

## **Designing a simple on-farm phosphorous (P) rate trial in winter cereals.**

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### **Background**

High phosphorous (P) fertiliser prices are placing pressure on farmers to closely review their P fertiliser application rates. Considerable detailed research has been done by NSW DPI and CWFS on P fertiliser rates in wheat, in particular calibrating soil tests such as the Colwell test to crop responses in Central West NSW. This research has shown that soil P levels and yield potentials are the key criteria by which P fertiliser rates are best calculated. Publications such as the NSW DPI Agfact “Phosphorous nutrition of winter crops” (available on the internet [www.dpi.nsw.gov.au](http://www.dpi.nsw.gov.au)) are a good start to begin to understand the subject

On-farm broad scale trials are a useful way of checking if your P fertiliser rates are adequate in your cropping system. They can also be used to evaluate alternative P fertilisers. The advent of Precision Agriculture (PA) utilising GPS technology such as guidance and yield mapping is very useful for conducting these types of broad scale on farm trials.

However, PA is not essential and the trial can still be done using weigh bins at harvest. This publication sets out to describe some of the key principles needed to conduct simple on-farm P trials that are free of bias. CWFS also has available a sister publication for suggestions on how to evaluate biological P fertilisers in on-farm trials.

### **The placebo effect**

The ‘placebo effect’ is an important factor that needs to be taken into account when conducting any trial. Human nature leads people to bias their judgement towards the treatments that they want to work or they have a greater emotional attachment too.

The classic example of the placebo effect is in a trial evaluating a new head ache tablet. Some people will feel better by taking a tablet whether or not it contains any medical ingredients. It is a challenge to remain impartial when conducting trials especially when evaluating rates, products or methods you prefer or favour before you have even trialled them. Scientists try to do this by making “blind” assessments of the different treatments without knowing what the treatments are when they do the assessments. The treatment locations are revealed after the assessments so that any chance of a placebo link is removed. Conducting on-farm trials is very open to placebo effects. The important thing is to be aware of it and try to minimise its effects where possible.

### **Methods for investigating P fertiliser rates**

The steps outlined below describe the basic procedure for conducting a simple on-farm P rate trial.

#### **Step 1. Site selection**

Select a site in the paddock that you want to do the trial that is free of confounding effects from headlands, old fence lines, sheep camps, old lime/fertiliser dumps etc.

## Step 2. Determine a recommended ('best bet') P rate

Determine a recommended P rate for the trial site through the use of soils tests and target yields. This is the 'best bet' rate given the available information to hand. The key aim of the trial will be to assess how close this rate matches to the crop requirements without exceeding it. See the NSW DPI Phosphorous Agfact for information of how to do this (available on the internet [www.dpi.nsw.gov.au](http://www.dpi.nsw.gov.au)).

## Step 3. Trial treatments

The example below provides P rate calculations in a trial that consists of 4 P treatments (ie. 4 different rates of P). A nil treatment is always required to help provide an indication of the P responsiveness of the site. The idea is then to have P rates above and below to the recommended rate to help check that the recommended rate is neither too much or too little.

The example below is based on an initial Colwell P level of 30 mg/kg and target wheat yield of 3 t/ha. The Colwell P level, target yield and recommended P rate in this trial are an example only. You need to determine these for your own site.

### Example calculations

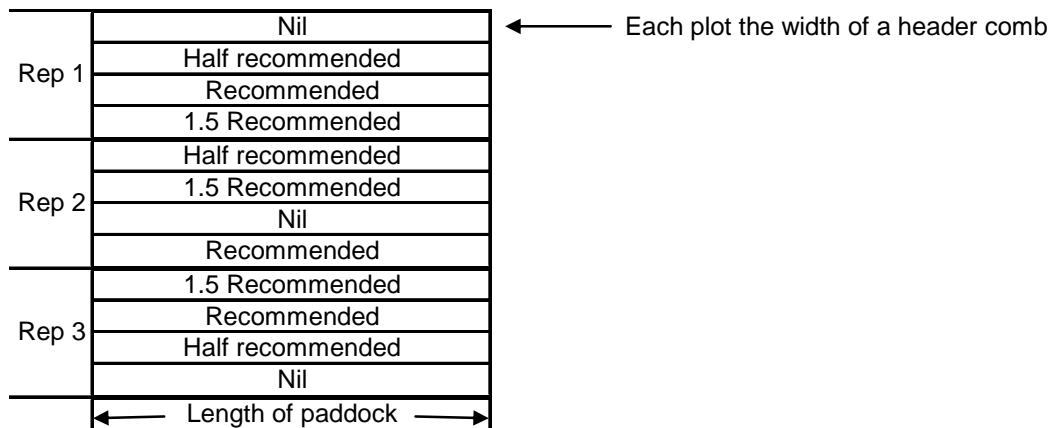
Soil Colwell P level =	30mg/kg
Crop and target yield =	Wheat @3t/ha
Fertiliser =	MAP (10N 22P)
Recommended fertiliser rate =	12kg P/ha or 55kg MAP/ha

