

Two SALTs - Simulation Assisted Learning Tools for N fertiliser rate calculation in the northern grains region

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Abstract

Farmers in all regions of Australia endure widely varying rainfall conditions whilst needing to make critical management decisions prior to every cropping season. All input options come with a range of potential outcomes and interact with other inputs. Calculation of a nitrogen fertiliser rate is an important decision in terms of potential yield and because it is often a large input cost. Advisors could benefit from quantitative tools to assist farmers to make such decisions. Two of these tools are described in this paper.

WhopperCropper is a data-base supported software tool that provides 'what-if' scenarios comparing different input levels and interactions with other inputs. Climate files spanning 100 years are used to predict the year-to-year variability in outcomes. Production effects of different levels of inputs can be compared side-by-side. One potential scenario comparison is the response to rates of N fertiliser. In addition, an N Fertiliser Calculator has been derived from WhopperCropper to provide a tool specifically for the calculation of the optimum N fertiliser rate for a season type. It uses a unique process based on optimising gross margin for season types, to produce the output. The aim of these tools is to provide agronomists and farmers with the capability to use crop modelling and climate forecasting to better manage cropping risks.

Key Words

Decision support, nitrogen fertiliser, calculator, WhopperCropper

Introduction

Learning Tool 1 - WhopperCropper

WhopperCropper currently has a database of four million pre-run simulations representing a factorial combination of relevant input options and SOI phases (Table 1) (Cox et al. 2004; Nelson et al. 2002). The desired options are easily selected from menus and no data entry is required, except for the costs and grain prices in the gross margin section. The intended use of WhopperCropper was a 'discussion-support tool' (Nelson 2002) that enabled users to gain insights from complex crop and climate simulation without requiring complex inputs or field data. This contrasts with Yield Prophet ? which benefits from precise inputs of soil and agronomic data because its aim is to provide forecasts and recommendations that are up-dated as the season progresses (Hochman et al. 2009). Yield Prophet is well suited to southern regions where decisions regarding in-crop N fertiliser applications are often required.

Table 1. Input and resource level components in WhopperCropper.

Factor	Typical input options
Soil water-holding capacity	80, 100, 120, 150, 190mm
Soil water at sowing	0.33, 0.67 and 1.0 of full profile

Crop type (dryland only)	Wheat, chickpea, sorghum, maize, cotton, mungbean, sunflower, canola
Time of planting	Fortnightly or monthly planting dates
Soil N content	3 to 4 N contents
N fertiliser rates	5 to 6 N rates
Crop maturity type	Early, medium, late
Sowing densities	2 to 3 plants populations
SOI phase effect on likely yields	All five phases of SOI + All years

Sites were chosen to represent climate areas of approximately 50 to 100km radius. Currently there are 53 districts included for across Australian states of Queensland, New South Wales, Victoria, South and Western Australia. A large number of output variables (Table 2) are able to be graphed with any of seven graph types.

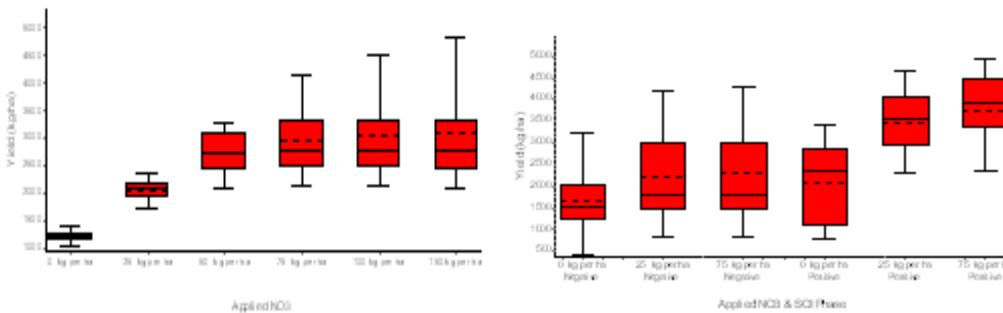
Using WhopperCropper to gain insights regarding yield response to N fertiliser: Figure 1 contains two examples of 'boxplots' demonstrating i) the yield response to applied N fertiliser (Figure 1 a) and ii) the interaction between the SOI phase and N rate response (Figure 1 b). These graphs are set up with single options for parameters other than the nitrogen rate and SOI phase. The other parameters can be quickly changed to create new 'what-if' scenarios on demand. These graphs give the user insights into the potential range of outcomes that can occur in response to N fertiliser in a variable environment and in response to SOI phase at planting. The purpose is not to predict an outcome but rather provide input to discussion regarding attitude to risk of N application. The graphs can be easily converted to gross margins or a different graph type.

Table 2. Output options in WhopperCropper.

