Precision Agriculture AUSTRALIA

Precision Ag Trials

TRIAL TYPE: Risk management
Birchip

Although PA tools have been available to Australian grain growers for many years, and the benefits have been well documented, it is estimated that less than 1-% of grain growers utilise PA 'beyond guidance' in any form.

The objective of this GRDC / SPAA funded project is to increase the level of adoption of PA 'beyond guidance' by broadacre farmers. The project specifically aims to increase the level of adoption of variable rate (VR) by growers in the project to 30% by 2013. This goal will be achieved by demonstrating how to use PA tools to growers at a regional level and by increasing the skills of growers and industry in PA to a level where they can then use PA tools in their farming systems to achieve economic, environmental and social benefits.

Trials and demonstrations are conducted on growers' properties and are visited throughout the season using farm walks and workshops to discuss the advantages and disadvantages of PA techniques with the involvement of other regional growers.

This information sheet presents the outcomes of the SPAA trial **3&4** from season 2011.

Aims:

To demonstrate the production risks associated with sowing different length maturity wheat varieties at different times.

Background:

When choosing a variety, it is important not only to know the classification of a variety (hard, APW etc.) and the disease rating (e.g. resistance to stem rust), but also its phenology (growth characteristics), especially the varietal relationship between sowing and flowering date. Severe yield penalties can occur when crops flower and fill grain during periods of high frost risk or during periods of heat shock. The optimum sowing time for a wheat variety is dependent on the rate at which it matures.

The maturity of cereal crops is controlled by their response to average daily temperatures (**thermal time**) but this is moderated by day length (**photoperiod**) and cold requirement (v**ernalisation**). Different wheat and barley varieties have different genetic sensitivity to photoperiod and vernalisation.

All cereal varieties accumulate heat (**thermal time**) to grow. For example, wheat varieties grown in our region develop a new leaf every 100 degree days. A 100 degree day is the average daily temperature over a number of days to add up to 100 degrees.

Photoperiod is the plant's response to day length (hours of daylight). Longer days induce the plant to speed up the rate of change from vegetative to reproductive development (from growing leaves to the development of flowering organs).

Vernalisation occurs when a plant is subjected to cold temperatures for a specific time. When the vernalisation requirement has been reached, the plant speeds up the rate of change from vegetative to reproductive development. True '**winter**' wheat types require a long vernalisation period before the crop develops into its reproductive phase (for example Rosella wheat). Most '**spring**' wheat types have only a little or no requirement for a cold period and will continue to grow and develop throughout the season (for example Catalina wheat).

As the climate is changing to warmer conditions and the atmosphere contains more CO_2 (also called CO_2 fertilisation), crops grow more quickly and mature earlier. It is important to be aware of these effects on crops so that the risk of frost or heat shock reducing crop yield can be better managed. Even though the climate is warming, it is not clear whether the occurrences of frosts are reducing. In fact, there is anecdotal evidence that frost severity and frequency are not changing, which could be because there is reduced moisture in the atmosphere. If this is the case, it will have implications for sowing time and variety choice.

Through the use of PA and VR, growers are able to sow different varieties on more frost prone areas. Without this technology, growers would either need to sow different zones separately, reducing efficiencies, or treat the paddock as a whole, which may see reduce yields and risk in various zones.

To demonstrate the advantages of this strategy, over the past two seasons, BCG and SPAA have undertaken paddock scale trials. Two demonstrations were undertaken to compare two varieties of different maturity at two different sowing times.

About the trial:

Two farmers participated in the sowing time study in the southern Mallee in 2011. David Smith farms 15km west of Birchip; Neil Leuhman farms 30km north of the town. Both farmers sowed single air-seeder width, long demonstration strips (>300m long) with two varieties of different maturity on two sowing dates. The demonstration plots were managed for weeds and diseases in the same manner as for the remainder of the paddock. At each farm, the harvester front was less wide than the sowing strips and the strips were harvested with a yield monitor. Yield for each treatment was recorded.

Two wheat varieties were used at each site: Axe was chosen as the early season wheat variety and Yitpi as the mid- to long-season variety. Table 1 lists the sowing dates and N inputs.

Table 1. Sowing information for the two Time of Sowing by Variety demonstration sites.

Treatments	Smith	Leuhman
Sowing dates	2 May and 2 June	10 May and 27 May
Target plant density (pl/m^2)	130	130

N at sowing (kg N/ha)	5	14
N in crop (kg N/ha)	None	28 (14 August)
Paddock history 2010	Fallow	Wheat

The soil type at Smith's was classified as a Mallee Clay Loam with a moderate level of subsoil limitations (elevated Chloride levels) and at Leuhman's as a Mallee Clay Loam with no subsoil limitations.

