# Talwood GRDC Grower Grains Research Update

## Thursday 5th March, 2015

## Talwood Community Centre
## 8:30am registration for a 9am start, finish 3:00pm

| Time | Topic |
|---|---|
| 9:00 AM | Welcome |
| 9:10 AM | **Finding more yield and profit from farming systems** (*Simon Fritsch, AgriPath*) (Page 10)<br>• Attainable yields<br>• Benchmarking yields using local WUE numbers<br>• Economics of profit draggers<br>• The farming system<br>• Better wheat, sorghum and chickpea yields<br>• Profit drivers, economics, management (labour, operations and timeliness) and agronomy. |
| 9:50 AM | **Profit suckers:** Understand salinity, sodicity and deep drainage to balance yield expectations and resources (*Mark Crawford, DNRM*) (Page 21) |
| 10:10 AM | **Managing sodicity and tillage in no-till:** A grower's experience (*Neville Boland*) |
| 10:50 AM | Morning tea |
| 11:20 AM | **Lessons learnt from 29 years of managing herbicide resistance in WA** (*Geoff Fosbery, ConsultAg*) |
| 11:35 AM | **Logistics and strategy behind the use of UAN - the WA experience** (*Geoff Fosbery, ConsultAg*) |
| 12:00 PM | **Local research:** Cereal timing, row spacing, vs. plant stand: N volatilization from urea on grey vertosols. (*Jo Weier & John Sturgess, DAFF Qld*) (Page 27) |
| 12:35 PM | **Fire suppression in headers - reducing and managing risk** (*Speaker TBC*) (Page 33) |
| 12:55 PM | Lunch |
| 1:40 PM | **Nitrogen management in wheat:** (*Richard Daniel, NGA*) (Page 35)<br>• Impact of timing and slow release products on canopy management and yield<br>• Late N for protein - do multiple low rates improve efficacy and economics? |
| 2:10 PM | **Chickpea and mungbeans:** Research on plant population and row spacing in current varieties to maximise yields. (*Bec Raymond, DAFF Qld*) (Page 47) |
| 2:35 PM | **Fababeans in western systems:** Where do they fit and issues to optimise yield. Disease management, varieties, agronomy, insects. (*Greg Rummery, Greg Rummery Consulting*) |
| 3:00 PM | Close |

## Contents



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# Finding more yield and profit from your farming system

*Simon Fritsch, Peter Wylie, Agripath Pty Ltd.*

**Key words**

Attainable yield, water use efficiency, farming systems, profit, farm management

**GRDC code**

APT00001 – Economics of closing the yield gap Northern Grains region

**Take home message**

There is enormous potential to improve farm profits if the gap between average farm yields and attainable grain crop yield, which is between 50 and 100%, can be reduced. This requires finely tuned farming systems and agronomy, but in conjunction with good management of machinery, labour, finance and the timeliness of operations.

The main difference between average and top farmers is the occurrence of problems which affect yield. In practice many crops are affected by several 'profit draggers', like disease, nematodes, weeds, low nitrogen, timeliness or harvest losses, which in combination affect yield by 20-30 % and drag down profit by 50-60%.

To manage well requires attention to all the profit draggers, but this also requires time and effort to be put into crop selection, rotations, crop frequency, risk management and farm cost choices. Teamwork, labour, safety and machinery decisions are also important.

## 1. Attainable yields

Water Use Efficiency benchmarks can be used to derive attainable yield for a location and season. In the higher rainfall areas of northern NSW and southern Queensland, an attainable average yield for wheat on short fallow is in the vicinity of 3.8 t/ha. This is based on average soil moisture of 140mm and 195mm of in-crop rainfall, of which 25 mm remains as harvest soil water. The 3.8 t/ha yield of wheat is produced from 310 mm at a water use efficiency (WUE) of 12.5 kg/ha/mm.

In western NSW and south-west Queensland, attainable yields decline with rainfall and soil water storage capacity. Where there is 150mm of in-crop rainfall, 20 mm of which is left as harvest soil water, and 110mm is stored in the soil during fallow, the attainable yield of short fallow wheat is 2.75 t/ha at a target WUE of 11.5 kg/ha/mm.

Attainable yields for grain sorghum, as shown in Table 1, vary between 2.7 t/ha where water available to the crop is around 245mm and WUE 11kg/ha/mm and 5t/ha where water available is 330 mm and WUE is at 15 kg/ha/mm. In the best of the sorghum growing districts, such as the Central Downs of Queensland and the Liverpool Plains of NSW a target yield for sorghum is 6 t/ha, produce from 375 mm of water at a WUE of 16 kg/ha/mm. Figures are shown for a September plant, but there are various scenarios for sorghum, such as where sorghum is grown on long fallow which can store an extra 50mm of water, and where the crop is planted in December or early January to maximise the chance of in-crop rainfall.

**Table 1.** Attainable yields of wheat and sorghum calculated from WUE and by APSIM

| Wheat<br>May 30 Plant | | Planting soil water | In-crop Jun - mid-Oct | Harvest soil water* | WUE kg/ha/mm | Yield** average | APSIM 150 mm PAWC # | APSIM 180 mm PAWC # |
|---|---|---|---|---|---|---|---|---|
| Northern NSW | | | | | | | | |
| High yield | Gunnedah | 149 | 236 | 31 | 12.5 | 4.43 | 3.94 | 4.41 |
| Medium yield | Moree | 146 | 191 | 21 | 12 | 3.79 | 3.33 | 3.52 |
| South Qld | | | | | | | | |
| High yield | Pittsworth | 162 | 219 | 31 | 12.5 | 4.37 | 3.75 | 4.36 |
| Medium yield | Goondiwindi | 151 | 199 | 24 | 12 | 3.92 | 3.45 | 3.95 |

| Sorghum<br>Sep 30 plant | | Planting soil water | In-crop Oct - mid-Jan | Harvest soil water | WUE kg/ha/mm | Yield average | APSIM 150 mm PAWC | APSIM 180 mm PAWC |
|---|---|---|---|---|---|---|---|---|
| Northern NSW | | | | | | | | |
| High yield | Gunnedah | 136 | 274 | 14 | 13 | 5.14 | 3.65 | 4.29 |
| Medium yield | Moree | 121 | 252 | 22 | 11 | 3.85 | 3.08 | 3.72 |
| South Qld | | | | | | | | |
| High yield | Dalby | 142 | 325 | 40 | 13 | 5.55 | 5.79 | 6.10 |
| Medium yield | Goondiwindi | 126 | 261 | 28 | 11 | 3.94 | 3.61 | 4.06 |

*Average soil water at harvest calculated by APSIM
**Yield calculated from average rainfall data and water use efficiency figures
# Yields modelled using APSIM show attainable yield is higher with increasing soil water capacity

**2. Benchmarking yields using local WUE numbers**

Water Use Efficiency estimates can be used as a benchmark to examine yields in hindsight or to project future yields. A better interpretation of WUE can reduce some of the variability that has limited the value of WUE in the past.

The French and Schultz model has been widely used in southern Australia to benchmark wheat yield for a given water use, with a target of 20 kg/ha/mm, allowing for 110 mm of soil evaporation. Current varieties and farming practices now produce WUE closer to 25 kg/ha/mm (Sadras and McDonald 2011).

Better benchmarks of WUE for the Northern Grains Region require soil stored moisture to be included in calculations, even if only an estimate. The application *CliMate* or the model *How Wet* can be used to estimate soil water. Deducting 110 mm for soil evaporation should be ignored because winter rainfall and soil evaporation is often below 110 mm and the deduction leads to spurious results where WUE is high in a poor yielding year, when in fact it is low due to a low harvest index.

In most years, there is little or no moisture left in the soil at harvest, but when there is heavy spring rainfall, some account can be made of *left-over* water by adjusting the estimate of in-crop rainfall.

This approach, where evaporation is ignored, is supported by Hunt and Kirkegaard (2011) who say; “It is water use efficiency that is important as a benchmark when reviewing management, not transpiration efficiency”. Doherty et al (2010) and Sadras and McDonald (2012) also conclude that the most practical way of estimating WUE is to subtract soil water at maturity from soil water at sowing and add the rainfall that falls in between. This is what is proposed in this paper as the most appropriate way to use WUE in the Northern Region.

***WUE should be more than a single number***

The accuracy of using WUE to estimate yield can be improved by using a range, rather than a single number. WUE improves with yield, as a result of a better harvest index. In extremely low yielding situations, the crop has used a lot of the available water growing to the flowering stage and the WUE can be less than a half of the WUE of a high yielding crop. As yield potential improves there is generally better tiller survival, more heads per hectare, more grains per head and higher grain weights. This all serves to improve the WUE.

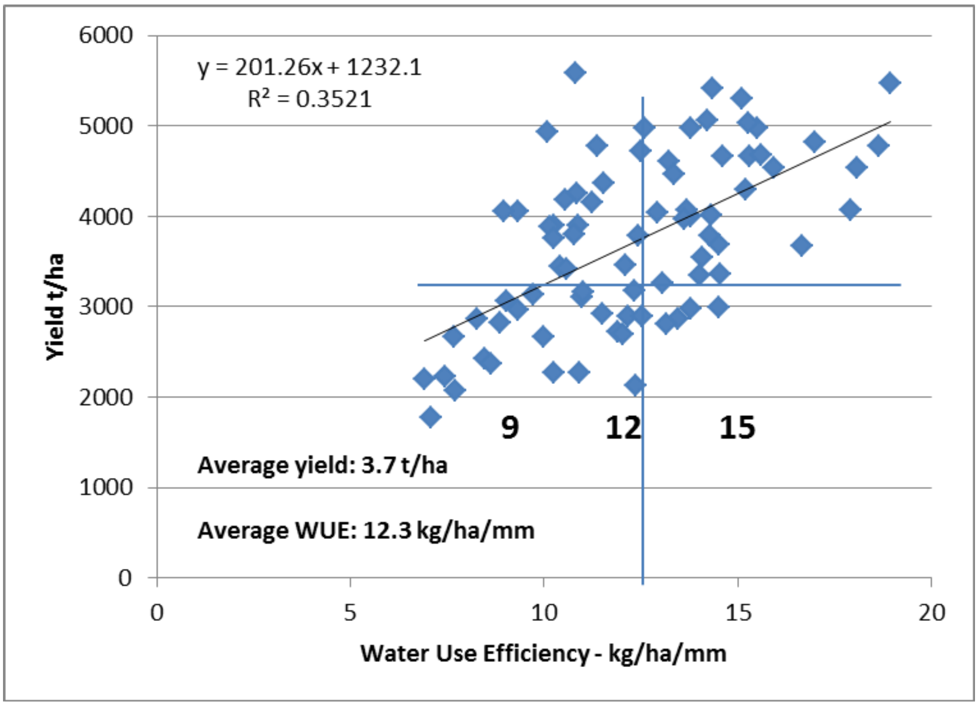


**Figure 1.** Water use efficiency of Wheat; NE NSW and SE Qld (2007-2012)

Data for wheat in NE NSW and SE Queensland, shown in Figure 1, demonstrates that WUE increases from around 9 kg/ha/mm where yields are less than 3 t/ha, to 12 kg/ha/mm for yields between 3 and 4 t/ha and is commonly above 15 where yields exceed 4 t/ha due to a favourable season. This data is derived equally from farm and trial observations and so variation at any yield or WUE level can be the result of seasonal effects or impacts on yield by disease, nitrogen or other factors.

Using several benchmarks for wheat, of 9, 12 and 15 kg/ha/mm, depending upon the yield potential greatly improves the accuracy of WUE compared to the use of one number, such as 12 kg/ha/mm. The other way WUE benchmarks can be adjusted to improve accuracy is to allow for sowing time. If the WUE for wheat planted in mid-May is 15 kg/ha/mm, this will decline by around 5% per week and would be only 12 kg/ha/mm for wheat planted in mid-June.

Chickpea has a good correlation between yield and WUE (as shown in Figure 2). At yields below 1.5 t/ha, WUE is around 5 kg/ha/mm, while above 2.5 t/ha the WUE is usually above 9 kg/ha/mm. Using three numbers for WUE; 5, 7 and 9, depending upon the yield range will improve the use and value of WUE calculations. At very high yield levels, the WUE of chickpea is usually above 11 kg/ha/mm. There is a reduction in WUE for chickpea with delayed planting, similar to wheat.

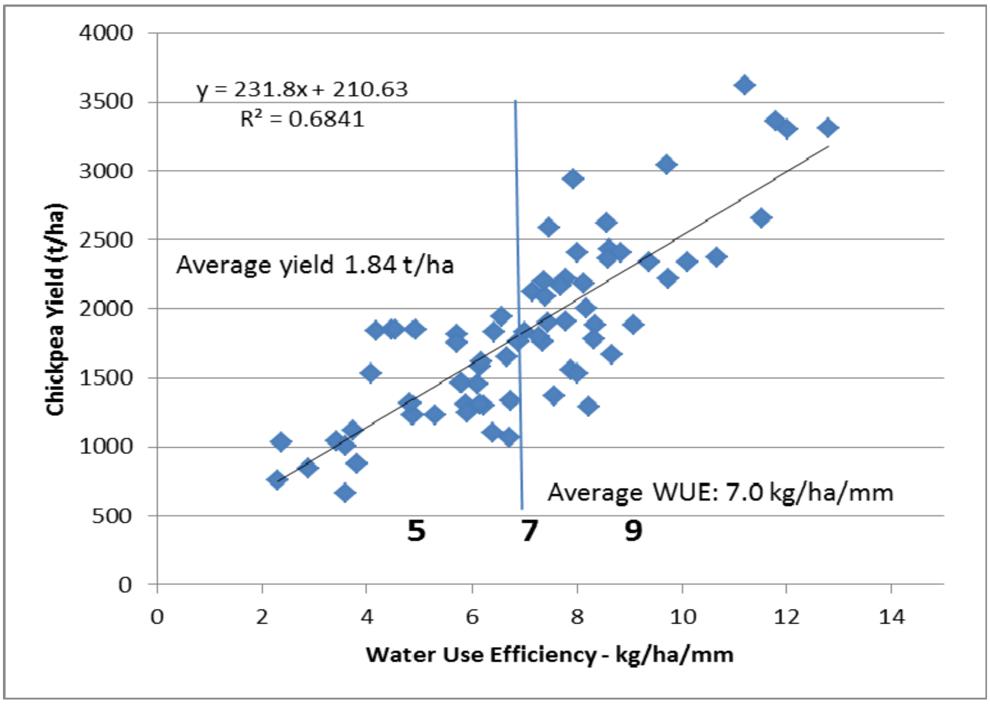


**Figure 2.** Water use efficiency of Chickpea; NE NSW and SE Qld (2007-2012)

Sorghum also shows increasing WUE as yields increase, due to a better harvest index at high yield levels. But WUE is affected also by temperature and humidity as well as yield and harvest index. It is higher in the cooler more humid areas or growing seasons than hotter drier areas or growing seasons, in much the same way as wheat responds to later planting dates, where maturity is shortened and heat impacts more on the developing crop.

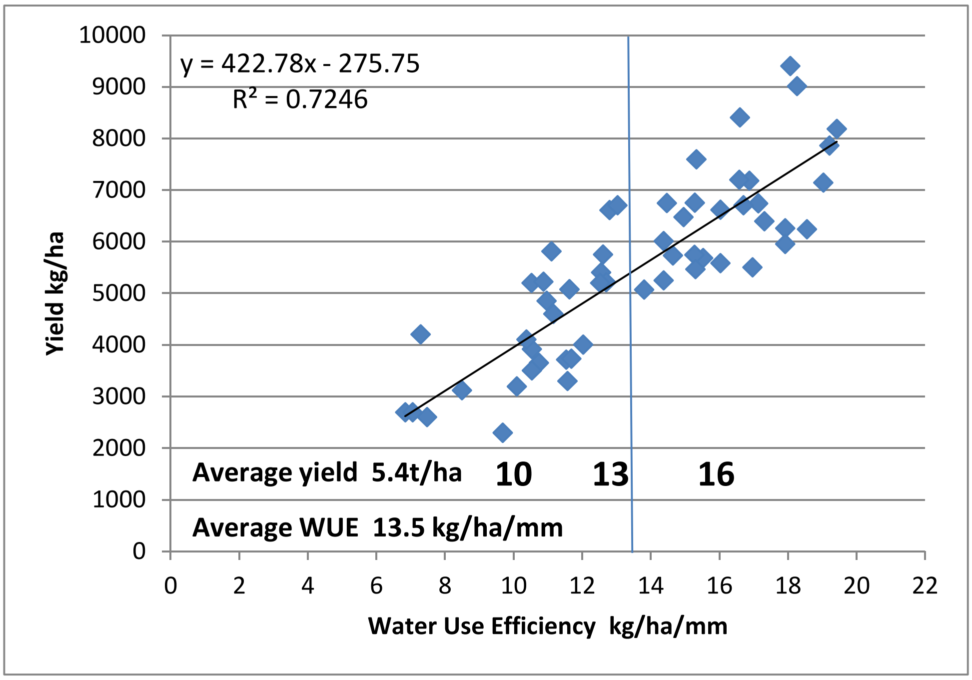


**Figure 3.** Water use efficiency of Sorghum – NE NSW and SE Qld (2005-2012)

The average WUE for sorghum grown on the Darling Downs and Liverpool plains should be in the vicinity of 15 kg/ha/mm. Benchmarks for sorghum are 10kg/ha/mm for yields less than 3.5 t/ha, 13 to 15 for yields from 5 to 6.5 t/ha and 18 kg/ha/mm for yields above 6.5 t/ha. (See Figure 3).

### 3. The economics of profit draggers

Every disease problem, every mistake with seed, planting or variety selection, or not enough spent on inputs such as weedicide and fertiliser, can cost more than 10% in yield. It is common for three or more of these issues to be dragging down crop yields by some 30% and profit by more than 60%

Closing the yield gap is about managing this multitude of factors which drag on yield. The gap between average farm yields and the attainable yields which result from good farming practices and systems is around 50 to 90% in northern NSW and southern Queensland. If this yield gap could be closed, farm profitability would increase enormously, up several times the present levels, as shown by the estimates below where 30% more yield can mean 260 and 300% better grain margins.

**Table 2.** Profit from 30% less yield – Northern NSW

| | Wheat | | Sorghum | |
|---|---|---|---|---|
| | good yield | less 30% | good yield | less 30% |
| Yield (t/ha) | 3.36 | 2.35 | 4.06 | 2.84 |
| Price | 240 | 240 | 210 | 210 |
| Gross $/ha | 807 | 565 | 853 | 597 |
| Fertiliser: | 112 | 86 | 131 | 99 |
| Seed | 30 | 30 | 32 | 30 |
| Fallow sprays | 60 | 48 | 50 | 40 |
| Weeds, Pests | 30 | 15 | 50 | 45 |
| Fuel & Repairs | 45 | 45 | 45 | 45 |
| Harvest costs | 55 | 50 | 60 | 55 |
| Freight & Misc. | 85 | 70 | 96 | 78 |
| Labour | 52 | 52 | 52 | 52 |
| Machinery costs | 66 | 66 | 66 | 66 |
| Total costs | 536 | 463 | 581 | 510 |
| Gross Margin | 271 | 102 | 271 | 87 |
| Gross Margin % | 265% | 38% | 311% | 32% |

Yield targets for Moree. Data from Agripath benchmarking

Good crop yields are a result of good planning and implementation of crop production involving a myriad of details, starting with the crop choice, the rotation program and how moisture is stored and used on the farm.

Combine this with good planting technology and timeliness, and the right details of fertilisers, weeds, pests and other aspects of crop agronomy and there is potential to substantially improve grain yields and profitability.

### 4. The farming system

The farming system needs to be designed to minimise the effects of crown rot in wheat and root lesion nematodes in wheat and grain legumes. Management of weeds, particularly glyphosate resistant summer grass weeds, is another factor driving farmer decisions on rotations. Disease control, diversification and risk management, as well as improved timeliness is often improved with a mix of summer and winter crop and making decisions on crop rotation is quite complex.

Crop yield is highly influenced by fallow rainfall storage and soil moisture at sowing. A high frequency of low yielding crops, with small margins may be less profitable than a well-planned rotation which includes some crops grown on long fallow during the change between summer and winter cropping.

Good farming systems take into account soil health, stubble cover and fallow management to reduce runoff and evaporation, thereby storing as much soil moisture as possible. A small amount of extra soil stored moisture can substantially improve crop profitability as shown in the following example derived from APSIM modelling. At Dalby an extra 27 mm is stored on average in a soil with a plant available water capacity of 180mm, compared to a soil with a PAWC of 150 mm. This extra water produced an extra 579kg/ha of wheat (at a WUE of 21 kg/ha/mm) which would improve profit from $208/ha to $318/ha.