Output Name

Season (summer crops)
 Sow Year
 Sow Day
 Days to flowering
 Day of flowering
 Biomass at flowering
 LAI at flowering
 Rainfall plant to flower
 Rainfall plant to harvest
 Days to maturity
 Dry grain yield
 Wet grain yield
 Biomass at harvest
 Final leaf number
 Fraction of soil water at harvest
 Minimum in-crop temperature
 Total soil nitrate at harvest
 Total available water at harvest
 Soil nitrate at sowing (soil only)
 Soil water at sowing
 Water use to flowering
 Water use to harvest
 Water use efficiency (flowering)
 Water use efficiency (harvest)
 Av MAX temp first month post sowing
 Av MIN temp first month post sowing

Av MAX temp 2 weeks pre & post flowering
 Av MIN temp 2 weeks pre & post flowering
 Av MAX temp 1 month pre maturity
 Av MIN temp 1 month pre maturity
 Grain protein
 Day of Start Tillering
 Days to Start Tillering
 Day of End Tillering
 Days to End Tillering
 Day of Start Heading
 Days to Start Heading
 Biomass at end of tillering
 Days MIN temp <2 °C 7 d pre, 14 d post flow
 Number of bolls maturity
 Number of squares at maturity
 Seed content/boll at maturity
 Day degrees to first boll
 Day degrees to flowering
 Day degrees to squaring
 Day of 500 day degrees
 Day of 750 day degrees
 Day of 1200 day degrees
 Days MIN temp <15 °C (flower to end pod fill)
 Days MIN temp <-5 °C (flower to end pod fill)
 Whole pod yield
 Kernel yield
 Aflatoxin %
 Rain end grain fill to harvest



a) b)

Figure 1. Boxplot of a) potential yield response of wheat to applied N fertiliser (100 years of weather data and b) response of wheat yield to N fertiliser under negative and positive SOI phases.

Adoption: WhopperCropper has been distributed to 675 advisors throughout Australia on CD. Internet hosting will facilitate adoption. Enquiries regarding evaluation results and current availability can be made to the authors.

Learning Tool 2 - Nitrogen Fertiliser Rate Calculator

Using this tool an optimum nitrogen fertiliser application rate based on the difference of the demand and supply of nitrogen for cereal crops can be determined. The nitrogen demand is calculated from crop yields simulated using the APSIM crop simulation model made available via the WhopperCropper program (Nelson et al. 2002). Grain yield response to applied N is automatically calculated from the

program. Nitrogen supply is calculated from soil test analysis results in a typical 'nitrogen budgeting' process (Lawrence et al.1996). Because it is a derivative of WhopperCropper, there is minimal data entry and the calculator is contained on a single page. It is well suited to the northern Australian grains region. The (Mallee) Yield and N calculator is more extensive and is targeted at inputs relevant to southern grain regions.

(<http://www.clw.csiro.au/products/ncalc/index.html>).

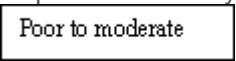
Steps in the calculation process:

Situation setup

'Drop-down' menus are used to define:

- Agronomy
- PAWC, depth of wet soil, soil organic carbon
- N test results – to calculate N supply (calculated on a separate page)
- Fallow rainfall

Displaying potential yield for season types

A 'drop down' menu allows the user to select one of four expected season types. This is effectively setting the farmers 'attitude to risk' for the forthcoming season. 

Each 'season type' is a subset of the full potential response. The graphed line represents yield response to the total soil nitrogen supply for that season type. The response lines represent:

- Poor: 12.5 percentile
- Poor to moderate: 37.5 percentile
- Moderate to good: 62.5 percentile
- Good: 87.5 percentile

Grain price and current costs of elemental nitrogen and total costs of other inputs need to be entered.

Using the Scenario 1 and Scenario 2 slider bars

The process of optimisation uses slider bars which may initially be unfamiliar to some users. However, at two recently-run (May 2010) advisor/grower groups, feedback was positive (Wayne Strong pers.comm.).

One slider bar is used to find the optimum N rate for each of the four season types in succession as separate graphs (two examples shown in Figure 2). The slider is moved until the maximum gross margin appears in the table area. The N rate that corresponds to this value is read from the left-hand-side of the page. The second slider bar can be used to compare the effect of a different N rate on the potential gross margin (Figure 3). The slider bars can be used to simultaneously view:

- Finding an 'optimum' N rate for the chosen or other season types
- Effects of N rate on gross margin for season types different from the one selected
- Effect of N rates on target yields
- Effect of alternative N rates on gross margins
- Total cost of N fertiliser

- Find the maximum N rate that can be applied before negative gross margins appear across the range of season types



Figure 2. Determination of optimum N rate for two different season types a) poor to moderate and b) moderate to good.

The other slider bar can be used to examine the effect of an alternative N rate on potential gross margin in all four season types. For example, the minimum N rate that is the optimum for a less favourable season can be displayed. This is effectively the minimum rate ('fallback value') that would balance crop demand and supply if less than the expected rainfall occurred.



Figure 3. Using the second slider bar to display gross margins outcomes from a different N rate.

Conclusion

These easy-to-use tools are freely available for use by advisors. They will assist advisors and farmers to understand the potential range of yield response to applied N fertiliser given that the forthcoming season is largely unpredictable. The N application rate chosen then becomes a decision made by the farmer based on their attitude to risk.

References

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