Prior to sowing, the sites were soil sampled for soil water and available Nitrogen (nitrate + ammonium) in four soil layers to a depth of 1m. At Smith's the Plant Available Water (PAW) was 132mm and at Leuhman's it was 102mm; Available Nitrogen content at Smith's was 140kg/ha and at Leuhman's it was 156kg/ha. These levels of PAW and available N were regarded as unusually high and were a direct result of the wet summer of 2010/11.

At both sites there were two sowing dates (early at Smith's was on May 2 and Leuhman's 10 May; and late at Smith's was on June 2 and at Leuhman's 27 May).

Seeding equipment:
Smith: Flexicoil seeder, tynes on 18cm spacing with full cut-out points, coil packer
Leuhman: Flexicoil seeder, tynes at 30cm spacing with knife points, press wheels

Yield Prophet® reports were run several times during the season to check crop performance, soil water and available nitrogen status and whether the crop was undergoing water or N stress. Measured yield was compared with simulated yield at maturity.

Assessments:
Soil analysis
Yield Prophet simulations
Grain Yield

Results:
(i) Sowing to booting
The 2011 season was dry, with only approximately 100mm of rain at both sites from April 1 to August 31. The first real opening rain of 14mm fell on May 23. Crop emergence of the early-sown crops was poor and full germination did not occur until after the first rain event. Judging from Yield Prophet reports and from visual observation of the paddock, the crops managed to get their roots into the wet subsoil and grew well over winter without any real stress until September. There was no N stress at either site during this period. The yield estimate at 50% probability soon after sowing for both sites is presented in Table 2.

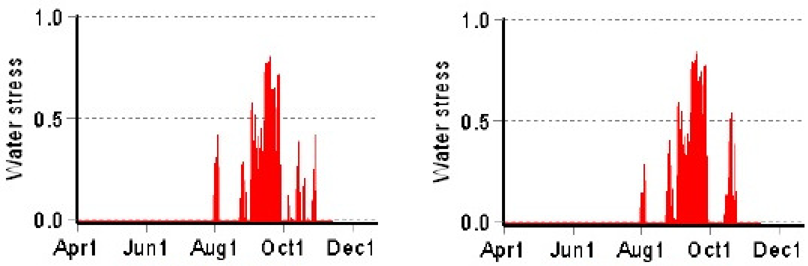
Table 2. Simulated yield at sowing for early sown Yitpi and Axe at both demonstration sites

	Simulated yield estimate - at 50% probability (t/ha)	
	Smith	**Leuhman**

Early Yitpi	4.5	4.0
Early Axe	2.9	3.0

(ii) Water and nitrogen stress immediately pre-flowering to the grain filling stage

At both sites, crops experienced water stress in late August and September (Figure 1, prior to flowering. At the Smith site a small rainfall event (16mm) on September 29 (flowering to early grain filling, depending on time of sowing and variety) reduced the stress for a short period. At Leuhman's a much larger rain (45mm) reduced water stress for a longer period. It is clear that water stress would have been much greater and persistent if it had not rained in late September.

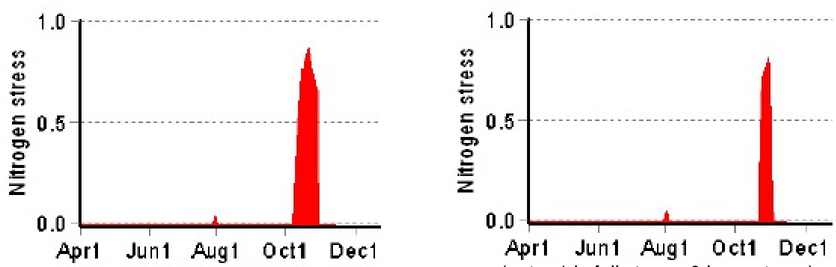


(note: 1 is full stress, 0 is no stress)
Smith

(note: 1 is full stress, 0 is no stress)
Leuhman

Figure 1. Water stress in early sowing Yitpi wheat at Smith and Leuhman.

At both sites, crops experienced nitrogen stress during grain-filling during mid October (Figure 2). Part of the nitrogen stress could be attributed to a lack of moisture which made it difficult for the wheat roots to extract available nitrogen from the soil.



(note: 1 is full stress, 0 is no stress)
Smith

(note: 1 is full stress, 0 is no stress)
Leuhman

Figure 2. Nitrogen stress in early sowing Yitpi wheat at Smith and Leuhman.

It is likely that water stress had a higher impact on crop yield than nitrogen stress.

(iii) Simulated and actual crop yield

The high yield expectation at sowing (50% probability) for Yitpi at both Smith's and Leuhman's did not eventuate because the season turned out to be very dry (Decile 1 and Decile 2 respectively) (Table 3). The simulated yield for Axe was closer to the eventual harvest yield at both sites (Table 3).