**Table 3.** Effect of soil water capacity on water storage and crop yield

| Soil PAWC mm | Wheat May 30 Plant | Planting soil water | In-crop Jun - mid-Oct | Harvest soil water | WUE kg/ha/mm | Yield average |
|---|---|---|---|---|---|---|
| | | | | | | |
| 150 | Gunnedah | 136 | 236 | 28 | 11.1 | 3814 |
| 180 | Gunnedah | 158 | 236 | 30 | 12.0 | 4351 |
| | Increase | 22 | | | 24.1 | 537 |
| 150 | Dalby | 144 | 188 | 28 | 9.5 | 2885 |
| 180 | Dalby | 171 | 188 | 29 | 10.5 | 3464 |
| | Increase | 27 | | | 21 | 579 |

APSIM modelling by G. Mclean, DAFF Qld. 2014

**5. How do good farmers achieve top yields of wheat, sorghum and chickpea?**

The following suggestions are ways in which good farmers achieve yields which may be high enough to more than double farm profitability.

**5.1 Better wheat and chickpea yields will result from sound rotations to manage disease, nematodes and weeds.**

Good rotations can manage crown rot, and if wheat has to be sown after wheat, it should be planted into the middle of the old wheat rows for up to 9% extra yield (Verrell 2014). New varieties of wheat, such as Suntop, offer potential to suppress nematode populations and avoid heavy losses from these pests, not only in wheat but in subsequent legume crops. Rotation plans which include some fixed cropping plans and long fallows can pave the way for increased use of residual herbicides to help reduce costs and to better manage glyphosate resistance.

**5.2 Manage profit margins with well-planned rotations and decisions based on soil stored moisture**.

Long fallow crop sequences can be more profitable than double crops. Do the sums! A double-crop of chickpea with a yield of 1.2 t/ha followed by wheat yielding 2.7 t/ha might have a combined margin of less than $200/ha. A chickpea crop on a long fallow with a yield of 2.6 t/ha, should have a margin close to $500/ha and could help to double farm profit. Good margins are important and too much opportunity cropping can result in reduced margins over the longer term.

**Table 4.** Margins from a double-crop sequence compared to a long fallow

| | Chickpea double-crop | Wheat after Chickpea | Chickpea on long fallow |
|---|---|---|---|
| Yield (t/ha) | 1.2 | 2.7 | 2.6 |
| Price | 400 | 240 | 400 |
| Gross $/ha | 480 | 648 | 1040 |
| Fertiliser: | 30 | 95 | 30 |
| Seed | 40 | 30 | 40 |
| Fallow sprays | 24 | 48 | 60 |
| Weeds, Pests | 72 | 15 | 80 |
| Fuel & Repairs | 52 | 52 | 60 |
| Harvest costs | 55 | 50 | 55 |
| Freight & Misc. | 53 | 76 | 74 |
| Labour | 45 | 60 | 60 |
| Machinery costs | 55 | 78 | 81 |
| Total costs | 426 | 504 | 540 |
| Gross Margin | 54 | 144 | 500 |

### 5.3 Maximise legume opportunities and yields

Faba beans, chickpea or other legume crops may improve farm profit if profitable in their own right and they provide soil and rotation benefits. If the legume is grown one year in three and provides half the nitrogen requirements of the following cereal crop it will halve nitrogen fertiliser costs.

Good seed and inoculation techniques can pay dividends if yield and nitrogen inputs are enhanced. Investment in water injection for inoculation may be profitable.

### 5.4 Extra soil water storage can double profit.

An extra 20 mm of soil stored water could add 400 kg/ha to yield – enough to double the profit in some situations! Soil moisture storage improves with soil health, which is about building soil organic matter with plenty of earthworms. This can be destroyed by tillage, compaction or low soil cover. Controlled traffic in combination with zero tillage improves infiltration which results in less runoff and more even moisture storage across a paddock. Good soil structure can also reduce waterlogging and its effect on crop yield and nitrogen losses.

### 5.5 More nitrogen for higher yields in better years

Sorghum has the potential in better growing areas to yield more than 8 t/ha in three years out of ten. It will usually not reach these higher yield levels because it runs out of nitrogen. Wheat also can benefit from adjusting fertilizer according to yield potential. Some farmers have developed ways to put more N on at planting time or soon after, while for wheat, urea is reasonably efficient, with around 5% N loss, when broadcast at tillering (Schwenke 2014), to match extra yield potential. Feedlot manure is useful to provide sorghum an extra reserve of nitrogen, some of which is released in a good season.

Seasonal forecasts are not helpful in most years, but when there is a strong signal, such as the 2010-11 La nina, changes should be made to the nitrogen management of sorghum.

**Table 5.** Nitrogen required by sorghum at Goondiwindi for different soil moisture and seasonal outlooks

| Soil water mm | In-crop rainfall SOI <-5* | In-crop rainfall average | In-crop rainfall SOI >+5* | Water use efficiency | Yield estimate t/ha** | Nitrogen required kg/ha |
|---|---|---|---|---|---|---|
| 80 | 185 | | | 10 | 2.65 | 45 |
| 80 | | 203 | | 11 | 3.17 | 54 |
| 80 | | | 221 | 12 | 3.61 | 61 |
| 160 | 185 | | | 13 | 4.5 | 76 |
| 160 | | 203 | | 14 | 5.08 | 86 |
| 160 | | | 221 | 15 | 5.7 | 97 |

**Sorghum is planted on September 30 at Goondiwindi
*Goondiwindi rainfall from Rainman with SOI values for August and September

**5.6 Develop planters to create results and more timely planting opportunities**

Timeliness of planting can often result in more than a 10% improvement in water use efficiency and yield – potentially doubling crop margins. In some years, it may be the difference between a crop and not planting at all. Planters need to be fine-tuned to obtain reliable results from the deep planting of wheat, sorghum and chickpea. The planter is perhaps one of the most important machines on the farm and deserves investment to enable a good planting result with a variety of soil and moisture conditions. A poor strike can easily cost more than 10% in yield.

**5.7 Better chickpea yields**

Chickpea has yielded more than 4 t/ha in favourable situations, where there is a total of 300 mm of available water, but not too much waterlogging or disease. Improving the drainage of paddocks has in some instances helped farmers to double chickpea yields in the wetter seasons.

Planting chickpea two weeks after wheat, in the last half of May, will result in smaller bushes, which can leave more moisture for pod filling. They will flower in late August, when flowers are less likely to be lost by cold weather (if the average daily temp is below 15). Row spacing around 0.5 metres has been demonstrated to improve yields under high yielding conditions (Verrell and Jenkins 2014 and Mckenzie 2014).

**5.8 Good harvest management will boost farm profit**

Harvest time losses can be severe in wet seasons, while chickpea can lose yield through shattering in all years. A loss of 200 kg/ha of chickpea, worth $80/ha, can result from a delayed harvest of chickpea and will pay for investment in storage with in-silo (high flow aeration) drying.

Increased storage is helping farmers to manage losses and in some instances reduce freight and handling costs where direct transport of grain to the end-user is possible.

**5.9 Learn from paddock variability and moisture**

Somewhere on the farm, a high yielding area of crop shows up what is possible. Yield maps, EM surveys, soil moisture and fertility testing and trials measured by yield maps can help farmers understand what produces high yields and the limitations of soils on their farm. Knowledge can lead to managing crops better or to understanding and managing paddock variability.

Moisture is the key driver of grain yields and measuring soil water holding capacity and soil water at planting time can improve decision making on farms. EM measurements allows rapid assessment of soil moisture and soil moisture variability across paddocks (Foley 2013).

**5.10 Precise operations, on-time**

Good results from spraying, planting and harvest and good timeliness of these operations are a result of good equipment, planning, training and staff management. Failure in any of these aspects, such as equipment breakdowns not being managed or staff doing a less than satisfactory job, will result in poor yields and profits. Capital investment in plant needs to be managed to ensure timeliness and to reduce breakdowns and the cost of repairs.

There are many aspects of farming systems, crop planning and risk management which can help timeliness. Some of these include diversification between summer and winter crop, the use of some long fallows and residual herbicides and a spread of varieties which do not have to be planted and harvested on the same date.

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# Profit suckers – understanding salinity, sodicity and deep drainage to balance yield expectations and resources

*Mark Crawford, Department of Natural Resources and Mines, QLD Government*

**Key words**

Electromagnetic induction, Electrical Conductivity, Chloride, Sodicity

**Take home message**

Develop an integrated management strategy by having a thorough understanding of landscape systems, soil profile properties, plant salt tolerance/capabilities and how current/past farming practices contribute to the salinity and sodicity of your soils.

The presence of salinity and sodicity within Australian agricultural areas is not a new phenomenon. The Australian landscape has accumulated salts from weathering of rocks and deposition by rainfall. The high evaporation, low rainfall and runoff of most inland landscapes means salts (sodium, chloride, sulphate, carbonates) tend to accumulate in our soils – particularly clay soils – our most common type of cropping soil. Rengasamy (2010) estimated that 5.7 million hectares of Australia's agricultural and pastoral zones are currently affected by groundwater associated salinity and rising watertables and that transient salinity (not influenced by groundwater processes) exists in 2.5 billion hectares of the agricultural area, being 33% of the total. It is therefore essential that the right approach is undertaken when management options are being considered.

Understanding both the processes involved in salinity occurrence and how sodicity interacts or contributes is the initial step that must be taken. Acknowledging how current and past agricultural practices contribute to salinity is the key to successful management. This is important because high concentrations of chloride below 0.9m (0.9–1.5 m) restricts the water extracted by crops through osmotic effects and can be associated with reduced grain yields (Dang et al 2011). The investigation process that identifies the presence of salinity in a landscape and determining the extent of current salting can be aided by tools such as electromagnetic induction (EM38), yield mapping and good old fashioned soil and landscape knowledge. Electromagnetic induction (EM) such as EM38 or EM31 provides a valuable resource when initially determining the extent of the problem area. It provides measurements of apparent soil electrical conductivity (EC), which can be related to soil properties such as salt content, soil water, and texture. The use of EM can only provide a surrogate measure of salinity and is not a direct measure. EM data must be supported by soil sampling to ground truth and make sense of what is otherwise just another pretty map. In order to develop an integrated management strategy it is essential to have a thorough understanding of landscape systems, soil profile properties and plant salt tolerance and capabilities.

Soils with an exchangeable sodium percentage (ESP) ≥6 are classified as sodic (Isbell 2002). Poor drainage, surface crusting, hardsetting and poor trafficability or workability are common when the soil has a large proportion of sodium ions ($Na^+$), leading to reduced crop yield. Crop growth is affected by salinity in two ways: firstly the osmotic potential effect and secondly specific ion toxicity. Salts lowers the osmotic potential (ie makes it more negative) or increases osmotic pressure leading to yield losses as plants cannot extract water from soils when soil solution has lower osmotic potential than the plant cell. The impact on grain productivity of rising electrical conductivity (EC) and exchangeable sodium percentage (ESP) values at different depths is shown in Figure 1, which demonstrates that identifying the complete picture is essential to applying the management option.

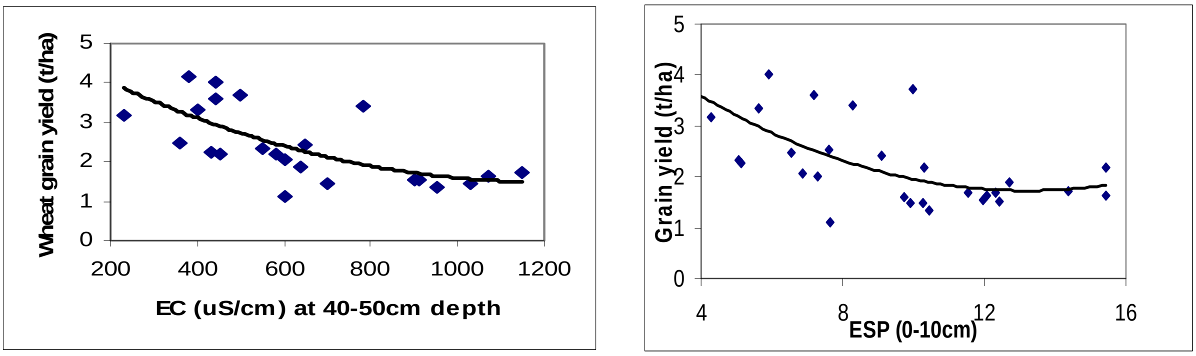


**Figure 1.** Impacts of Salinity and Sodicity on productivity (Source: Dalal et al. 2002)

A number of options exist when managing salt affected areas that are caused by catchment scale interactions. They can be utilised on an individual basis or in combination and include: Managing the land use in its current state (fence and forget), reducing recharge by retaining native or perennial vegetation, intercepting water in the transmission area and increasing water use in the discharge area by using salt tolerant plant species. Paddock management includes using salt tolerant plants and utilising the available water. The Importance of these measures also depends on the mechanism(s) causing salinity expressions (e.g. Landform features).

The goal of these management options is to re-establish a hydrological relationship closer to the pre-development one and allow the continuation of agricultural production. Crop species that have a high salt tolerance such as: barley (*Hordeum vulgare*), wheat (*Triticum aestivum*) and cotton (*Gossypium hirsutum*) can be grown if maintaining current management practices. Allowing a portion of water to reach the subsoil and below will accommodate salts being leached. However, salinity is largely self-regulating in terms of it is a mass balance relationship (input = output). If salinity increases too much, the crop will struggle to use the soil water, which leads to increased deep drainage and hence reduced salinity. Rarely do opportunities arise to deliberately flush the soil profile in dryland cropping systems. Most 'flushing' is incidental/natural and associated with major rainfall events. The other factor to consider is that soils can have a number of saline-sodic combinations.

Sodic soils are prone to poor soil structure, particularly if the natural equilibrium between salinity and sodicity are out of balance. High salinity helps to counteract the effects of sodicity, but as described above, can cause yield issues. Both acidic–sodic and alkaline–sodic soils occur within the northern grains zone, often within the one soil profile. Sodic soils often disperse more after mechanical disturbance (e.g. compaction) and erosion. Gypsum application to these soils improves the soil structure facilitating leaching of salts, even under dry land conditions (Rengasamy 2010). Correcting cation imbalances requires providing a source of the 'good' cations, $Ca^{2+}$ and/or $Mg^{2+}$, which might come from gypsum, lime, dolomite applications. The choice will depend on considerations such as cost, the existing cation balance in the soil and the speed at which a change is required. The application of gypsum will generally give quicker results as it has a relatively high solubility, whereas agricultural lime has a very low solubility and therefore takes longer to observe results. It is also dependant on the pH of the soil.

The use of decision process models such as Gypsy© can be used as a guide when deciding on the cost of gypsum applications. Gypsy was originally designed by CSIRO to help Australian sugarcane growers with the decision process of what rates of gypsum to apply to sodic soils but can be used as a guide to attain ball park costs of remediation. Like all models though, it is only an estimate and the best measure can be obtained by small in-field trials of different application rates.

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**Acknowledgements**

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# Nitrogen application timing –Mungindi Cropping Group

*Jo Weier DAFF*

**Key words**

Nitrogen, volatilisation, urea

**GRDC code**

DAQ00162

To further confirm research work being carried out on nitrogen volatilisation, the Mungindi cropping group initiated trials in 2012. The trial was carried out on wheat with a standard rate of 55kg of nitrogen applied as urea spread at various crop stages. It was set up as a basic grower run strip trial with results collected at harvest.

The treatments were as follows:

A. Control- No N
B. 55kg N applied pre plant
C. 55kg N applied post plant pre- emergent
D. 55kg N applied post emergent.

**Bullawarrie 2012 results**

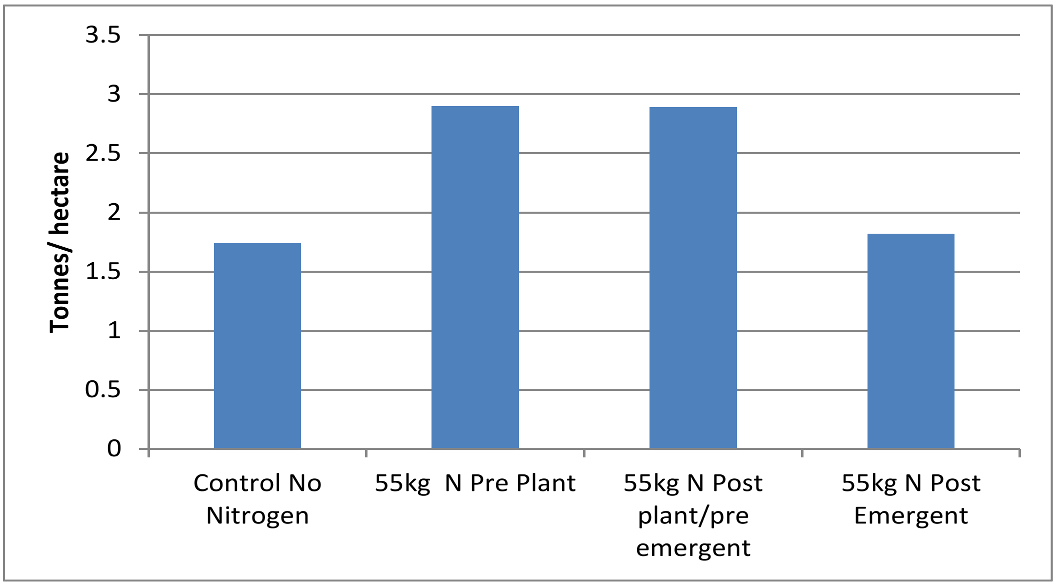


**Figure 1.** Yield (t/ha) 2012 Bullawarrie fertiliser timing trial

The results demonstrate that 55kg of N applied either pre plant or post plant pre-emergent yielded about 1.2t/ha more than the control. Treatment D was not applied until late tillering and received no rainfall so wasn't used by the crop.

The trial was then repeated in 2013 and 2014 with several extra treatments added. Along with the volatilisation work timing of nitrogen application was looked at in terms of yield and protein. The most common practice for nitrogen fertiliser in the Mungindi cropping area was to apply 80kg/ha of urea at planting. Having the ability to better match nitrogen with seasonal conditions would prove beneficial in western farming areas.

A replicated strip trial was set up with the following treatments:

A. Pre plant N spread (80kg/ha urea)
B. Pre plant N incorporated by the planter (80kg/ha urea)
C. Control No Nitrogen
D. Post plant Pre-emergent (80kg/ha urea)
E. Half pre plant half early tillered (90kg/ha urea)
F. Half pre plant and half when a minimum of 10mm of rain falls (90kg/ha urea)

**Bullawarrie 2013 results**

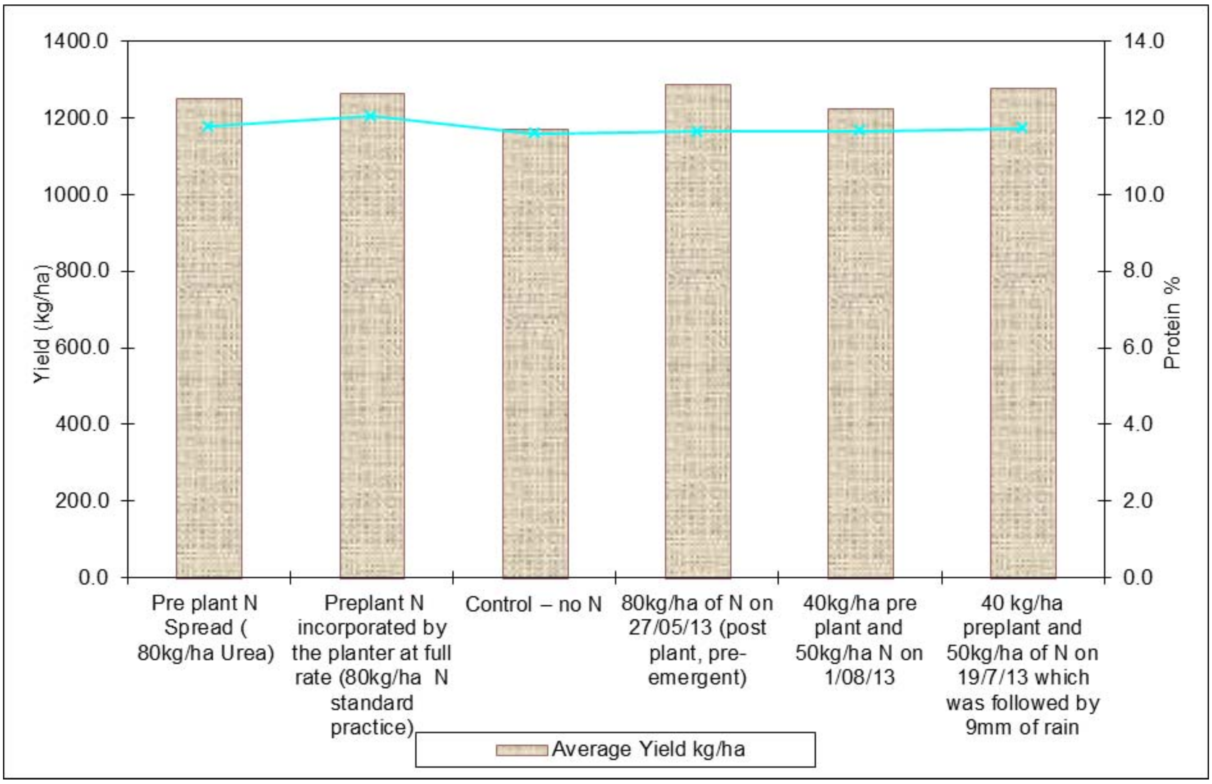


**Figure 2.** Yield (t/ha) and protein (%) results from 2013 Bullawarrie trial

Similarly to the 2012 trial the post plant pre-emergent applications of N have yielded the highest. Very little difference in grain protein was noticed across all treatments with a range from 11.6% to 12.1%.