Treatment name	Comments	Phosphorous rate kg P/ha	MAP rate kg MAP/ha
Nil	Nil P	0	0
Half recommended	0.5 (ie half) X recommended P rate	6	27
Recommended	Recommended P rate	12	55
1.5 Recommended	1.5 X recommended rate	18	82

## Step 3. Trial design

The treatments are best replicated several times in case unforeseen and confounding issues arise during the trial that favour one treatment over the other. Variation in soil type and topography (affecting soil moisture due to effects on runoff/infiltration) are common factors that give rise to variability. For example, unwittingly locating a treatment in an area with a more favourable soil type and / or in a low lying area that concentrates runoff, could significantly bias trial results!

To avoid any bias the treatments should be reordered or randomised in each replicate (e.g. draw them from a hat to get a random order). An example trial design is provided below where the treatments have been replicated 3 times. At least 2 replicates are required and preferably 3 or 4. GPS guidance equipment makes sowing of these types of trial much easier.



#### Step 4. Eliminating other variables

In the trial above you are trying to identify the effect of different P fertiliser rates. Other variables such as variety, sowing date, sowing rate, sowing method, herbicides etc need to remain the same for the comparison of P fertiliser rates to be valid. Therefore within the trial only the P fertiliser rate is varied with no other changes to the sowing set up.

In the example shown in step 2, the use of MAP (or any other fertiliser with a N content) will result in variable rates of N also being applied. This may confound the trial results if the crop responds to the extra N applied in the higher starter fertiliser rates. The use of triple super (0N, 18P) will overcome this problem and as such is the desired product when doing P fertiliser rate trials. Lower analysis N fertilisers such as MAP (10N 22P) are preferable over DAP (18%N, 20%P), as the lower N content of MAP reduces the risk of bias. The problems of differing N rates between treatments when using a starter fertiliser that contains N can be corrected by applying N to the other treatments at a rate such that all the treatments have the same total N rate, although the practicalities of doing this in large scale on farm trials is questionable.

However, in the real world of on farm trials, practical compromises have to be made, and having confounding N rates in a P rate trial is an issue that maybe beyond control and just needs to be considered when interpreting the results.

Fertiliser is hard to come by this year so seek advice in adapting the trial design to suit the fertiliser type(s) that you can access!

#### Step 5. Monitoring and harvesting

Monitoring of plant growth (e.g. tillering) maybe useful when trying to account for any P responses. P tissue tests may also be of some benefit.

Crop imaging derived from either satellite or airborne remote sensing is another option for checking the progress of a trial mid season. These images provide a visual clue to response differences between treatments. For greater accuracy you need to 'ground truth' these images by conducting on ground measurements (ie. look at the images for 'good' and 'poor' areas of crop growth and check this corresponds with what the crop looks like in the paddock!).

GPS yield mapping is the ideal way to interpret yield results. However, the calibration of the header needs careful checking. Weigh bins are a more traditional way of measuring the yield of each plot.

## **Interpreting the results**

### Data Analysis

Averaging is a very simple tool for looking at trial results from multiple replicates. However, averaging doesn't take into account variability. Scientists use statistical procedures which indicate how reliable each of the plots fit with their sister replicates and over all treatment trend. This type of analysis produces a minimum confidence level (least significant difference or LSD) by which treatments must differ for the results to be considered statistically significant. Such statistical analysis is possible of large scale farm trials, but needs to be done with the help of a trained agronomist and statistician. A simple approach to assessing the variability between replicates is scatter graphing in Excel. Trials that show large amounts of variation between replicates should be treated with caution. NSW DPI and CWFS can provide support in analysing techniques of on farm trials.

### Interpretation

Good trial design will make trial interpretation easier. An important point to remember is that the results will apply in hind site to that location in that year, and cautious thought is needed before applying the results to a wider range of situations and seasonal conditions. In particular soil P levels, sowing date and yield potential are known to have large impacts on P response. Lower P rates will be favoured on soils with high soil P, in years when early sowing occurs and when yield potentials are Low. Trials conducted over several years are needed to help build confidence in the results and even then the results need to be compared and matched with the other research information available.

One of the key concepts when interpreting fertiliser trial results is to look at the yield curve. The curve is generated by graphing P fertiliser rate vs yield. The aim of such an analysis is to identify the fertiliser rate which gives 90% of the relative yield. The idea is that this level of P helps to ensure yield is close to maximum, but that fertiliser is not being wasted due to no additional response.

An important process in scientific research is peer review. This allows other scientists to check and critique the results and interpretation before publication. Such a long winded process is not needed for on farm trials. However, the principle of getting a second opinion on the trial results and your interpretation from an agronomist who is independent of the products being evaluated is just as valid.