Table 3. Simulated yield at sowing, post flowering (both at 50% probability) and actual yield at harvest for both demonstration sites.

	Yield early sown Yitpi (t/ha)		Yield early sown Axe (t/ha)	
	Smith	Leuhman	Smith	Leuhman
Simulated at sowing	4.5	4.0	2.8	3.0
Simulated post flowering	3.8	3.9	2.7	2.9
Actual harvest	3.0	3.4	3.1	3.4

(iv) Frost events during flowering/grain filling in 2011

Temperature was recorded at crop canopy height at both sites with 'Tiny Tag' loggers which recorded temperature every 15 minutes. In the last week of August and first week of September there were numerous moderate (0 to -2 ^{o}C) to severe (< 2 ^{o}C) frosts recorded at both sites (Figures 3 and 4). This period of high frost occurrence coincided with flowering for Axe TOS1 and Yitpi TOS1 (for the latter at Smith's only). Due to the severity of the frosts, it is possible that damage occurred during flowering in the early sown crops. Unfortunately, insufficient crop information was collected (grain number per head and the occurrence of sterile florets) to determine the extent of the damage. The other observation illustrated by the temperature loggers placed at canopy height is the much higher frequency and occurrence of frosts compared with the normal temperature measurements taken at regional Bureau of Meteorology weather stations (taken at 1.5 m above the ground).

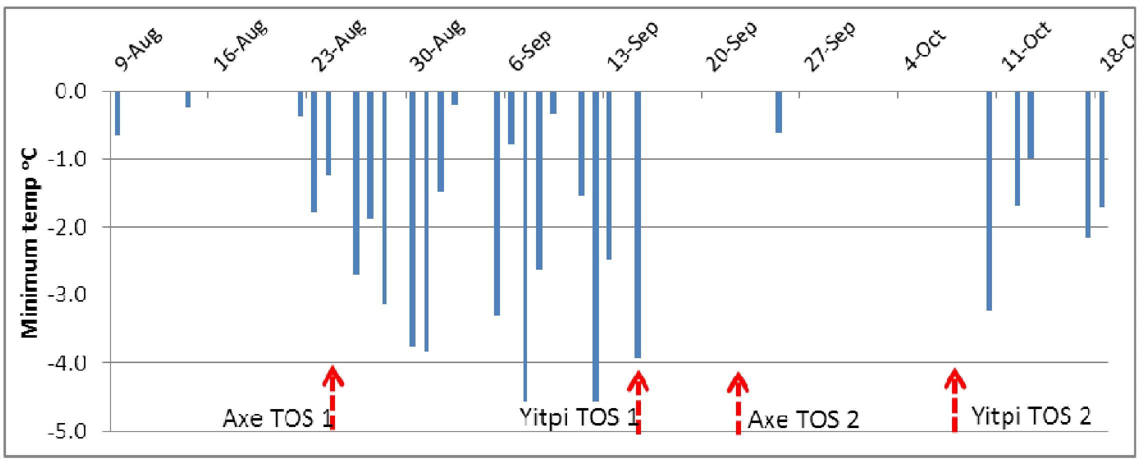


Figure 3. Moderate to severe frosts recorded at Smith's during the 2011 season (the arrows and text indicate the flowering time for the two varieties sown at different times)

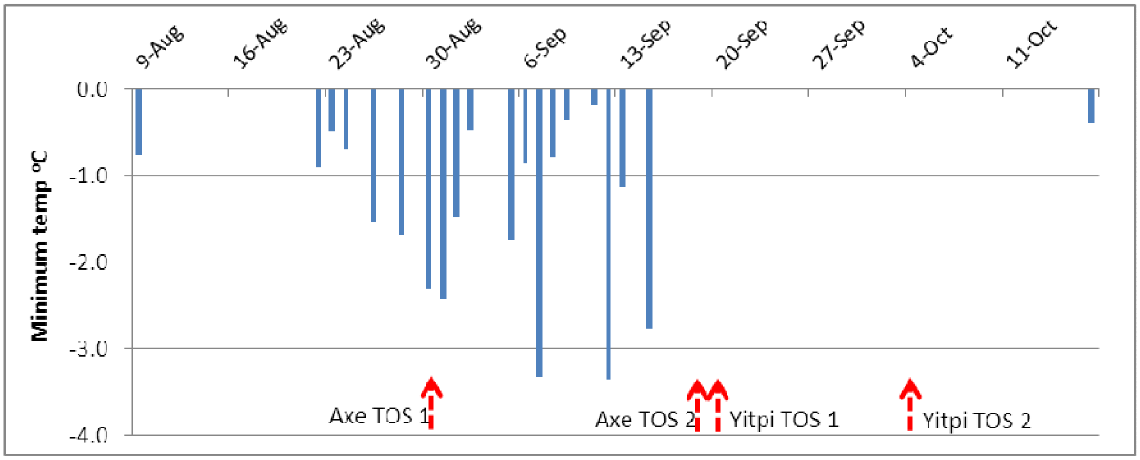
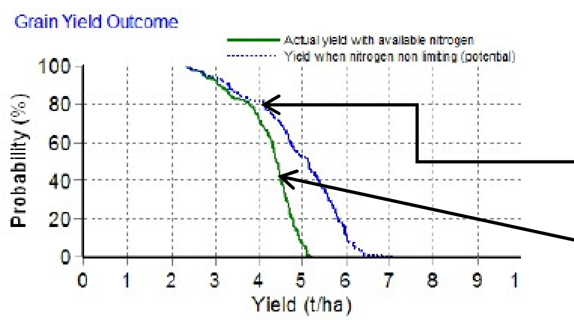