The 2014 trial was set up with similar treatments to 2013 but with an extra site included.

A. Pre-plant N spread (80kg/ha Urea)
B. Pre-plant N Incorporated by the planter (80kg/ha Urea)
C. Control no N
D. Post plant pre-emergent, unincorporated N (80kg/ha Urea)
E. Half pre-plant half early tillered. (40kg/ha Urea +40 kg/ha Urea)
F. Half early tillered and half when a minimum of 10mm of rain fell (40kg/ha Urea+40kg/ha urea)

**Bullawarrie 2014 Results**

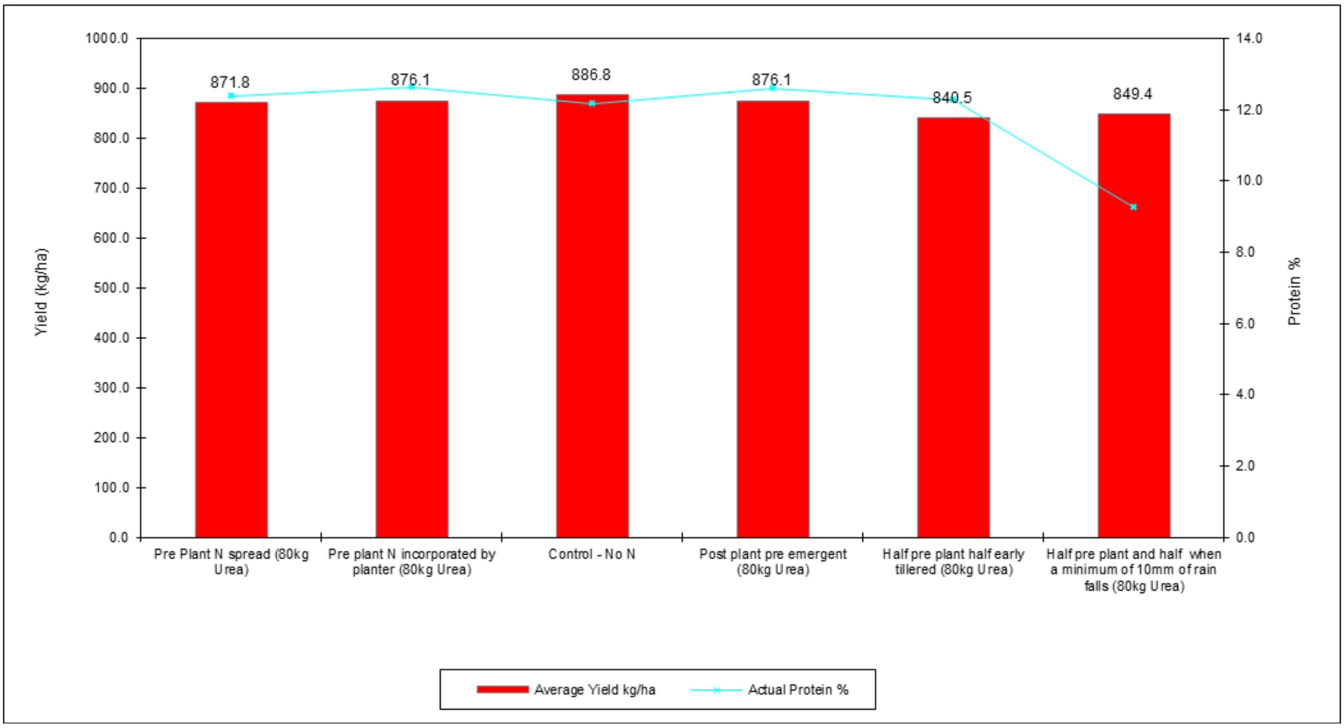


**Figure 3.** Yield (t/ha) and protein (%) results from 2014 Bullawarrie trial

The highest yielding was Treatment C (control) and the lowest yielding was E (half pre plant half early tillered). In saying this though the difference in yields is only 46.3kg/ha.

**Bullawarrie $/ ha**

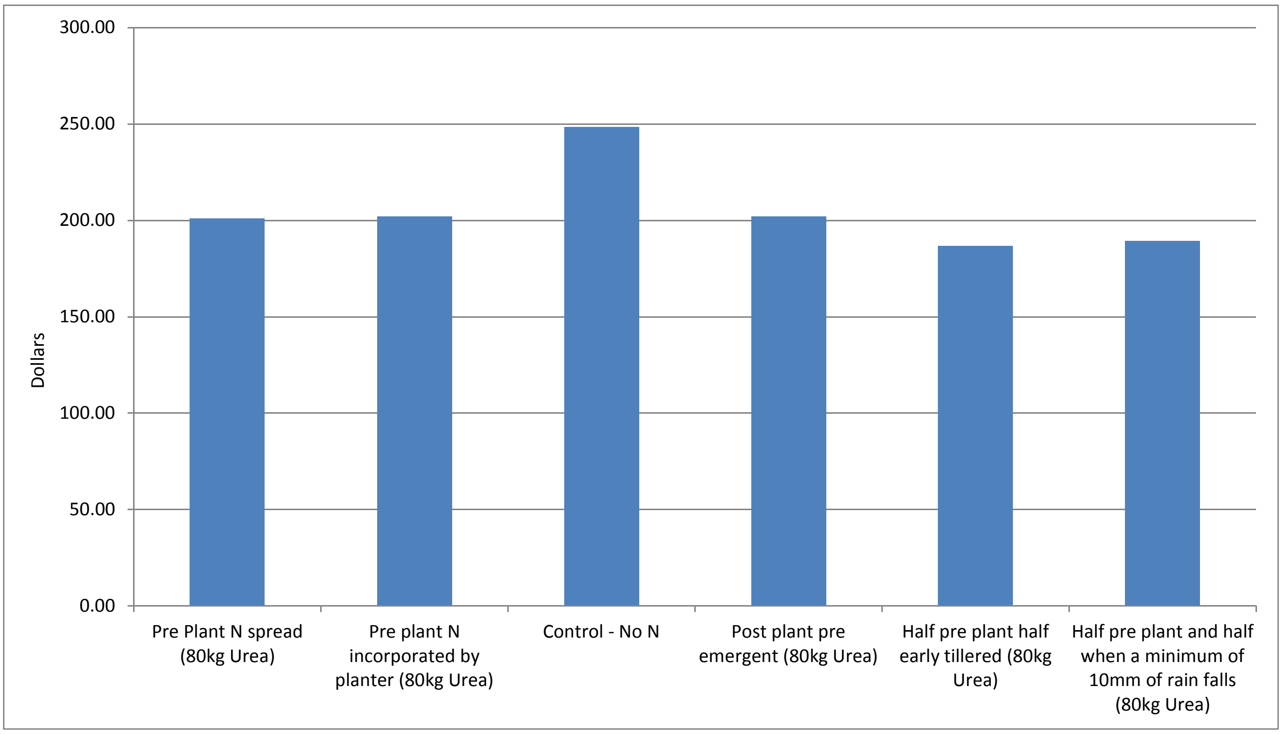


**Figure 4.** Income in dollars/ha (grain yield × grain price – fertiliser cost /ha) Bullawarrie 2014
*(Urea price $540/tonne. Wheat price $280/tonne)*

Treatment C (control) was the better option returning close to $50/ha more than other treatments.

**Collybidgelah results 2014**

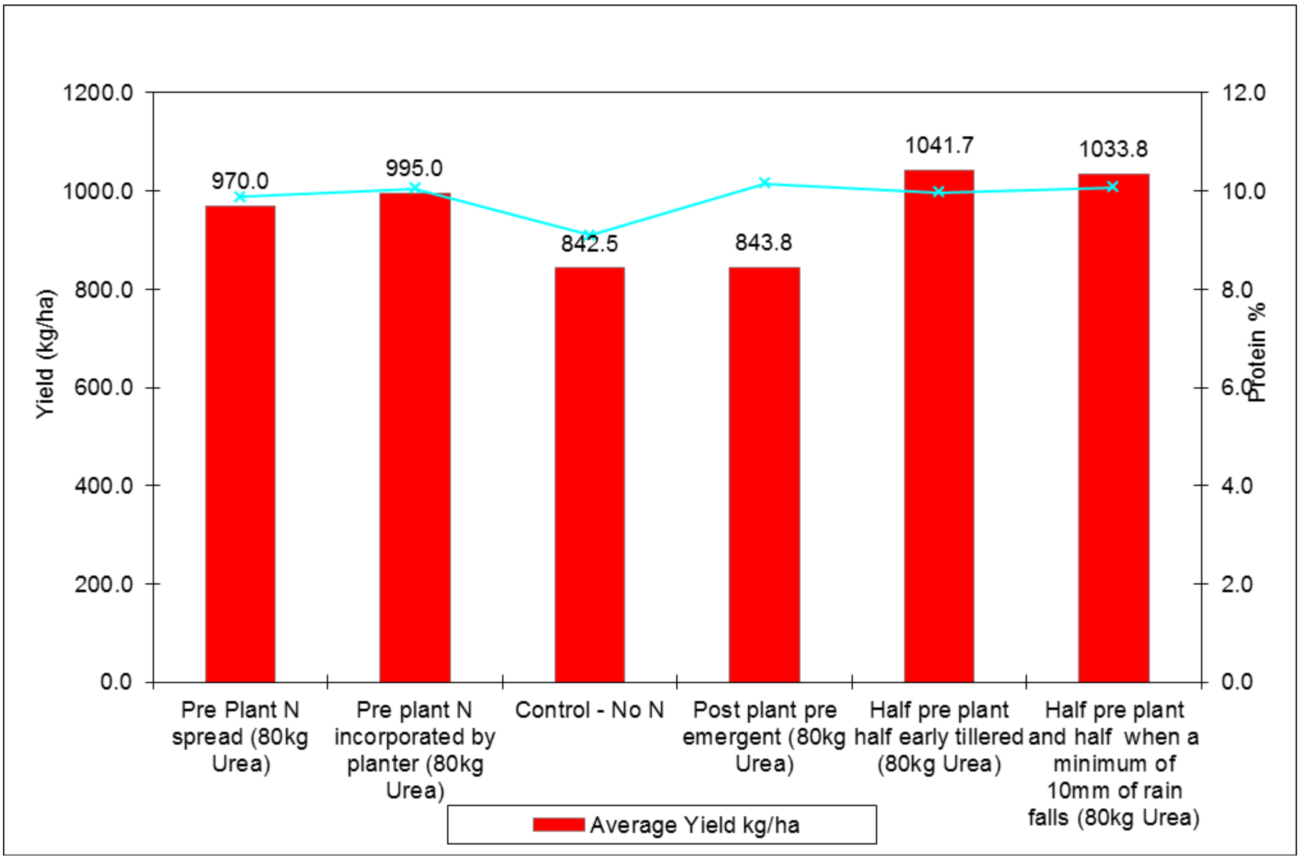


**Figure 5.** Yield (t/ha) and protein (%) results from 2014 Collybidgelah trial

The highest yielding was treatment E (half pre plant half early tillered) and the lowest yielding was treatment C (control)

Treatment A has yielded higher than treatment C so even though the urea was spread 10 days prior to planting and not incorporated the nitrogen has been available to the crop.

**Collybidgelah $/ha**

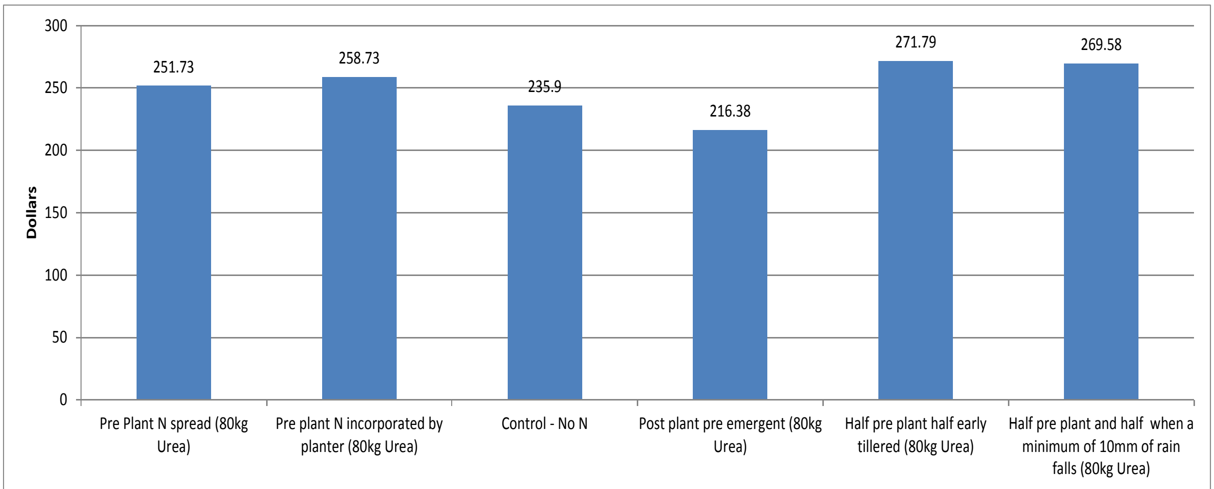


**Figure 6.** Income in dollars/ha ( grain yield × grain price –N cost /ha) Collybidgelah 2014
*(Urea price $540/tonne. Wheat price $280/tonne)*

Treatment E was the most profitable option returning $35.89 more /ha than Treatment C.

*2014 Trial Notes: -*

- Crops were planted using broad acre planting implements.
- Urea was spread using a 16m spreader
- Crop was harvested using conventional headers with yields calculated on header width by plot length.
- Grain was analysed for protein, test weight, screenings and moisture.
- Bullawarrie was planted into a third of a profile of soil moisture with 90mm of in crop rainfall.
- Collybidgelah was planted on half a profile of moisture with 100mm of in crop rainfall.

**Acknowledgements**

The work was conducted through the GRDC funded Grain & Graze project. Thanks to Mick Brosnan, Andrew Earle and Phil Tonkin for assistance and cooperation with trial sites.

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# Harvester fires – A research update

*Ben White, Kondinin Group*

**Key words**

Harvest, fire

**Take home message**

South Australian operators experience in 2013 and 2014 shows harvester fires may be reduced with improved harvester hygiene, maintenance and exhaust system shielding treatments, particularly in volatile crops.

Further research is required to further quantify crop ignition temperatures and the areas of harvesters that exceeding these temperatures and therefore require safeguarding.

The best method of fire prevention for harvesters has been harvester hygiene, regular maintenance and vigilance.

A back-pocket-guide produced for GRDC by Ben White and Dr Graeme Quick serves as a summary of fire prevention and minimisation methods for Australian operators.

http://www.grdc.com.au/GRDC-BPG-ReducingHarvesterFireRisk

Research by Dr Graeme Quick on behalf of Grain Producers South Australia (GPSA) indicated ignition temperatures of some crop dusts could be as low as 130˚C but this was only for a handful of crops in one season.

Dr Quick also concluded "The primary cause of harvester fires is found in the engine bay and specifically on the exhaust system."

Following the lead of the mining industry, a handful of harvester operators in South Australia have trialled exhaust system shielding treatments and have anecdotally reported fewer harvester fires while harvesting pulse and oilseed crops.

**Figure 1.** Left and centre: Examples of muffler and exhaust system insulation in South Australia in 2014. Right: Thermal blankets as used in marine and mining equipment applications.

These operators have used an alumina-silica compound in cement form has been applied to the exhaust stream including the exhaust manifold, turbocharger and exhaust stream including the muffler. This product has also been used in combination with exhaust blankets and in some cases commercial prototype exhaust plumbing modifications.

Application of the cement is laborious and requires preparation and skill to minimise cracking in-situ due to linear shrinkage and formed stress concentrations. According to operators, drying requires around 1-week in warm dry weather.

Cracks in the cement in operation can see dust ingress and accumulation around the exhaust posing fire risk.

Outside the work of Dr Quick, little research has been conducted to quantify the range of ignition temperatures of various crops across a range of conditions. Similarly, there is little research documenting which harvester components exceed these ignition temperatures.

Additional research in these areas will assist in determination of ignition points and the prevention of fires through the identification and guarding of areas on various models of harvester that may exceed these temperatures.

**Acknowledgements**

Dr Graeme Quick

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# Nitrogen management in wheat – 2014

*Richard Daniel, Rachel Norton, Anthony Mitchell and Linda Bailey*
*Northern Grower Alliance*

**Key words**

Nitrogen, wheat, yield and protein

**GRDC code**

NGA00003: GRDC Grower Solutions for Northern NSW and Southern Qld

**Take home messages**

1. Despite a generally moisture limited season, significant grain protein responses were measured at all 'enhanced' urea trial sites
2. The rate of nitrogen applied was the critical factor in all 'enhanced' urea trials
3. No 'enhanced' urea product provided any significant benefit compared to urea alone with ESN resulting in significantly reduced biomass and grain protein at two of the four sites
4. Urea at 100 kg N/ha spread post sowing, and with no physical incorporation, provided at least equivalent crop responses to urea at 100 kg N/ha spread and incorporated by sowing
5. A split application of urea at 50 kg N/ha incorporated by sowing followed by 50 kg N/ha spread in-crop at ~GS31 provided at least equivalent crop responses to urea at 100 kg N/ha spread and incorporated by sowing
6. There was no significant impact on screenings at any site from nitrogen application at up to 200 kg N/ha
7. Late foliar nitrogen application increased protein in only one of four trials
8. At the responsive site, mean protein increases of 1-1.5% were obtained but net benefits were only obtained from four of fourteen treatments ($9-33/ha)
9. Multiple application of low rates did not improve agronomic or economic benefits
10. Foliar applications of 20 kg N/ha trended to improved efficiency of grain N recovery and economic returns compared to applications of 40 kg N/ha

NGA have been heavily involved in projects focussed on nitrogen management in wheat during 2012 to 2014. The key aim in 2012 and 2013 was to evaluate the impact and fit of late nitrogen application (from awn peep onwards) to manipulate grain protein. Benchmark treatments in 2013 included the equivalent quantity of nitrogen added at sowing or split between sowing and the start of stem elongation.

In 2014 NGA conducted two distinct projects involving nitrogen management; 1) The impact and fit of 'enhanced' urea products applied at planting, and 2) The impact of lower or multiple rates of late application foliar nitrogen. The second project was designed to complement and conclude the 2012-2013 activity.

## 1. Comparison of urea and a selection of 'enhanced' urea products applied at sowing

This project was designed to evaluate the impact from 'enhanced' urea products under northern conditions. Benefits may be obtained by reducing N losses or by delaying the release of nitrogen to better match crop needs. Two of the products were polymer coated formulations that slow the N availability in an attempt to provide a canopy management benefit (ie slow the early crop growth to allow more moisture at grain fill and provide more of the N late in the crop to benefit protein levels). The other two products were nitrification inhibitors which impact on the soil bacteria *Nitrosomonas* to slow the conversion of ammonium to nitrate and reduce denitrification and leaching losses.

