through the ratios. A twist to be played with by greater minds than mine!

**Patches** of better growth in crops are common and worth following up. Better growth in single plants (1 in 50 to 1 in 200) often symptomizes traffic pans in the subsoil because only the roots of plants which find old root channels through the pan can keep up with leaching nitrogen early in the season. Larger patches of better growth or lengths of row with poorer or later establishment can symptomize non wetting soils where water penetration is patchy. Sometimes there are larger patches, several metres across and these often symptomize ash heaps or overturned trees where subsoil has come to the surface in the clearing process. Paired plant sampling on and off such patches together with simple development scores and seeding depth measures all help with paddock diagnoses.

One such example (farmer 10 above) had circular patches a metre or so in diameter on the upslope cropping areas Such patches were not obvious in the crop on finer texture surface soils down slope where the bulk crop was similar to the good growth patches up the slope. Seeding depth on and off the patches was the same as was the development at the time of sampling (ear peep), but off the patches the crop looked severely droughted with emerging heads caught in the dry ligules. There was no evidence that the patches were water run on depressions. Tissue analyses showed severe K deficiency on those upper slopes and no deficiency on the patches. Soil sampling confirmed extremely low soil K status. The patch distribution was similar to that you see for stump burning but the soil pH was the same on and off the patches. The surface soil on the patches had a finer texture than the sandy bulk crop areas, so we hypothesized that the patches occurred where trees had been uprooted during clearing and had brought better K status sub soil to the surface. Another hypothesis is that these were old termite mounds in the original scrub. A yield component analysis should have been, but was not, carried out.

**Image 1: A) Upturned tree? Patch in barley (farmer 10)**

**B) non-wetting patches with a ripping response at left (farmer 4)**




Autumn **ripping** induced better and more uniform establishment of cereals at non-wetting sites. At most sites there was no visible response to ripping early in the season because it was too dry for nitrogen leaching. However in all cases, the ripped strip could be found using the probe so ripping did change the penetration resistance to about 30cm. There were negative effects on canola establishment at one site which resulted in larger individual plants and a taller crop in the spring. Positive effects of ripping were seen mainly where the ripping was across non-wetting soil and even there, the response was more likely due to better penetration of water on a rougher surface than to any soil mixing and dilution of the non-wettability. One of these ripped sites is discussed in more detail in the accompanying paper (Bowden and Wilkins 2016 WMG Research Annual), where yield component analysis (not recommended for growers to do) showed positive effects of ripping on increasing harvest index and reduced screenings. Ripping through a traffic pan often allows deeper rooting and better access to soil water in tough finishes to the season. Unfortunately we did not have the resources or time to carry out the yield component analysis on any of the strips other than the one reported above.

The economic value of diagnostic work of this type is self-evident. By remedying a diagnosed problem hundreds of dollars a hectare can be gained in better yields and by knowing where in a paddock the problems occur, 10s of dollars per hectare can be saved in better distribution of the fertiliser dollar.

The COGGO project funded the purchase of “innovative equipment”. The most valuable item was the hand held green seeker (NDVI) device which allowed non-destructive and objective measurements of relative growth and greenness on and off the strips etc. This device probably has few implications for growers unless they intend to do comparative strip work such as was done in this project. The greatest problem in using it for direct biomass assessment is that it has to be calibrated if /when absolute values are needed. A temperature meter was purchased but was not put too much use because of the dryness of the season and the difficulty of interpretation. Stressed plants have higher leaf temperatures but the dynamics of water use for high and low biomass crops can lead to confusing results. For example, temperature readings on the fertilised and unfertilised crop (farmer 5) at the time of the satellite imagery would have shown that the poorer crop was less stressed.

The GRDC project provided funds for a cheap ($500) and expensive ($7,000) penetrometer. The cheap version was more than adequate for this diagnostic work. The expensive version is better suited to detailed trial work.

**Acknowledgments**
Thanks go to the COGGO and GRDC for funding this work and the many farmers who let us put out ripping strips and allowed us to sample their windrows and patches in crops.

**Paper reviewed by**: Steve Davies, DAFWA