Figure 4. Moderate to severe frosts recorded at Leuhman's during the 2011 season (the arrows and text indicate the flowering time for the two varieties sown at different times)

Interpretation:

At sowing, both demonstration sites were well set up for a high yield potential, with wet soil profiles following the record rainfall over the summer 2010/11. Unfortunately, the growing season (April to October) was very low at both sites (Smith: Decile 1; Leuhman: Decile 2). Actual yield, though less than initial expectations, was still above average.

- Yield Prophet simulated the expected yield outcomes quite well, if at sowing the 90% and 80% (roughly representing the decile rainfall outcomes for Smith and Leuhman respectively) yield probabilities were taken into account (see Figure 5 for an example for Smith's simulated yield at sowing).



Using the Yield probability curve, at sowing, representing the estimated yield with the amount of N in the soil profile.

Yield at 90% probability (roughly representing a decile 1 season)

Yield at 50% probability (roughly representing an 'average' or decile 5 season)

Figure 5. Yield Prophet yield simulation at sowing for Smith's, illustrating the simulated yield at 90% probability and 50% probability.

- the crops at both sites suffered from moisture stress from pre-flowering to early grain filling. This is a critical period during the crop's development because cell division (meiosis) of the flower organs takes place during the two weeks immediately prior to flowering. If crops are in stress during this time, cell division in the forming flowers can be interrupted, resulting in empty flowers and possible serious yield penalties.
- a quite severe frost period occurred during the flowering period for the early sown crops; it is quite possible that damage was caused and that these crops suffered a yield penalty.

More work on the effect of stress conditions in the weeks prior to flowering (including the stresses imposed on crops from lack of water or nitrogen or from the application of fungicides and herbicides) needs to be carried out to develop better management practices for the late application of fertilizer and fungicides/herbicides.

The impact of frost and heat shock during flowering and grain-filling has not been clearly identified. As it is likely that crop flowering dates will change as the temperatures and atmospheric CO_2 levels rise, it is important to measure the extent of possible damage during this critical phase of crop development so that better risk profiles can be developed for sowing opportunities for cereal varieties with different phenology characteristics.

What does this mean for the farmer:

It is essential that farmers understand the phenology of different crop varieties and what determines the difference in flowering dates for the varieties they are planning to sow. Unless these characteristics are known, it is difficult for farmers to develop low risk strategies for sowing different varieties.

The different zones, if management will be different, should be soil tested separately so fertiliser can be allocated to the most responsive zones. Yield Prophet is a proven and useful tool to assist farmers in making decisions on sowing time to reduce the risk of frost and heat shock damage during flowering and grain-filling. Yield Prophet can also assist growers in managing crop nitrogen requirements.

As the climate slowly warms and the atmosphere contains more CO_2 crops will mature more quickly, this has implications on managing the risk of frost and heat shock during flowering and grain filling. Sowing frost prone or high risk soil types with different varieties using VR, may reduce the growers exposure to risk.

By using PA software and VR, two varieties can be placed in different seeder boxes. This practice is best completed with a triple box seeder, where Variety 1 and 2 can be sown from the front 2 boxes, while starter fertiliser (MAP) from the back box. Preparation is important and creating a prescription map prior to sowing will make life dramatically easier.

Who was involved?

David Smith and Neil Luehman – site hosts
Harm van Rees (CropFacts) and De-Anne Ferrier (BCG) – Principal researchers
Harm van Rees (CropFacts) – Trial Coordinator
Simon Craig (Farming Systems Group Contact)

Grower/Regional feedback:

Growers have been interested in this work but have mentioned the complication of balancing management within varieties in a paddock. Most growers have preferred to keep it simple, and having a AH variety in a paddock with a APW variety, makes it very difficult at harvest. The feedback was if the management of the varieties was not an issue (e.g. same classification and disease management) then the practice could easily be adopted.

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For more information

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