**Table 1.** Urea and 'enhanced' urea products and rates used in 2014 trials

| Product | Urea | 'Enhanced' urea products | | | |
|---|---|---|---|---|---|
| | | **ESN** | **Agrocote N38** | **eNtrench** | **Entec** |
| Rates kg N/ha as IBS | 50, 100, 200 | 50, 64*, 100 | 50, 84*, 100 | 50, 62*, 100 | 50, 89*, 100 |
| Formulation or Active ingredient | - | Polymer coated urea | Polymer coated urea | Nitrapyrin | DMPP |
| Mode of action | - | Controlled release | Controlled release | Nitrification inhibitor | Nitrification inhibitor |
| Application | - | 60% ESN blend with 40% Urea | 30% Agrocote blend with 70% Urea | 2.5 L/ha on urea | Urea pretreated |

IBS = Surface spread and Incorporated By Sowing
*For each 'enhanced' urea product, the middle rate was an equivalent cost to a 100 kg N/ha applied as urea. All comparisons in this paper between 'enhanced' products and urea alone are for the 50 and 100 kg N/ha rates only.

There were two extra urea alone treatments not listed in Table 1; 100 kg N/ha spread on the soil surface immediately post sowing (PSPE) and a split application treatment of 50 kg N/ha IBS and 50 kg N/ha spread in-crop at ~GS30 was also evaluated.

Five trials were established in 2014 in paddocks nominated by agronomists as low in nitrogen or likely to be N responsive. Unfortunately the site near Moree became severely moisture stressed with grain yields below 600 kg/ha and associated high variability. Data from this site has not been presented.

All trials were established with small plot planters using row spacings of 32-36cm and plot lengths of 8-12m. EGA Gregory⫯ was evaluated in all trials with 4 replicates at all sites.

**Table 2.** Urea and 'enhanced' urea products site details 2014

| **Location** | **Narrabri (AM1410)** | **Gunnedah (AM1411)** | **Tummaville* (LB1412)** | **Biniguy (RN1415)** |
|---|---|---|---|---|
| Sowing Date | 11/6/14 | 10/6/14 | 23/7/14 | 20/5/14 |
| Available soil nitrogen at sowing (kg N/ha) | 128 (0-60cm) | 138 (0-60cm) | 100 (0-90cm) | 42 (0-60cm) |
| Basal starter application to all plots | Granulock Z 80kg/ha | Granulock Z 100kg/ha | Granulock Z 80kg/ha | Granulock Z Extra 40kg/ha |
| In-crop rainfall (mm) | 111 | 164 | 138 | 144 |
| Timing and quantity of first rain post sowing | 3DAA 26mm | 4-5DAA 23mm | 3DAA 1mm 24DAA 25mm | 1-2DAA 2mm 9DAA 5mm |
| In-crop application – date and growth stage | 13/8/14 (GS30) | 13/8/14 (GS31) | 16/9/14 (GS30) | 22/7/14 (GS30) |
| Timing and quantity of rain post in-crop application | 3-5DAA 32mm | 3-6DAA 31mm | 6DAA 5mm 9-10DAA 18mm | 5DAA 1mm 25DAA 54mm |
| PreDicta B – Crown Rot | Low | BDL | Not analysed | BDL |
| PreDicta B – RLN | BDL | Medium *Pt* (2.0/g soil) | Medium *Pt* (7.1/g soil) | Medium *Pt* (2.6/g soil) |

Available soil nitrogen = total soil mineral N kg/ha (to soil depth) using a bulk density of 1.3. It does NOT include any mineralisation credit. DAA= Days after application. BDL= Below detection level.
*Tummaville is a locality near Millmerran on the southern Darling Downs. It was a late planted, irrigated site that was a replacement for an intended dryland trial that failed to receive sufficient planting rain.

## Results

### Biomass responses

NDVI (Normalised Difference Vegetation Index) was used to provide an objective measurement of nitrogen response between treatments. Higher NDVI results indicate larger biomass and/or greener treatments.

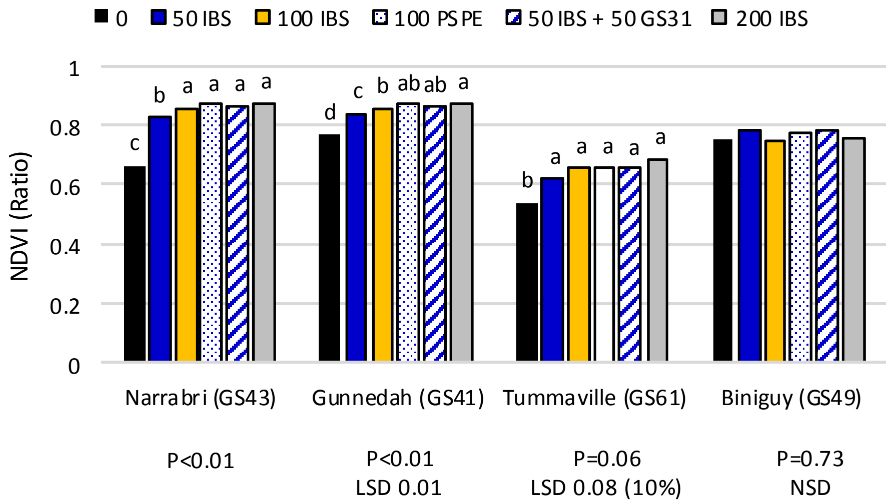


**Figure 1.** Effect of N rate (kg N/ha), application method and timing on NDVI from urea alone in 2014
Treatments that share the same letter within each site are not significantly different at P=0.05, except Tummaville P=0.10.
The main crop growth stage at the NDVI assessment is shown in brackets for each site. NSD = No significant difference

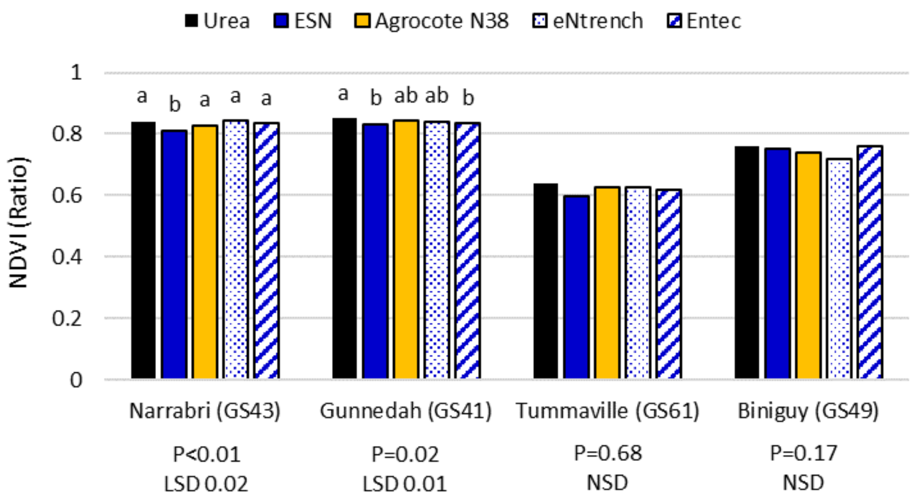


**Figure 2.** Mean effects from urea and 'enhanced' urea products on NDVI in 2014
Treatments that share the same letter within each site are not significantly different at P=0.05.
The main crop growth stage at the NDVI assessment is shown in brackets for each site. NSD = No significant difference.
Means presented are from factorial analysis of all five products at both 50 and 100 kg N/ha

- Nitrogen rate was the major factor affecting NDVI results (Figure 1)
- 50 kg N/ha significantly increased NDVI compared to the untreated at 3 of the 4 sites

- 100 kg N/ha significantly increased NDVI compared to the 50 kg N/ha rate at both Narrabri and Gunnedah
- There was no significant difference in NDVI, at any site, between the 100 kg N/ha treatments applied IBS, PSPE or split between IBS and GS31
- There was no significant difference in NDVI between urea alone and eNtrench or Agrocote N38 at any site
- Both ESN and Entec significantly reduced NDVI at Gunnedah and ESN also resulted in significantly reduced NDVI at Narrabri compared to urea alone

**Key points:**

Significant crop growth responses to nitrogen were recorded at 3 of the 4 sites with nitrogen rate the main factor. Conditions for incorporation of nitrogen spread after planting or at GS31 were sufficient to provide equivalent results to the IBS application. ESN provided the most consistent 'canopy management' difference to urea alone and significantly reduced NDVI results at 2 of the 4 sites.

**Yield**

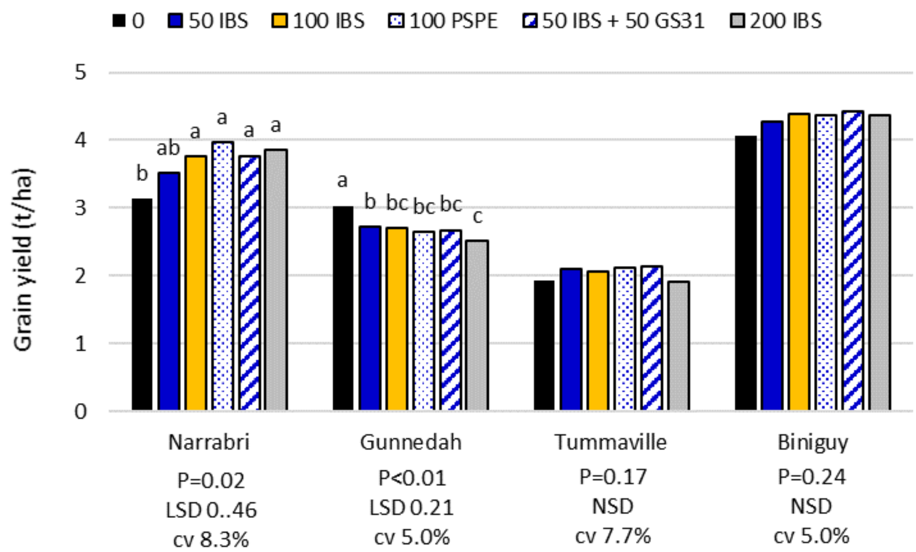


**Figure 3.** Effect of N rate (kg N/ha), application method and timing on yield from urea alone in 2014
Treatments that share the same letter within each site are not significantly different at P=0.05. NSD = No significant difference

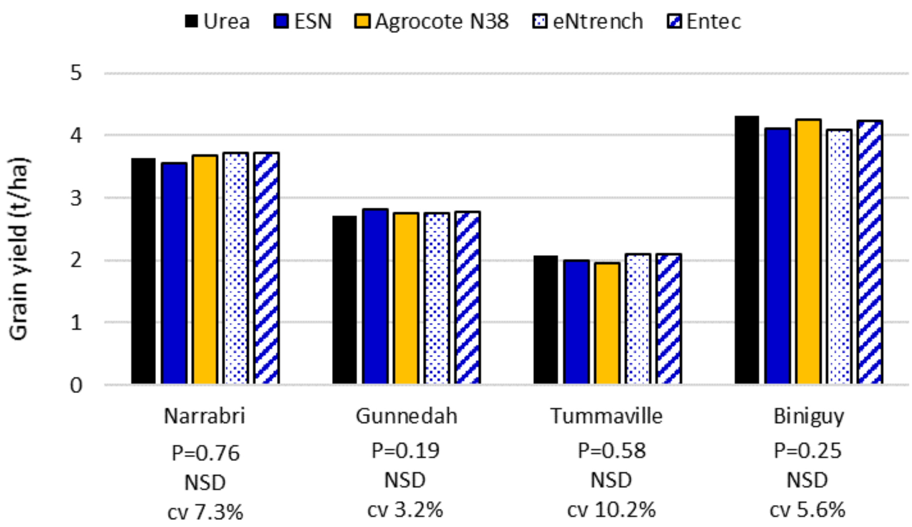


**Figure 4.** Mean effects from urea and 'enhanced' urea products on yield in 2014
Treatments that share the same letter within each site are not significantly different at P=0.05.
NSD = No significant difference. Means presented are from factorial analysis of all five products at both 50 and 100 kg N/ha

- At Narrabri there were significant yield increases compared to the untreated from 100 or 200 kg N/ha
- At Gunnedah, all nitrogen rates and timings resulted in significant yield decreases
- At both Tummaville and Biniguy there was no significant impact on yield from any nitrogen treatment
- At the two responsive sites, there was no significant difference between the 100 kg N/ha treatments applied IBS, PSPE or split between IBS and GS31
- There was no significant difference in yield between any 'enhanced' urea product and urea alone at any site

**Key points:**

Although the addition of nitrogen produced significant crop growth benefits at 3 of the 4 sites, yield benefits were only recorded at Narrabri. Nitrogen rate was the key factor affecting yield with no significant difference between the 'enhanced' urea products and urea alone at any site. The most likely explanation for the negative yield response at Gunnedah is a combination of planting date, low to moderate starting soil moisture (following canola in 2013) and extreme temperatures during grain fill in late October. Yields were disappointing at the Tummaville site, despite frequent irrigations. The late planting resulted in flowering just prior to the late October heat extremes.

**Grain protein**

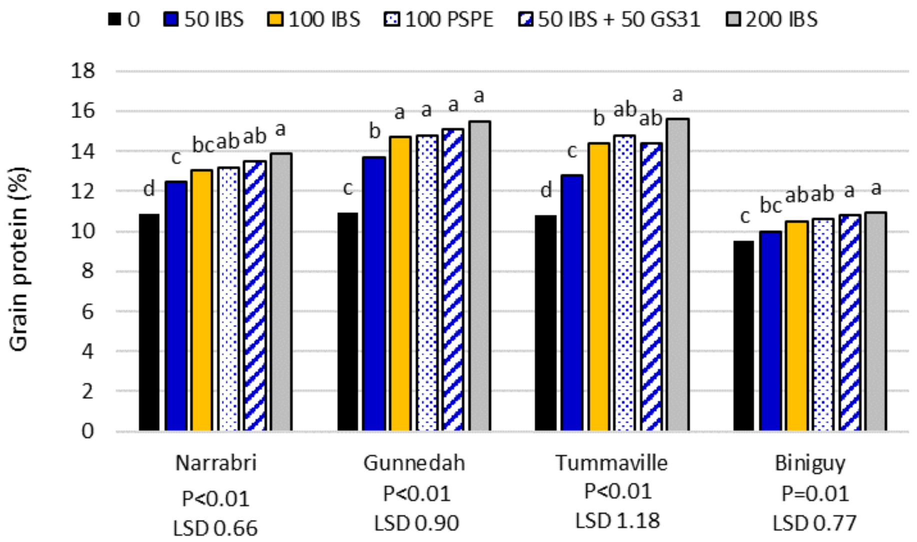


**Figure 5.** Effect of N rate (kg N/ha), application method and timing on grain protein from urea alone in 2014

Treatments that share the same letter within each site are not significantly different at P=0.05.

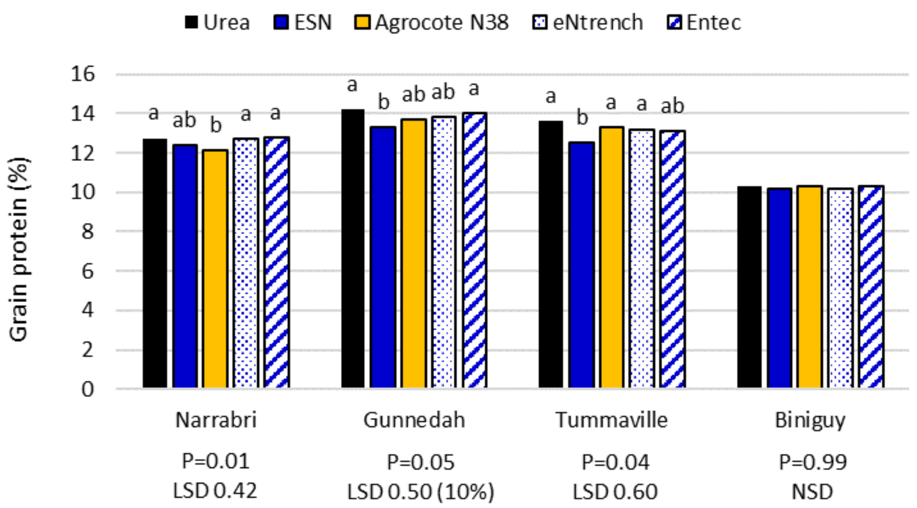


**Figure 6.** Mean effects from urea and 'enhanced' urea products on grain protein in 2014

Treatments that share the same letter within each site are not significantly different at P=0.05, except Gunnedah P=0.10. NSD = No significant difference. Means presented are from factorial analysis of all five products at both 50 and 100 kg N/ha

- Untreated grain protein levels ranged from 9.5 to 10.9%
- All urea rates and timings resulted in significant protein increases at all sites except the 50 kg N/ha urea treatment at Biniguy
- All treatments of 100 kg N/ha or more, resulted in protein levels >13% at Narrabri, Gunnedah and Tummaville
- Although the Biniguy site recorded significant protein increases, the maximum protein recorded was <11%

- There was no significant difference in protein level between the 100 kg N/ha treatments applied IBS, PSPE or split between IBS and GS31. However the split application trended to increased protein compared to the IBS application at Narrabri, Tummaville and Biniguy
- No 'enhanced' urea product provided any significant increase in grain protein compared to urea alone at any site
- Agrocote N38 (at Narrabri) and ESN (at Gunnedah and Tummaville) resulted in significantly lower protein levels than urea alone

**Key points:**

Despite the mixed yield results from the additional nitrogen, all sites recorded significant protein responses with the highest protein achieved at 200 kg N/ha in all trials. The split application of urea (50 kg N/ha IBS + 50kg N/ha ~GS30) had significantly higher protein than 50 kg N/ha IBS and resulted in at least equivalent protein levels to 100 kg N/ha IBS at all sites. This indicated that the in-crop application had been effective at all sites.

The addition of nitrogen improved grain receival grades at all sites. The largest improvements were at Narrabri and Tummaville where the untreated was APW grade and grain from the 100 kg N/ha IBS treatment was APH2 or APH1 at the two sites respectively. At Gunnedah application of nitrogen improved the receival grade from GP to AUH2 and at Biniguy the change was from ASW to APW.

### Screenings

Screening levels were <2% from all treatments at Narrabri, Tummaville and Biniguy with no significant difference between product or nitrogen rate. At Gunnedah, screenings levels were between 6 and 8% with no significant difference between any nitrogen rate or product and the untreated.

### Grain nitrogen recovery

The grain nitrogen recovery (yield kg/ha x protein/100 x 0.175) was calculated to assess the efficiency of fertiliser use. Even at 50 kg N/ha, the recovery levels at Gunnedah, Tummaville and Biniguy were low and varied between 13 and 22%. The Narrabri site had the highest grain N recovery of 34%. Soil and stubble testing is being conducted to determine the fate of the remaining nitrogen.

### Economics

The maximum spread in receival grade prices at the end of October 2014 was only ~$25/t. As a result, yield was the main driver of economic benefit. Figure 7 shows the net benefit/loss across all sites for urea alone.

At Narrabri there was no significant difference in yield or grain receival grade between urea and the 'enhanced' urea products. However there was a significant benefit in both yield and grain protein by applying 100 kg N/ha compared to the 50 kg N/ha rate.

All rates of urea - except the 200 kg N/ha rate – provided a net benefit ranging from $46-151/ha. All rates of Agrocote N38, eNtrench and Entec also provided a net benefit with a range from $12-123/ha (Figure 8). All ESN rates however resulted in a net loss of between $9 and 40/ha.

Despite significant improvements in grain protein levels at Gunnedah, Tummaville and Biniguy, all nitrogen treatments resulted in a net loss.

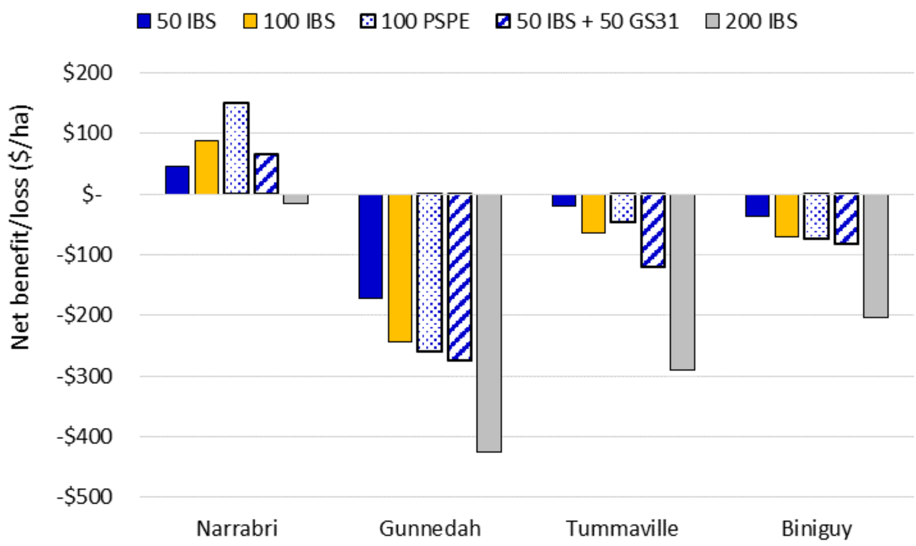


**Figure 7.** Effect of N rate (kg N/ha), application method and timing on net benefit from urea alone in 2014

Assumptions: urea at $1.30/kg N ($600/t), spreading cost of $25/ha/application, grain prices delivered Moree 29/10/14 APH1 $293/t, APH2 $288/t, H2 $277/t, APW/ASW/GP $267/t

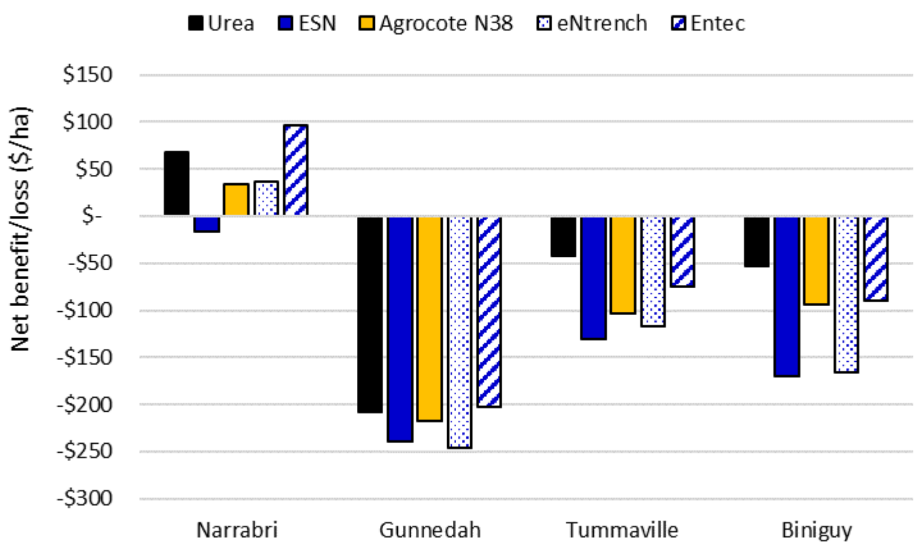


**Figure 8.** Mean effects from urea and ‘enhanced’ urea products on net benefit in 2014

Assumptions: urea at $1.30/kg N ($600/t), spreading cost of $25/ha/application, grain prices delivered Moree 29/10/14 APH1 $293/t, APH2 $288/t, H2 $277/t, APW/ASW/GP $267/t. Means presented are from factorial analysis of all five products at both 50 and 100 kg N/ha

**Conclusions – Impact and fit of ‘enhanced’ urea products**

2014 was not an ideal year to evaluate ‘enhanced’ urea products. Even in situations with untreated protein levels at or below 11%, factors other than nitrogen were generally more important for yield determination. However there were clear and significant nitrogen responses in crop biomass at 3 of the 4 sites and in protein levels at all sites which still allowed sound treatment comparisons:

- Under conditions where useful rain was received within 3 to 24 days after sowing, urea spread immediately post sowing (PSPE) provided at least equivalent benefits to the same quantity incorporated by sowing

- Under conditions where useful rain was received within 3 to 25 days after in-crop spreading at ~GS30, split application of urea with 50% IBS and 50% in-crop provided at least equivalent benefits to 100% IBS
- There was no benefit from the nitrification inhibitor products at any site compared to urea alone. Benefit from these products is most likely to occur under wetter conditions resulting in denitrification or leaching losses
- There was no benefit from the polymer coated products at any site compared to urea alone. However ESN in particular did appear to provide a significant canopy management benefit indicating reduced/slower N availability. However there was also a clear trend to lower grain protein from ESN treatments. Soil sampling may help to determine whether the ESN availability was delayed 'too long'
- In terms of crop growth and grain protein, the rate of nitrogen applied was the most critical factor

**2. Late foliar application of nitrogen for grain protein – are lower/ multiple rates the answer?**

NGA conducted a total of 11 trials during 2012 and 2013 to evaluate the impact from late nitrogen application on protein levels in wheat. Nitrogen solutions were applied at a rate of 40 kg N/ha in an attempt to ensure that protein differences could be reliably measured. Despite the high rate, leaf scorch or tipping was generally minor.

Although significant increases in grain protein were generated, there was no net benefit at any site. The project activity in 2014 was designed to examine whether a lower rate of N, or multiple low rates of N, may provide improved efficiency of uptake and deliver economic benefits.

The products used in 2014 were Ranger – a 24% N aqueous urea solution - and an experimental urea formulation with added macro and micronutrients. Both products were evaluated at the equivalent rate of nitrogen.

Four trials were established in 2014. Two trials were conducted in commercial crops with the other trials conducted at the Tummaville site, adjacent to the 'enhanced' urea trial, in a 'planted small plot' design. One of the Tummaville trials was on the site's exitsting low N background, the second was on a high N background where 107 kg N/ha was applied prior to planting. EGA Gregory⁽ᴰ⁾ was evaluated in all trials. Plot sizes varied from 2-4m width x 8-12m length, all with 4 replicates.

Three foliar application timings were evaluated with single application treatments of 20 or 40 kg N/ha at all timings. Timing 1 was planned for awn peep to early head emergence (GS49-GS55), timing 2 for early flowering (GS61) and timing 3 was planned for ~ 10 days after timing 2. It was hoped that these timings would generate a timing response curve.

In addition, two multiple application treatments were evaluated. Applications of 20 kg N/ha at both timings 1 & 2 or applications of 13.3 kg N/ha at timings 1, 2 & 3. Both multiple application treatments applied a total of 40 kg N/ha. Table 3 shows the timings and growth stages in each trial.

**Table 3**. Late N application timings and growth stages

| **Application timing** | **1** | **2** | **3** |
|---|---|---|---|
| Yallaroi (RN1421) | 30/8/14 (GS51) | 11/9/14 (GS65) | 22/9/14 (GS71) |
| Mullaley (AM1418) | 14/9/14 (GS49) | 24/9/14 (GS61-65) | 4/10/14 (GS65-71) |
| Tummaville High N (LB1413) | 21/10/14 (GS49) | 30/10/14 (GS61) | 5/11/14 (GS71) |
| Tummaville Low N (LB1416) | 21/10/14 (GS49) | 29/10/14 (GS61) | 5/11/14 (GS71) |

Untreated grain yields and protein contents were: Yallaroi 3.5t/ha and 11.2%, Mullaley 5.9t/ha and 9.2%, Tummaville High N 2.0t/ha and 15.2%, Tummaville Low N 2.0t/ha and 10.8%.

## Results

### Yield and protein

Late application of nitrogen did not significantly impact on yield in any trial – as expected. At Yallaroi, and at both Tummaville sites, there was no significant difference in grain protein level between any treatment and the untreated grain.

However, at the high yielding and low protein site, at Mullaley there were significant increases in protein from all treatments except Ranger at 20 kg N/ha applied at GS49. Figure 9 shows the results from the factorial analysis of product x rate x application timing. Figure 10 shows the performance of the multiple application treatments compared to the equivalent total nitrogen rate applied at the individual application timings.

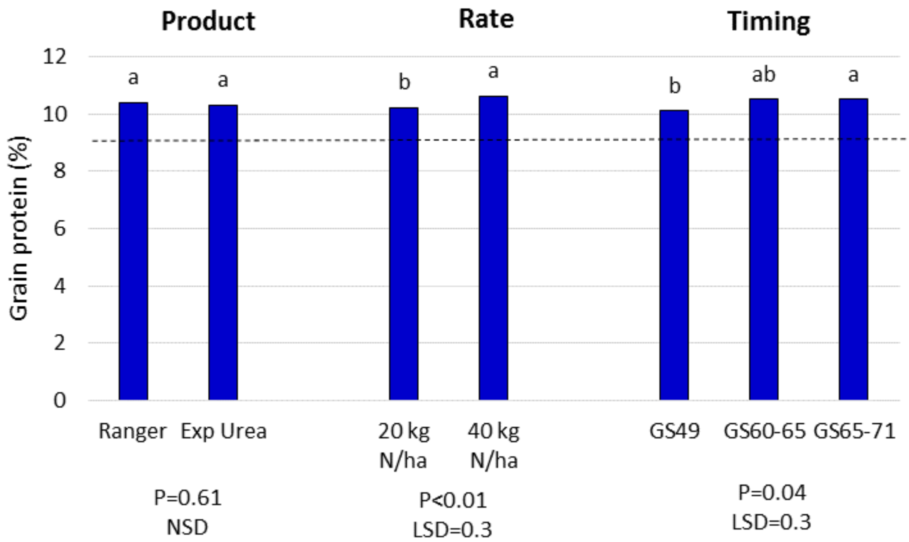


**Figure 9.** Effect of late nitrogen application product, rate and timing on grain protein level, Mullaley 2014

Treatments that share the same letter within each group are not significantly different at P=0.05. NSD = No significant difference. The broken line indicates the protein level achieved in the untreated grain (9.2%)

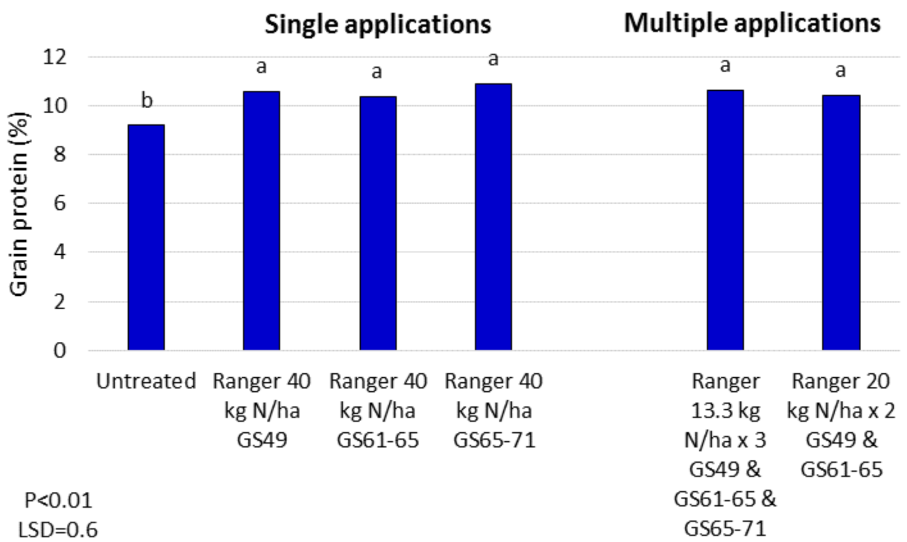

**Figure 10.** Effect of multiple late nitrogen application on grain protein level, Mullaley 2014
Treatments that share the same letter are not significantly different at P=0.05.

- There was no significant difference between the two urea formulations with both increasing mean grain protein by 1.1 to 1.2% compared to the untreated
- The 40 kg N/ha rate significantly increased grain protein compared to the 20 kg N/ha
- The largest increases in grain protein were achieved from nitrogen application during flowering
- There was no significant difference in grain protein level from multiple applications of low nitrogen rates compared to the equivalent nitrogen rate applied in a single application
- The largest protein increases compared to the untreated (+1.7 to 1.8%) were achieved from a single 40 kg N/ha application of either urea formulation at GS65-71

**Key points:**

Large responses in protein level were achieved in this trial with the main factors being product rate and application timing. There was no protein benefit from multiple low rate application of nitrogen compared to a single application of the equivalent rate at this location.

### Screenings and test weight

There was no significant difference in screenings or test weight between any treatment and the untreated. Screenings were below 2% at Yallaroi and Mullaley but between 6-10% at Tummaville.

### Grain N recovery

The Mullaley trial had the highest levels of grain N recovery of all 15 late N application trials conducted during 2012 to 2014. The mean level of recovery was ~50% with an individual treatment range from 26-98%. Factorial analysis did not show any significant difference in total grain N recovery between product, rates or timings. The highest mean recovery (64%) was achieved using the 20 kg N/ha rates compared to 38% when 40 kg N/ha was applied.

### Economics

Despite the significant increases in protein, only 6 of the 14 treatments increased the receival grade from ASW to APW. In 2014 there was no price difference between these grades. Economic analysis was based on a grain price of $267/t, Ranger at $1.8/kg N and application cost of $8/ha/application.

Four treatments provided a net benefit compared to the untreated ranging from $9-33/ha. These were the 20 kg N/ha rates of either urea formulation at GS61-65, the 20 kg N/ha rate of Ranger at GS65-71 and the multiple applications of 13.3 kg N/ha.

### Conclusions – Late foliar application of nitrogen

NGA have conducted a series of 15 trials over the last three seasons on the varieties EGA Gregory⊕ and Suntop⊕. Although none of these seasons were ideal for late foliar nitrogen application, there are some consistent conclusions from this work:

1. Significant increases in protein can be gained from late foliar application of nitrogen
2. The level of protein increase in these trials has only delivered economic benefit at one site and for four out of fourteen treatments at that site
3. Timing differences have not been consistent but generally supported application between late head emergence and early milk stages for maximising protein

4. In the 2014 trials, multiple low rate application did not appear to improve the response compared to the same rate applied in one application
5. Single applications of low rates (20 kg N/ha) trended to improved efficiency of grain N recovery and economic benefits compared to single applications of 40 kg N/ha
6. Largest protein responses have been obtained in four trials conducted in high yielding crops (>4.5t/ha) with low untreated grain protein levels (9-11%). At these sites protein levels increased by ~1-1.5%.
7. Economic benefits will only be delivered when grain N recovery rates are high, untreated protein levels are close to a receival grade threshold and the premium between receival grades is at least $20/t
8. Application of the additional nitrogen earlier in-crop (IBS or GS30) has appeared a more economic option by improving both protein and yield

The conclusions from the 2014 GRDC Update Paper 'The effectiveness of nitrogen application for protein' are still very appropriate "These results suggest that trying to increase wheat protein with late foliar nitrogen application is unlikely to be a very effective management tool in areas where spring rainfall is highly erratic. Unless nitrogen in grain recovery levels can be increased dramatically, grain price differentials of ~$20-40/t are probably necessary before even considering this type of approach. Supply of nitrogen requirements either prior to or at planting, or as a top up during early crop growth stages would appear a much more reliable and effective strategy. Economic benefits from nitrogen application targeting yield potential are likely to be far easier to achieve than when targeting protein increases".

**Acknowledgements**

The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC, the author would like to thank them for their continued support.

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# Impact of row spacing on chickpea and faba bean

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**Key words**

Chickpea, faba bean, row spacing, sowing

**GRDC code**

UQ00067

**Take home message**

- Changes in agronomy can affect yield of chickpea and faba bean.
- In general increasing row spacing may decrease yield of chickpea and faba bean varieties, even in a dry season.
- Optimising time of sowing and row spacing can improve yields in faba bean.

**Background and aims**

Despite the potential environmental and economic benefits, the adoption of winter and summer pulse crops in the Queensland Grains Region is around 8% and 4% of total cropping area respectively, much less than what is required to keep grain cropping systems profitable in the long term. To increase the share of pulses in the total cropping area, strategies are required to enable growers to more consistently realise the potential productivity and profitability of pulse cultivars in their farming systems.

Winter pulses (chickpea and faba bean) currently comprise approximately 8% of total cropped area in the Queensland Grains Region although the adoption varies from 5 to 12% depending on the growing region. Chickpea (*Cicer arietinum*) is the most adapted winter pulse crop in the Queensland with the area expanding to historically high levels in 2010. Seasonal yields of chickpea ranged from 0.5t/ha to 2t/ha depending on the timing and severity of biotic and abiotic stresses during the growing season. Although yields as high as 4.0t/ha have been achieved in varietal evaluation trials in favourable environments through optimal combination of varieties and management, the average yield during the 2008 – 2011 was approximately 1.2t/ha in the focus regions included in this project (Source: ABS statistics), suggesting a significant gap between seasonal potential and harvested yields.

Faba bean (*Vicia faba*) is gaining popularity in the northern grains region thanks to higher prices in recent seasons and improved varieties. Although southern regions dominate the production for Australia; Northern NSW and Southern Qld are looking more favourably upon faba bean as part of their rotation as a break crop for disease and for its nitrogen fixing ability. Yield of faba beans ranges from 2-4t/ha however the pulse agronomy trials have shown a potential of up to 6t/ha.

Even a modest 10% increase in yield would result in a $20 to $25 increase in gross margin (based on a $200/ha gross margin). Over a winter pulse area of 125,000 ha, the increase in crop production would be valued at $2.5 to $3 million per annum.

Although the area sown to winter pulses in Queensland has increased over the last three years, there have been many challenges for growers with erratic seasonal conditions and a range of disease pressures on yield and quality. Growers' attitude to pulse crops is also influenced by forecast prices relative to other cropping options including cotton and experiences from the previous season. The area of winter pulses in the region needs to be stabilised and the reliability of achieving seasonal yield potential improved.

The Pulse Agronomy project has consulted widely within the pulse industry to determine the priorities to be investigated throughout the term of the project and to assist in developing trials and subsequently answers to new questions that arise.

This paper presents highlights of chickpea and faba bean agronomy trials aimed at investigating row spacing and plant population effects on the yield performance of commercially relevant varieties including a pre-release line grown dryland during the 2014 winter season.

**FABA BEAN**

**1. Effect of Row spacing on yield of faba bean**

**1.1 Garah**

The trial design consisted of 3 varieties CairoⒹ, PBA WardaⒹ and a pre-release line X220-D grown at 4 row spacings (0.25m, 0.5m, 0.75m and 1.00m) with a targeted density of 25 plants/m$^2$. The trial was planted on grey vertosol which had been on a long fallow prior to planting. The crop received 96mm of in crop rain.

***Results***

Overall, above average yields were obtained at the Garah site and significant effects of the agronomic treatments. The highest yielding treatment was 60% greater than the lowest yielding treatment. There was deemed to be no significant difference overall between the cultivars PBA WardaⒹ and CairoⒹ however the breeding line X220-D performed significantly better than the other two varieties *(Table 1).*

**Table 1.** Effect of cultivar on yield, Garah (LSD = 0.482, P=0.05)

| **Cultivar** | **Grain yield (t/ha)** |
|---|---|
| PBA WardaⒹ | 4.41 |
| CairoⒹ | 4.09 |
| X220-D | 4.94 |

The narrow row spacing of 0.25m has significantly out yielded other spacings at 5.51t/ha (Table 2). X220-D was significantly higher yielding than the other two cultivars at 0.25m and at 0.5m while there was no significant difference between the cultivars at 0.75m or 1.0m.

**Table 2.** Effect of row spacing on yield, Garah (LSD = 0.513, P=0.05)

| Row Spacing | 0.25 | 0.5 | 1.0 |
|---|---|---|---|
| Mean Yield | 5.51 | 4.95 | 3.25 |

Similar to the Warra site, the same trend can be found when comparing the effect of row spacing and cultivar on yield, narrower rows are gaining the highest yields *(Fig 1).* The pre-release variety, X220-D yielded 20% greater in the 0.25m and 0.5m treatments than both PBA Warda Ⓓ and Cairo Ⓓ.

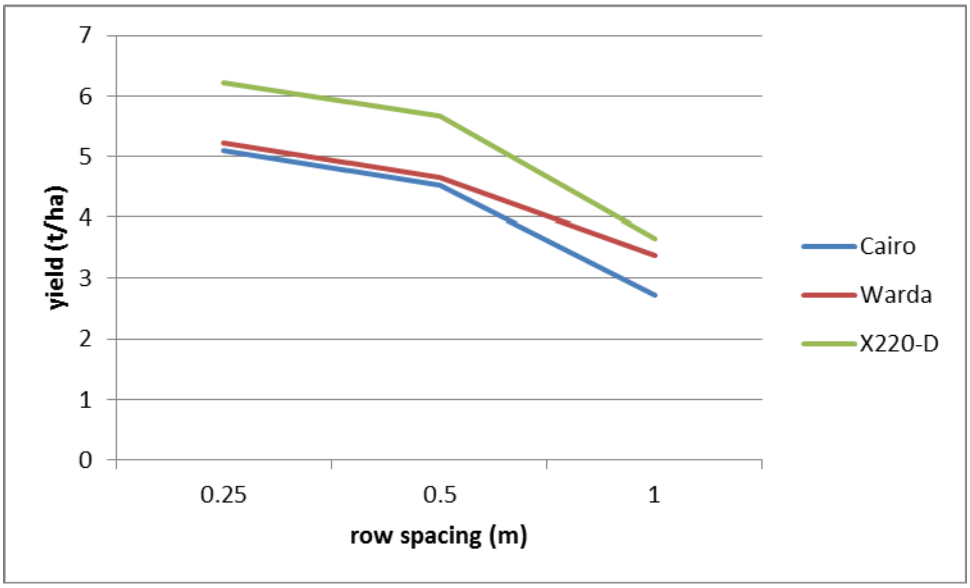


**Figure 1.** Effect of row spacing and cultivar on yield of fababean, Garah, winter 2014

### 1.2 Warra

The trial design consisted of 2 varieties PBA Warda ⍬ and X220D (a pre-release line) grown in 4 row spacing (0.25m, 0.5m, 0.75m and 1.00m) at a density of 30 plants/m2. The soil type is a grey cracking clay vertosol and the trial was planted on an available water content of 140mm in 0- 120cm profile. The crop received 113mm rainfall during the season.

***Results***

Overall, there was no significant difference between the two cultivars *(Table 3)* however the breeding line X220-D achieved marginally better yields than PBA Warda ⍬. However, significant effects of the agronomic treatments were observed with both varieties responding positively to decreasing row spacing.

**Table 3.** Effect of cultivar on yield, Warra, winter 2014 (LSD = 0.4915, P=0.05)

| Cultivar | Grain yield (t/ha) |
|---|---|
| PBA Warda ⍬ | 3.081 |
| X220-D | 3.252 |

When comparing the row spacing there is a trend indicating that narrower rows are producing higher yields. There is significant difference in yield between the 0.25m and 0.5m spacing as well as between 0.75m and 1.0m (Fig 2) However, the yield response of the pre-release line X220-D to decreasing row spacing was consistent whereas the yield increment between 0.50m and 0.25m was marginal for PBA Warda ⍬.

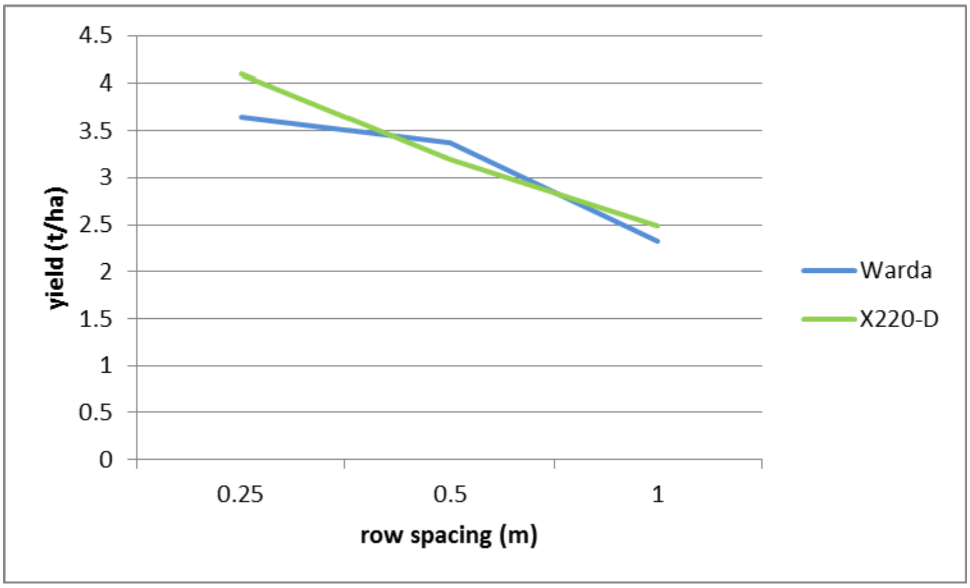


**Figure 2.** Effect of row spacing on yield of two faba bean varieties, Warra, winter 2014 (LSD = 0.0527, P=0.05)

**2. Effect of time of sowing on yield of faba bean**

This preliminary trial was planted and managed by Glenn Milne near Dalby. The variety PBA Warda ⏀ was planted into standing corn stubble on a well-structured, uniform deep to very deep, fine, self-mulching, cracking clay, with a targeted plant population of 25plants/m$^2$ on 32cm row spacing and there were three times of sowing:

1. 23 April 2014
2. 19 May 2014
3. 9 June 2014

There was a linear reduction in yields as the planting time delayed beyond 23 April (Fig 3). However, there was no significant difference in yield between the first and second dates nor the second and third dates but there is between the first and third dates. The first planting date (23 April) had the highest yield at 1.82t/ha, followed by the second date at 1.43t/ha and then the latest at only 0.99t/ha. This trend indicates that there is a need to investigate earlier dates of sowing with more varieties for the Southern Downs region for achieving higher yields.

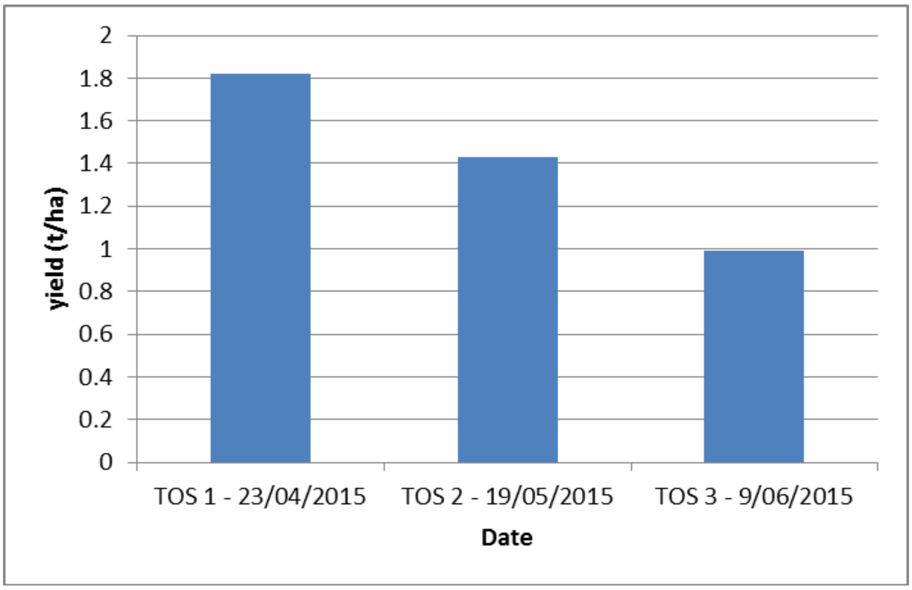


**Figure 3.** Effect of time of planting on yield of faba bean, Dalby, 2014 winter (LSD = 0.593, P=0.05)

## 3. CHICKPEA

### Effects of Row spacing

### 3.1 Dalby

The row spacing trial design was based on genotype (3 varieties PBA HatTrick, PBA Boundary and CICA0912 an advanced breeding line), four row spacing treatments (0.25m, 0.50m, 0.75m and 1.00m). A separate plant population trial with the same varieties and 4 plant densities (10, 20, 30 and 40 plants/m$^2$) was also conducted planted on 50cm row spacing.

The trial was planted on a well-structured, uniform deep to very deep, fine, self-mulching, cracking clay at a starting mositures of 143mm in 120cm profile. The crop received 113mm of rain during the growth phase.

***Results***

At the Dalby site, no significant difference was found between the varieties however CICA0912 was found to achieve the highest yield in both the 25 and 50cm row spacing, with a 30% yield increase over PBA HatTrick and a 20 % increase over PBA Boundary (Fig 4). At the 25cm row spacing, there was no significant difference between CICA0912 and PBA Boundary but there was between CICA0912 and PBA HatTrick and also not between PBA Boundary and PBA HatTrick. There were no sig. differences found at 50cm or 100cm.

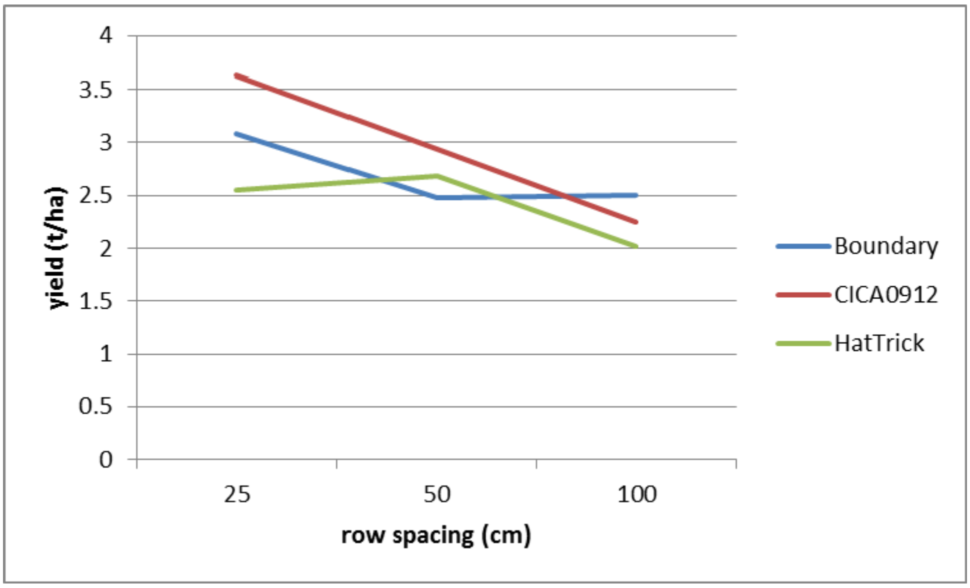


**Figure 4.** The effect of row spacing and cultivar on yield at Dalby, winter 2014

### 3.2 Billa Billa

The trial site was 40km NE of Goondiwindi on a well-structured, uniform deep to very deep, fine, self-mulching, cracking clay, grey vertosol and was planted into standing wheat stubble. The starting soil water content was 132mm in 120cm profile and the crop received 82mm of in-crop rain.
The row spacing treatments were similar to those used at as Dalby.

***Results***

There was no significant difference between cultivars at Billa Billa nor between 25 and 50cm rows (except for PBA Boundary$^{\text{(b)}}$), however there is difference when it comes to the 1.0m rows (Fig 5). From this trend it can be assumed that 1.0m row spacing is not optimal at this site.

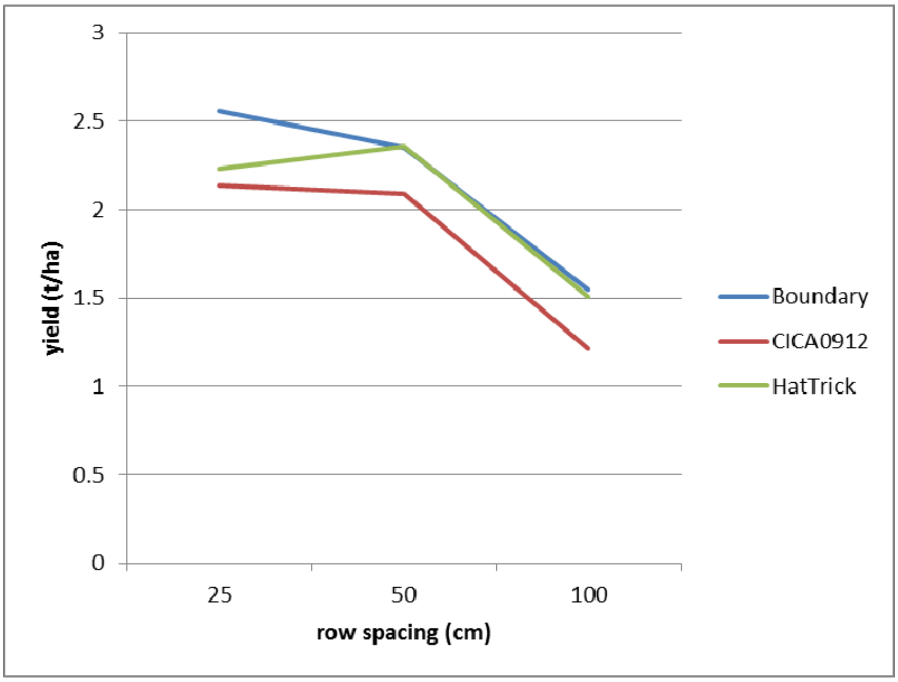


**Figure 5.** The effect of row spacing and cultivar on yield at Billa Billa, winter 2014
(LSD = 0.323, P=0.05)

***Water use efficiency***

Water use efficiency is a valuable measure of the potential suitability of a crop especially in the northern grains region farming systems where rainfall can be limited and temperatures high. Values for chickpeas are usually in the range of 7 to 8 kg/ha/mm water used, at Billa Billa, above average water use efficiencies were achieved.

Narrow row-spacing produced the highest WUE and PBA Boundary⁽ᴾ⁾ produced a higher WUE but statistically it was the same as was achieved by PBA HatTrick⁽ᴾ⁾ (Fig 6). Effects of row spacing was significant with 25cm resulting in higher WUE (13.l kg/mm) compared to 8.4 kg/mm in 100cm rows. However, cultivar differences for WUE was not significant. A statistically higher result in all three cultivars in the 25cm spacing over 100cm.

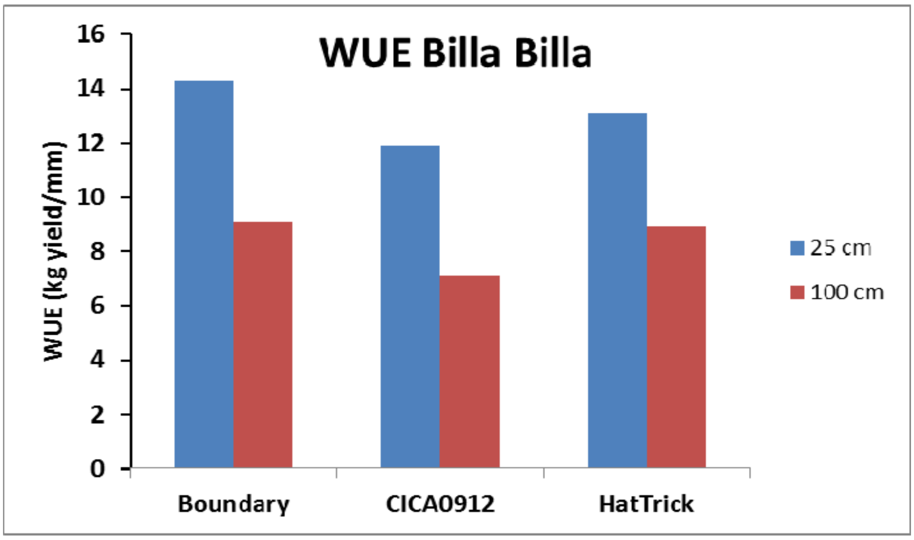


**Figure 6.** The effect of row spacing and cultivar on water use efficiency at Billa Billa, winter 2014

**3.3 Garah**

The trial design was the same as at the Dalby site, the chickpeas were planted into standing wheat stubble into a grey vertosol soil, with low planting moisture but opportunistic rain post planting.

***Results***

Overall, low to average yields were obtained at the Garah site but significant affects from the agronomic treatments were achieved (Fig 7). The lower yields were due to a very low starting moisture and low rainfall throughout the season.

The highest yielding treatments being all varieties on 25cm, were 66% greater than the lowest yielding treatment (varieties at 100cm). There was deemed to be no significant difference overall between the cultivars. With the row spacing trial the trend is indicating that narrower row spacings are achieving higher yields in all three cultivars.

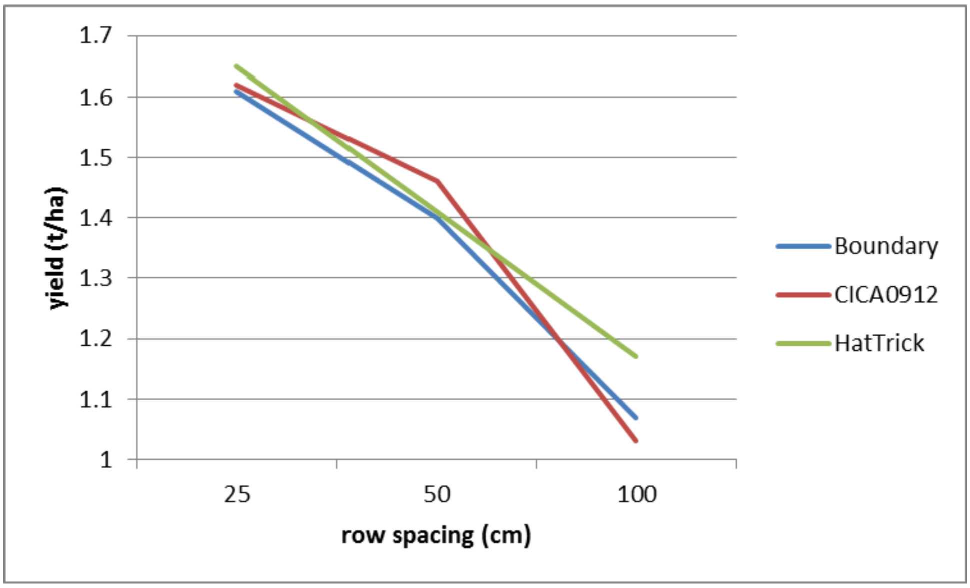


**Figure 7.** The effect of row spacing and cultivar on yield at Garah, winter 2014 (LSD = 0.288, P=0.05)

### 3.4 Warra

The trial design was the same as at Dalby and Garah and the soil type was a grey cracking clay vertosol.

***Results***

On average, higher yields were obtained at the Warra site than at Billa Billa and Garah, and again significant affects from the agronomic treatments were achieved (Fig 8).

The highest yielding treatments being all varieties on 25 cm, were greater than the lowest yielding treatment (varieties at 100cm). There was significance between each row spacing of each variety however there was deemed to be no significant difference overall between the cultivars. With the row spacing trial the trend is indicating that narrower row spacings are achieving higher yields in all three cultivars.

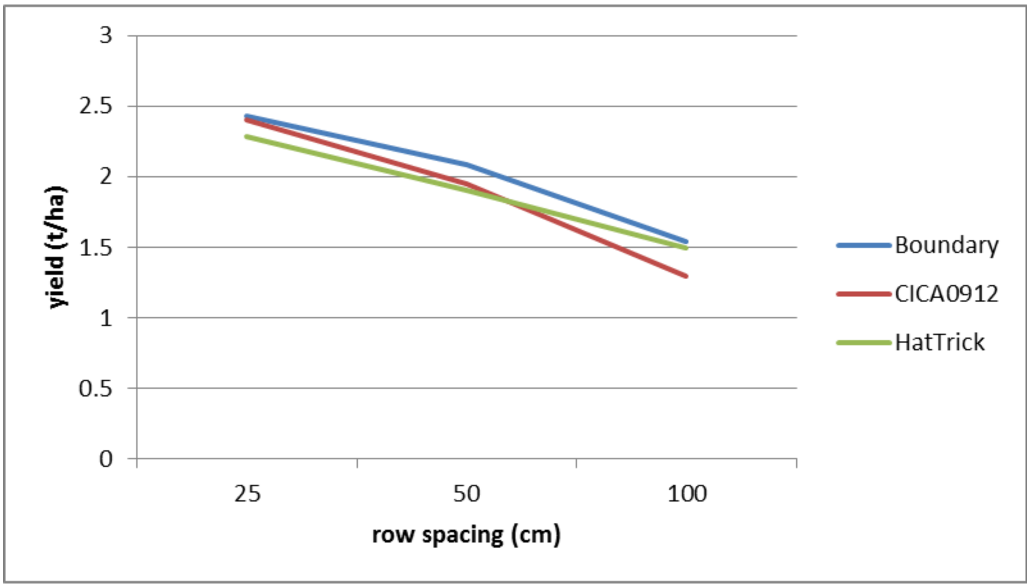


**Figure 8.** The effect of row spacing and cultivar on yield at Warra, winter 2014 (LSD = 0.3379, P=0.05)

***Water use efficiency***

Slightly lower WUE's were achieved at the Warra site (grand mean 8.3) which only achieved average WUE compared with the Billa Billa site (grand mean of 10.7) which is considered above average.

Row spacing had significant effect on WUE with narrow row-spacing producing the highest WUE and CICA0912 produced higher WUE but statistically there was no difference in the WUE across cultivars (Fig 9). There was however a statistically higher result in all three cultivars in the 25cm spacing over 100cm.

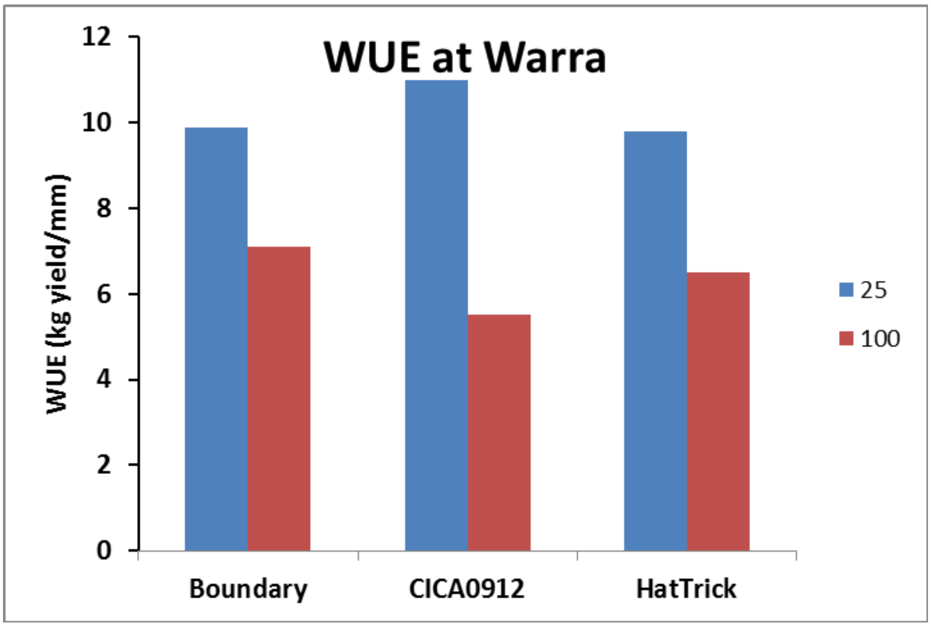


**Figure 9.** The effect of row spacing and cultivar on water use efficiency at Warra, winter 2014 (LSD= 1.77, P=0.05)

***Summary and conclusion***

Narrower rows (0.25m and in some cases 0.5m) gave significantly higher yields for both chickpea and faba bean crops at all sites. Narrow rows did not result in yield reduction even under drier conditions.

The pre-release faba bean variety, X220-D yielded 20% greater in the 0.25m and 0.5m treatments than both PBA Warda⫯ and Cairo⫯.

Earlier time of sowing dates showed to be achieving higher yields in fababean but more investigation on earlier planting dates is required.

2014 was the second winter season where these trials were conducted; the results outlined above that were achieved in 2014 were also consistent with the results from 2013.

Across the sites where WUE was measured, narrower rows consistently produced higher water use efficiency.

Trials are continuing in 2015 to confirm the trends seen in 2014, following harvest and analysis of results a firm recommendation can be made in relation to current varieties and management strategies.

**Acknowledgements**

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# Chickpea ascochyta – is the pathogen changing and what are the implications for management?

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**Key words**

chickpea, Ascochyta, pathogenicity, latent period

**GRDC code**

DAN00176, UM00052, DAN00151

**Take home message**

Ascochyta blight occurred in more chickpea crops (62 of 332 crop inspections) in 2014 than in 2012 and 2013 combined. Most infected crops were PBA HatTrick⁽ᴰ⁾ but PBA HatTrick⁽ᴰ⁾ was also the most commonly grown variety.

Inoculum for the 2014 Ascochyta infections resulted from dry summer (2012/2013 and 2013/14) conditions contributing to slow stubble breakdown and infection of volunteers.

Work to determine if the unexpected number of 2014 infections, especially on PBA HatTrick⁽ᴰ⁾, is related to the changes in the Ascochyta fungus has started. Initial results show that the population varies both in ability to cause disease (pathogenicity) and time to develop fruiting bodies (latent period).

Localities where Ascochyta was found on any variety in 2014 are considered high risk for 2015 crops and growers are advised to apply a preventative fungicide before the first post-emergent rain event to all varieties with less resistance than PBA HatTrick⁽ᴰ⁾, PBA HatTrick⁽ᴰ⁾ will also need to be sprayed.

## The 2014 GRDC Northern Region chickpea season

Although all parts of north central NSW, northern NSW and southern QLD experienced a very wet March, the 2014 winter crop season in the GRDC Northern region was a mixed bag depending on where you were. Overall, southern areas (north central NSW) were wetter than the northern ones (northern NSW/southern QLD), especially early in the season with above average rain in June and July. However, from about mid-August onwards things started to get tough, with rainfall well below average throughout the region; some centres recording single digit falls in September and/or October. In those areas, many chickpea crops were harvested before the end of October. So how dry was it?

- At Trangie, from June to November, 137 mm fell on 16 days with 6 days >1.0mm, compared with a long-term average of 225 mm on 41 days (28 days >1.0mm).
- At Dubbo, for the same period, 167 mm fell on 37 days with 20 days >1.0mm, compared with a long-term average of 277 mm on 46 days (32 days >1.0mm).
- Moree had 129 mm on 20 days with 12 days >1.0mm, compared with a long-term average of 258 mm on 36 days (26 days >1.0mm).

- Goondiwindi had 101 mm on 21 days with 15 days >1.0mm, compared with a long-term average of 254 mm on 35 days (26 days >1.0mm).

The season also had some unusual temperature events. June was milder than normal which encouraged rapid growth and many crops sown mid-May had 10-15 nodes by the end of June. In most areas, July and August had considerable extremes in daily temperatures with warm days and cold nights and some severe frosts. The cool weather continued with frosts and low temperatures common well into spring. The average daily temperature in all districts fluctuated above and below 15°C until several times from early September to mid-October and did not stay above 15°C until the 3rd week in October. These milder conditions led to intermittent flower and pod abortion from August to mid-October, which, coupled with the lack of decent spring rain, resulted in missing pods, ghost pods and pods with single seed. Many growers were disappointed in that crops looked better than they were. In most areas, yields were restricted to 800 to 1500kg/ha; however, in more favourable areas yields reached 2t/ha and higher. Hail storms on 25 Oct and 5 Nov caused some losses in a strip from east of Gilgandra to west of Armatree.

These seasonal conditions did not favour diseases and across the region they were uncommon and generally had no or little impact on yield. Most chickpea crops in northern NSW west of the Newell highway did not receive a single fungicide spray. However, two diseases did occur in 2014 that warrant discussion because they highlight some basic elements of epidemiology. One disease also raises the question of "has the pathogen changed ie has resistance broken down"?

There were two noteworthy cases of Phytophthora root rot (PRR) both illustrating the key drivers of PRR. At Gilgandra, PBA HatTrick⍉ had been direct drilled with a tyne planter on 19 May into a paddock with a history of PRR (although no chickpeas had been grown in the paddock for 10 years). From the end of May till 14 Jun, there were 6 rain events totalling 60mm. When inspected on 25 Jun, the planter furrows in low spots had 5-10mm water. Seedlings in these spots were chlorotic, wilting and dying; laboratory work confirmed PRR. The second crop, at North Star, had been sown into a paddock that had never had chickpeas but prior to wheat in 2012 and 2013, had been grass pasture with clover and medic. On 23 May, it was sown 25mm deep with a tyne and levelling bar; 13mm rain fell that night. When first inspected on 8 July, there was no sign of PRR; but when re-inspected on 1 September, there were several foci of chlorotic, wilting PBA HatTrick⍉ plants (early flowering) but only where water had sat in the contours. Following a call from the concerned grower, a 3rd inspection was done on 12 October (crop turning). Scattered throughout most of the paddock were small circular patches of 2 – 10 dead or dying plants with black rotted roots. Laboratory work confirmed PRR. The problem was absent from the lighter areas of the paddock and the grower noted that medics were far less prevalent in those areas.

By far the most striking chickpea disease in the region in 2014 was Ascochyta.

**Ascochyta in 2014 chickpea crops**

Ascochyta Blight (AB) was first found in the GRDC Northern Region at North Star on 2 July as a small (2-5 plants) focus in a crop of Flipper⍉. By the end of September, AB had been detected in 62 of 332 crop inspections (18.7%), considerably more than was found in 2013 (5/280 crops, 1.8%) and 2012 (11/213 crops, 5.2%). Most of the 2014 cases were in NSW but four were confirmed in QLD, including one crop of PBA Boundary⍉ at Toobeah, west of Goondiwindi. The NSW cases covered an area from Yallaroi in the east, west to Mungindi, Nevertire and Tullamore and south to Forbes.

Four cases of AB were found in July, with the majority detected in August (25) or September (33) with none in October.

Two cases involved Flipper⍉, two PBA Boundary⍉, one PBA Slasher⍉, one Yorker⍉ (that the grower believed was PBA HatTrick⍉) and the rest were PBA HatTrick⍉. This distribution of cases by variety reflects the fact that in 2014, PBA HatTrick⍉ was by far the predominant variety grown in north central NSW, northern NSW and southern QLD.

Infected crops had typical symptoms of AB including ghosting leaf lesions, mature leaf lesions and stem lesions. In most cases, the disease was limited to isolated areas in the paddock but in several crops the infection was widespread with foci being detected every 10-30 seconds. In these crops, stem breakage was common. In spite of the incidence of AB infection and severity of symptoms, all growers were able to manage the disease with judicious use of chlorothalonil fungicides (up to four applications in the worst cases), further, all believed the disease had little if any impact on yield although it did impact on production costs.

**Why was there more Ascochyta in 2014 than in the previous two seasons?**

Although total winter crop rainfall was well below average across the region, June and July were above average in southern parts (57.4mm & 34mm respectively at Trangie; 57.6mm and 55.6mm at Dubbo). At Moree and Goondiwindi, Jun/Jul rain was 23.8/5.0mm and 29.2/15.4mm, respectively. The AB fungus requires the impact energy of raindrops to disperse its conidia so it has to rain for the disease to establish ie dews alone will not produce the initial infection. However, the pathogen only needs 3-6 hours leaf wetness to infect; a few mm of rain falling late on a winter's day or at night will satisfy that requirement. Although Moree Airport only recorded 23.8/5mm in Jun/Jul, the AWS at Kindee (north east of Moree) recorded 44.0/11.4mm for the same period with 5/2 days >1.0mm respectively. Kindee is only a few km from a local epidemic of AB in several PBA HatTrick$^{\oplus}$ crops. That the disease did occur over such a broad geographical is evidence that sufficient rain fell to initiate and spread infections. As well as favourable weather conditions, another explanation for the amount of AB in 2014 is varietal impurity ie not every plant in a paddock of PBA HatTrick$^{\oplus}$ was actually a PBA HatTrick$^{\oplus}$ plant. Varietal purity is a concern in the GRDC Northern Region and the presence of plants of susceptible varieties in a crop of PBA HatTrick$^{\oplus}$ would increase disease pressure on bona fide PBA HatTrick$^{\oplus}$ plants.

**Where did the inoculum come from?**

The AB pathogen, *Phoma rabiei* (previously called *Ascochyta rabiei*) survives on volunteer chickpeas, on chickpea residue and on seed. Volunteers with AB were reported in fallows and nearby wheat crops. We tested some of the seed used to plant the crops in the above-mention local epidemic. Five thousand seeds (untreated) were surface sterilised and plated to detect any seed borne infections – none were found. This does not exclude seed as a source of primary inoculum, but together with the absence of any lesions on pods of 2012 and 2013 crops, presents a robust case against seed as the main source of inoculum for the 2014 infections.

We believe the main source of inoculum was infected chickpea residue from 2012 and 2013 crops. We propose the dry summers of 2012/13 & 2013/14 slowed residue breakdown both in situ and in the following years chickpea paddocks and that this provided inoculum for summer volunteers and the 2014 crop.

**Has the Ascochyta pathogen changed?**

The short answer is we don't yet know. Why? Because we have limited data on pathogenic variability in the pathogen population. However, as a population of living individuals (isolates), we should expect it to change. The little research that has been done shows that there are differences in pathogenicity among isolates. Table 1 classifies 35 isolates of *Phoma rabiei* collected from northern NSW chickpea crops in 2013. Isolates were rated low, medium or high based on their ability to cause disease on ICC3996 (R), Genesis™ 090 (R) and PBA HatTrick$^{\oplus}$ (MR). We conclude from Table 1 that none of the isolates caused severe disease on the two resistant genotypes and that most did likewise on PBA HatTrick$^{\oplus}$. Three caused severe, and three caused moderate, disease on PBA HatTrick$^{\oplus}$. This establishes that the pathogen varies in pathogenicity.

**Table 1.** Pathogenicity ranking of 35 isolates of *Phoma rabiei* collected in 2013 (location and host shown) on three chickpea genotypes, ICC3996, Genesis™ 090 and PBA HatTrick⁽ᶦ⁾

| Location | Variety | ICC3996 | Genesis™ 090 | PBA HatTrick⁽ᶦ⁾ | Overall Pathogenic Rank |
|---|---|---|---|---|---|
| North Star | Flipper⁽ᶦ⁾ | Low | Low | Low | Low |
| North Star | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | High | High |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | High | High |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Medium | Medium |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Medium | Medium |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | High | High |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Medium | Medium |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Tooraweenah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Garah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Garah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Garah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Garah | PBA HatTrick⁽ᶦ⁾ | Low | Low | High | High |
| Garah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Garah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Garah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Garah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |
| Garah | PBA HatTrick⁽ᶦ⁾ | Low | Low | Low | Low |

Another way of assessing pathogenic variability in the AB pathogen populations is to determine the latent period for individual isolates. The latent period is the time from infection to the development of pycnidia, the small dark fruiting bodies that develop in the leaf and stem lesions. Six isolates representing a sub-set of the pathogen population in Eastern Australia were evaluated in a growth cabinet (20°C/15°C 12h day/12h night) on four chickpea genotypes ICC3996 (rated R, coded ICC), Genesis™ 090 (rated R, coded GEN), PBA HatTrick⁽ᶦ⁾ (rated MR, coded HAT) and Kyabra⁽ᶦ⁾ (rated S, coded KYB). There were eight replicates (pots) for each of the 24 genotype by isolate combinations.

The latent period was estimated by survival analysis with the status of a pot being whether pycnidia had or had not developed. For each pot, the data is the latent period or the day of last observation if pycnidia had not developed. Details of the isolates are:

- T12437 – 2010, Darling Downs, QLD, highly pathogenic on PBA HatTrick⁽ᵈ⁾ and ICC3996, moderate on Genesis™ 090 (glasshouse)
- 10TEM005 – 2010, Temora, NSW, highly pathogenic on PBA HatTrick⁽ᵈ⁾ and ICC3996, moderate on Genesis™ 090 (glasshouse)
- 13MUR002 – 2013, Murtoa, VIC, highly pathogenic on Genesis™ 090 (field and glasshouse)
- 13DON002 – 2013, Donald, VIC, highly pathogenic on Genesis™ 090 (field and glasshouse)
- TR6415 – 2014, Yallaroi, NSW, highly pathogenic on PBA HatTrick⁽ᵈ⁾ (field)
- 10MEL001– 2010, Melton, SA, extremely low pathogenicity

Latent Period (LP) varied with isolate and genotype (Table 2). All isolates had the shortest LP on the most susceptible entry, KYB and the longest LP on the most resistant entry, ICC. The isolate from Yallaroi (TR6415) had the shortest LPs on all genotypes and we interpret this as meaning that isolate was the most aggressive in the experiment. This LP experiment complements the pathogenicity work and confirms variability does exist in the pathogen population. However, it does not prove that it has changed in response to the widespread cultivation of PBA HatTrick⁽ᵈ⁾

**Table 2.** Mean Latent period (days) of six P. rabiei isolates on six isolates of P. rabiei on four chickpea genotypes, ICC3996 (ICC), Genesis™ 090 (GEN), PBA HatTrick⁽ᵈ⁾ (HAT) and Kyabra⁽ᵈ⁾ (KYB).

| Genotype | Isolate | Latent Period | SE (mean) |
|---|---|---|---|
| GEN | T12437 | 7.13 | 0.117 |
| HAT | T12437 | 6.75 | 0.153 |
| ICC | T12437 | 7.75 | 0.153 |
| KYB | T12437 | 6 | 0 |
| GEN | 10TEM005 | 7.25 | 0.153 |
| HAT | 10TEM005 | 7 | 0 |
| ICC | 10TEM005 | 7.88 | 0.117 |
| KYB | 10TEM005 | 6 | 0 |
| GEN | 13MUR002 | 7.38 | 0.303 |
| HAT | 13MUR002 | 6.88 | 0.212 |
| ICC | 13MUR002 | 8 | 0 |
| KYB | 13MUR002 | 6 | 0 |
| GEN | 13DON002 | 6.13 | 0.117 |
| HAT | 13DON002 | 6.38 | 0.171 |
| ICC | 13DON002 | 7.25 | 0.153 |
| KYB | 13DON002 | 6 | 0 |
| GEN | TR6415 | 6 | 0 |
| HAT | TR6415 | 6 | 0 |
| ICC | TR6415 | 7.13 | 0.117 |
| KYB | TR6415 | 6 | 0 |
| GEN | 10MEL001 | 7 | 0.25 |
| HAT | 10MEL001 | 6.88 | 0.117 |
| ICC | 10MEL001 | 7.88 | 0.117 |
| KYB | 10MEL001 | 6 | 0 |

**Management of Ascochyta in 2015 chickpea crops**

The following strategy should reduce losses from Ascochyta in 2015:

- Spray all varieties with less Ascochyta resistance than PBA HatTrick$^{\phi}$ with a registered Ascochyta fungicide prior to the first rain event after crop emergence, three weeks after emergence, or at the 3 branch stage of crop development, whichever occurs first.
- For localities where Ascochyta WAS found on any variety in 2014 inoculum will be present in 2015 and the Ascochyta risk is high. Apply a registered Ascochyta fungicide prior to the first rain event after crop emergence to all varieties with less resistance than PBA HatTrick$^{\phi}$, PBA HatTrick$^{\phi}$ will also need to be sprayed. Monitor the crop 2 weeks after rain and if Ascochyta is detected, consider a second fungicide spray.
- Localities where Ascochyta was NOT found in 2014 are considered low risk. PBA HatTrick$^{\phi}$ or PBA Boundary$^{\phi}$ and most Genesis™ varieties should not require their first Ascochyta spray until the disease is detected. Monitor these crops 2-3 weeks after each rain event from emergence onwards and spray if Ascochyta is detected in the crop or is found in the district on any variety.
- Ground application of fungicides is preferred. Select a nozzle such as a DG TwinJet® or Turbo TwinJet® that will produce no smaller than medium droplets (ASAE) and deliver the equivalent of 80–100 litres water/hectare at the desired speed.
- Where aerial application is the only option (e.g. wet weather delays) ensure the aircraft is set up properly and that contractors have had their spray patterns tested.

**Further information**

Further information on chickpea disease management can be found at the Pulse Australia website www.pulseaus.com.au and in the NSW DPI 2015 Winter Crop Variety Sowing Guide eg:

http://www.pulseaus.com.au/pdf/Chickpea%20Ascochyta%20Blight%20Management.pdf

http://www.pulseaus.com.au/pdf/2011%20Chickpea%20Disease%20Management%20Considerations.pdf

http://www.pulseaus.com.au/pdf/Chickpea%20Botrytis%20Grey%20Mould%20Management.pdf

http://www.pulseaus.com.au/pdf/Chickpea%20Integrated%20Disease%20Management.pdf

http://www.pulseaus.com.au/pdf/Chickpea%20Phytophthor%20Root%20Rot%20Management.pdf

http://www.pulseaus.com.au/pdf/Virus%20Contol%20in%20Chickpea.pdf

http://www.pulseaus.com.au/pdf/Pulse%20Seed%20treatments%20&%20Foliar%20Fungicides.pdf

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# Chickpea Ascochyta – evidence that varieties do differ in susceptibility of *pods*

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**Key words**

chickpea, Ascochyta, management

**GRDC code**

DAN00176, DAN00151

**Take home message**

- The susceptibility of pods to Ascochyta Blight is important as infection can cause pod abortion, blemish or kill seed, infected seed is also an inoculum source
- Field trial results indicate that the varietal resistance of chickpea pods are similar to that of vegetative tissue

## Background

Understanding the susceptibility of chickpea pod tissue to Ascochyta Blight (caused by *Phoma rabiei* formerly known as *Ascochyta rabiei*) is important. Because if pods get infected early in their development they will abort; if fully developed pods get infected near the peduncle (as many do because the calyx holds water), they will abort; pods with developing seeds will either abort, or the seed becomes infected and is killed or the seed becomes infected, but remains viable and is a potential source of inoculum to initiate an epidemic.

Current Australian chickpea varieties and advanced breeding lines differ in susceptibility of their vegetative plant tissues to Ascochyta Blight (see paper on VMP14 trial in these proceedings). However, the chickpea industry believes that pods of all varieties are equally susceptible to Ascochyta (see http://www.grdc.com.au/GRDC-FS-ChickpeaDiseaseManagement). The 2011 Tamworth chickpea Ascochyta management trial, VMP11 suggested that may not be the case - anecdotal evidence indicated varieties with higher levels of resistance to Ascochyta eg Genesis™ 425 had less disease on their pods. For the past three seasons we have conducted trials at Tamworth designed specifically to capture data on susceptibility of pods of different chickpea genotypes to Ascochyta. Each season we protected the plants with fungicides until 50% podding, then waited for a rain event to inoculate the trials but no rain came. However, the 2014 Tamworth chickpea Ascochyta yield loss trial, VMP14, which was inoculated before flowering, provided an opportunity to collect data on susceptibility of pods of ten genotypes consisting of released varieties and advanced breeding lines.

## Methods

Details of VMP14, including disease ratings of the varieties and breeding lines, are reported elsewhere in these proceedings. The trial was inoculated on 15 Jul and re-inoculated on 16 Aug using a new isolate collected from HatTrick⁽ᴰ⁾ at Yallaroi on 24 July. By the end of August, Ascochyta was well established throughout the trial, especially in the unprotected Nil plots (no fungicides). Podding commenced in the 2nd week of September. Eight mm rain fell on 24 Sep followed by 10mm on 25 Sep; 16.4mm fell on 13 Oct with 0.6mm on 14 Oct. On 29 October, 5-6 plants were collected from the outer 2 rows on each side of the 4m wide x 10m long plots. The pods were stripped from each plant, discarding the youngest two pods on each branch (these formed after the last rain event and could not have infected by Ascochyta). The pods were sorted into four classes based on their Ascochyta status: Clean = no Ascochyta lesions; 1 lesion = pods with a single lesion; 2-5 lesions and >5 lesions. A lesion was not called Ascochyta unless pycnidia could be seen either with the naked eye or under a low power dissecting microscope. For each variety the number of pods falling into each of the 4 Aschochyta classes was analysed using ordinal regression. The model estimates (+/- SE) the 3 cut points between the 4 classes and gives a coefficient for each variety.

**Results**

We acknowledge that this Ascochyta pod data could be confounded, as the plots (JIM and KYB) with the most infected pods and the greater number of lesions were also those that had the highest levels of Ascochyta infection in the vegetative stage. However, we are confident there was sufficient inoculum pressure in the trial. In particular during the two rain events, all pods in the trial would have been exposed to the same aerosol of conidia (40 unsprayed Nil plots in the trial with a combined area of 1600 m$^2$ and an estimated 48,000 infected plants, all with leaf and stem lesions bearing pycnidia). The 2015 trial will hopefully clarify the potential issue of susceptible variety effects on pod infection.

There were large differences in pod infection among the genotypes. Only about 0.3 (30%) of Jimbour and Kybara$^{\text{Ⓟ}}$ pods were clean (no disease), whereas about 96-99% of CICA1007, CICA0912, and Genesis$^{\text{TM}}$ 425 pods had no Ascochyta (Table 1). Not only did Jimbour and Kyabra$^{\text{Ⓟ}}$ have a greater proportion of Ascochyta infected pods, but these pods were more severely diseased with most of the infected pods having 2-5 or more than 5 Ascochyta lesions (Table 1).

Analysis showed that the varieties can be put into 4 groups with no differences between varieties within a group but significant differences between varieties in different groups. The four groups from least to most susceptible were (C1007,C0912,G425), (BOU,HAT,KAL,MON), (C1211 ) and (JIM,KYB) (Fig. 1).

**Table 1.** Percentages of pods in each of four Ascochyta categories for ten genotypes

| Genotype | %Clean | %1 Lesion | %2-5 Lesions | %>5 Lesions |
|---|---|---|---|---|
| C0912 | 98.5 | 1.0 | 0.3 | 0.3 |
| C1007 | 97.2 | 1.5 | 1.0 | 0.3 |
| G425 | 96.8 | 2.5 | 0.3 | 0.5 |
| KAL | 86.7 | 7.5 | 5.5 | 0.3 |
| HAT | 86.2 | 9.3 | 4.0 | 0.5 |
| MON | 86.2 | 7.8 | 3.3 | 2.8 |
| BOU | 84.3 | 5.5 | 6.3 | 4.0 |
| C1211 | 67.2 | 13.8 | 14.5 | 4.5 |
| KYB | 33.8 | 15.5 | 30.5 | 20.3 |
| JIM | 28.6 | 21.8 | 31.3 | 18.4 |

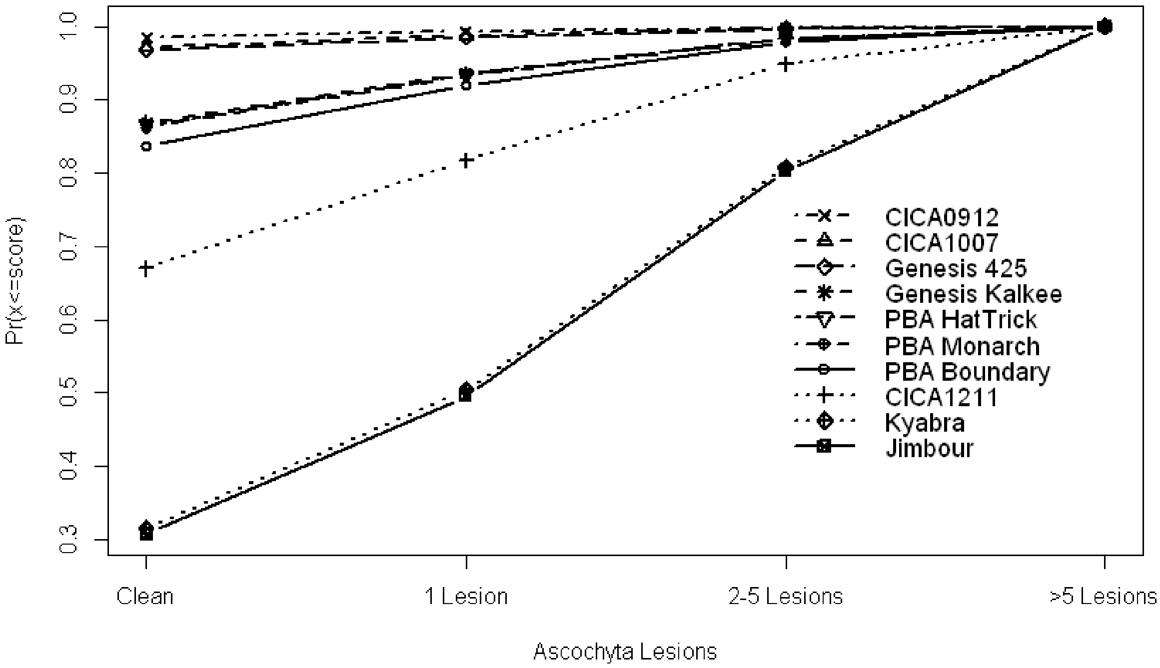


**Figure 1.** Predicted cumulative proportions of pods for each of four categories of Ascochyta lesions for ten chickpea genotypes in VMP14 trial

Key pod infection findings of VMP14 were:

- Genotypes differed in the number of Ascochyta infected pods.
- Genotypes differed in the severity of Ascochyta on infected pods.
- The ten genotypes fell into four significantly distinct groups in the four pod disease categories with (C1007, C0912, G425) > (BOU, HAT, KAL, MON) > C1211 > (JIM, KYB)
- This grouping agrees closely with current Ascochyta ratings for vegetative tissues

## Further information

Further information on chickpea disease management can be found at the Pulse Australia website www.pulseaus.com.au and in the NSW DPI 2015 Winter Crop Variety Sowing Guide eg:

http://www.pulseaus.com.au/pdf/Chickpea%20Ascochyta%20Blight%20Management.pdf

http://www.pulseaus.com.au/pdf/2011%20Chickpea%20Disease%20Management%20Considerations.pdf

http://www.pulseaus.com.au/pdf/Chickpea%20Botrytis%20Grey%20Mould%20Management.pdf

http://www.pulseaus.com.au/pdf/Chickpea%20Integrated%20Disease%20Management.pdf

http://www.pulseaus.com.au/pdf/Chickpea%20Phytophthora%20Root%20Rot%20Management.pdf

http://www.pulseaus.com.au/pdf/Virus%20Contol%20in%20Chickpea.pdf

http://www.pulseaus.com.au/pdf/Pulse%20Seed%20treatments%20&%20Foliar%20Fungicides.pdf

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# Effect of chickpea Ascochyta on yield of current varieties and advanced breeding lines – the 2014 Tamworth VMP14 trial

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**Key words**

chickpea, Ascochyta, management

**GRDC code**

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**Take home message**

Under medium to high disease pressure, Ascochyta can be successfully and economically managed on susceptible varieties such as Kyabra⍉ and Jimbour.

However, Ascochyta management is easier and more cost effective on varieties with improved resistance eg PBA HatTrick⍉, PBA Boundary⍉

The Ascochyta resistance of the advanced breeding lines CICA0912 and CICA1007 has been improved to the point that in a typical average rainfall to dry season neither will require fungicide sprays.

**Background**

Ascochyta first caused widespread damage to chickpea crops in eastern Australia in 1998. At the time, all Australian chickpea varieties were susceptible (some highly so) to the pathogen (*Phoma rabiei* formerly known as *Ascochyta rabiei*). Following the 1998 epidemic, efforts to develop chickpea varieties with resistance to Ascochyta were increased, aided by considerable support from GRDC. Fortunately Ted Knights, who led the National breeding program had already started incorporating Ascochyta resistance into desi chickpea types suited to the GRDC Northern Region. Howzat, released in 2002, had better resistance than Amethyst but it wasn't until 2005 when Flipper and Yorker were released that substantial gains in resistance were available to the chickpea industry. These were followed by PBA HatTrick⍉ in 2009 and PBA Boundary⍉ in 2011. Since 1999, Ascochyta management trials have been conducted at the Tamworth Agricultural Institute to determine yield losses caused by Ascochyta in current varieties and advanced breeding lines. We report here on the 2014 trial.

**2014 Tamworth Ascochyta management trial, VMP14**

VMP14 sought to match Ascochyta management to a variety's Ascochyta rating. The trial was sown into standing cereal stubble on 15 May 2014 using disc openers on 40cm row spacing in plots 4m wide by 10m long. Each plot was separated from its neighbour on all sides by a 2m x 10m buffer of Genesis™425 (rated R to Ascochyta). There were ten genotypes and four replicates. On 15 Jul, when most genotypes were at the 6-7 node stage, the trial was inoculated with a cocktail of twenty isolates of the Ascochyta pathogen collected from commercial chickpea crops from 2009 onwards at a rate of 233,000 spores per mL in 100L/ha water. Five and a half hrs elapsed before the rain started and whilst Ascochyta did develop, not all unprotected plants were infected and those that were had a limited numbers of lesions. On 16 Aug, when plants had 13-15 nodes, the trial was re-inoculated during a rainfall event with the same isolate cocktail that also included a highly aggressive isolate collected from PBA HatTrick⍉ at Yallaroi on 24 July (not included in the 15 Jul inoculation) containing 833,000 condia/mL. It rained for 3.5 days and this time, every unprotected plant had multiple Ascochyta infections. From re-inoculation to desiccation (6 Nov), the trial received 94mm rain in 16 rain days (8 days >1.0mm) compared with the 120 year average for the same period of 141mm and 20 rain days (15 days >1.0mm).

Table 1 lists the ten genotypes and their current ratings to Ascochyta and Phytophthora (S = Susceptible, MS = Moderately Susceptible, R = Resistant, MR = Moderately Resistant).

**Table 1.** Chickpea varieties and advanced breeding lines used in the Tamworth VMP14 trial and their current ratings for Ascochyta and Phytophthora

| Genotype | Ascochyta (AB) | Phytophthora (PRR) | Notes |
|---|---|---|---|
| Jimbour | S | MS/MR | Industry standard |
| Kyabra⁽ᴾ⁾ | S | MS | Drought tolerant |
| PBA Boundary⁽ᴾ⁾ | MR | S | High yield |
| PBA HatTrick⁽ᴾ⁾ | MR | MR | High yield, moderate AB & PRR |
| PBA Monarch⁽ᴾ⁾ | MS | VS | Medium/large seeded kabuli |
| Genesis™ Kalkee | MS/MR | VS | Large seeded kabuli |
| Genesis™ 425 | R | S | Small seeded AB resist kabuli |
| CICA0912 | R | MR/R | Potential release, good AB & PRR |
| CICA1007 | R/MR | MR | Potential release, high yield |
| CICA1211 | S | MR | Potential release, high quality |

There were three fungicide treatments: a low disease scenario with regular applications of 1.0L/ha chlorothalonil (720g/L active) (5 applications were made), a high disease scenario with Nil sprays and a VMP treatment with low and off-label rates of chlorothalonil. Data for the VMP treatment are not presented here but we describe the strategies for each genotype as these reflect their Ascochyta rating. The first VMP spray for Jimbour, Kyabra⁽ᴾ⁾ and CICA1211 was applied before the first inoculation. The first VMP spray for PBA Monarch⁽ᴾ⁾ and Genesis™ Kalkee was applied on 14 Aug after two infection events, when the Jimbour, Kyabra⁽ᴾ⁾ and CICA1211 were getting their 2nd spray. The first VMP spray for PBA Boundary⁽ᴾ⁾, PBA HatTrick⁽ᴾ⁾, Genesis™ 425 and CICA0912 was applied on 12 Sep after four infection events, when Jimbour, Kyabra⁽ᴾ⁾ and CICA1211 were getting their 4th spray. Conditions were not consistently favourable for Ascochyta and plants grew away from the disease between rain events. Nevertheless, unprotected (Nil) Kyabra plots were severely affected by Ascochyta and had no yield; unprotected Jimbour yielded only 22% of protected Jimbour.

In spite of treating all planting seed with metalaxyl (and thiram), Phytophthora root rot, PRR developed following 39mm rain on 18-20 Aug and 18mm on 25-26 Sep. By harvest, PRR had become quite severe in some areas of the trial; accordingly, %PRR infection was used as a covariate in the yield analyses The covariate adjusted yields for label rate and nil fungicide treatments only are summarised in Table 2, covariate adjusted yields were also used to calculate gross margins.

Key yield findings of VMP14 were:

1. Under moderate to high disease pressure, Ascochyta can be successfully managed on susceptible and MR varieties with registered rates of chlorothalonil
2. Under these moderate to high disease pressure conditions the Ascochyta resistance of two R and R/MR PBA breeding lines (CICA912, CICA1007) was robust and chlorothalonil application did not significantly improve yield

Findings for susceptible varieties:

- all susceptible varieties had significant improvements in yield with chlorothalonil for Ascochyta management
- Well managed Kyabra⁽ᵖ⁾ yielded 2.4t/ha with a GM of $669/ha compared to zero yield and a GM of minus $377/ha where the disease was not controlled
- The desi line, CICA1211 was perhaps the surprise of the trial, as although yield losses were significant the unsprayed CICA1211 yielded 86% of sprayed treatment. CICA1211 was rated Susceptible to Ascochyta in PBA Chickpea screening nurseries under very high disease pressure. In this drier than average season CICA1211 certainly handled Ascochyta much better than the other two S rated entries, Jimbour and Kyabra⁽ᵖ⁾

Findings for MR and R/MR varieties:

- The Ascochyta resistance of PBA HatTrick⁽ᵖ⁾ was promising at 76% of the sprayed PBA HatTrick⁽ᵖ⁾, although yield losses were significant. Treatment effects for PBA HatTrick⁽ᵖ⁾ resulted in a significantly lower unsprayed GM value of $492/ha in comparison to value of $630/ha for the sprayed treatment
- Unsprayed PBA Boundary⁽ᵖ⁾, yielded 88% of the well managed PBA Boundary⁽ᵖ⁾ with GM of $637/ha
- The recently released kabuli, PBA Monarch⁽ᵖ⁾, also performed well, with the unsprayed yielding 74% of the sprayed
- The potential desi release, CICA0912, performed exceptionally well with no significant difference (P<0.001) in yield between five sprays of chlorothalonil fungicide (2183 kg/ha) and no sprays (2132 kg/ha)
- There was also no significant difference (P<0.001) in yield of the desi line CICA1007 between five (2340 kg/ha) and no sprays (2343 kg/ha)

**Table 2.** Number and rate/ha of chlorothalonil sprays, cost of spraying, grain yield, and gross margin (GM) for ten chickpea genotypes in the Tamworth VMP14 trial (yield LSD 274.7 kg/ha; GM LSD 132.9 $/ha). (GMs also take into account other production costs estimated at $300/ha; chickpea price desi: $450/t, kabuli: $550/t)

| **Variety and treatment** (rate/ha of chlorothalonil sprays) | **No. Sprays** | **Spray cost $/ha** | **Yield kg/ha** | **GM $/ha** |
|---|---|---|---|---|
| Kyabra⁽ᴾ⁾ 1.0L | 5 | 105 | 2385 | 669 |
| Jimbour 1.0L | 5 | 105 | 2180 | 575 |
| Genesis™ Kalkee 1.0L | 5 | 105 | 1971 | 681 |
| PBA Monarch⁽ᴾ⁾ 1.0L | 5 | 105 | 2205 | 810 |
| PBA HatTrick⁽ᴾ⁾ 1.0L | 5 | 105 | 2301 | 630 |
| Genesis™ 425 1.0L | 5 | 105 | 2143 | 775 |
| CICA1211 1.0L | 5 | 105 | 2244 | 605 |
| PBA Boundary⁽ᴾ⁾ 1.0L | 5 | 105 | 2351 | 653 |
| CICA912 1.0L | 5 | 105 | 2183 | 577 |
| CICA1007 1.0L | 5 | 105 | 2340 | 649 |
| Kyabra⁽ᴾ⁾ Nil | 0 | 0 | 0 | -377 |
| Jimbour Nil | 0 | 0 | 501 | -76 |
| Genesis™ Kalkee Nil | 0 | 0 | 1461 | 504 |
| PBA Monarch⁽ᴾ⁾ Nil | 0 | 0 | 1625 | 594 |
| PBA HatTrick⁽ᴾ⁾ Nil | 0 | 0 | 1761 | 492 |
| Genesis™ 425 Nil | 0 | 0 | 1878 | 732 |
| CICA1211 Nil | 0 | 0 | 1936 | 571 |
| PBA Boundary⁽ᴾ⁾ Nil | 0 | 0 | 2080 | 637 |
| CICA912 Nil | 0 | 0 | 2132 | 659 |
| CICA1007 Nil | 0 | 0 | 2343 | 754 |

### Further information

Further information on chickpea disease management can be found at the Pulse Australia website www.pulseaus.com.au and in the NSW DPI 2015 Winter Crop Variety Sowing Guide eg:

http://www.pulseaus.com.au/pdf/Chickpea%20Ascochyta%20Blight%20Management.pdf

http://www.pulseaus.com.au/pdf/2011%20Chickpea%20Disease%20Management%20Considerations.pdf

http://www.pulseaus.com.au/pdf/Chickpea%20Botrytis%20Grey%20Mould%20Management.pdf

http://www.pulseaus.com.au/pdf/Chickpea%20Integrated%20Disease%20Management.pdf

http://www.pulseaus.com.au/pdf/Chickpea%20Phytophthora%20Root%20Rot%20Management.pdf

http://www.pulseaus.com.au/pdf/Virus%20Contol%20in%20Chickpea.pdf

http://www.pulseaus.com.au/pdf/Pulse%20Seed%20treatments%20&%20Foliar%20Fungicides.pdf

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# Phytophthora in chickpea varieties –resistance rankings and yield loss

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Phytophthora root rot, variety, risk management

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**Take home message**

- Even in a dry season, substantial yield losses from PRR can occur in susceptible varieties such as PBA Boundary⏀
- do not grow PBA Boundary⏀ if you suspect a PRR risk
- avoid paddocks with a history of lucerne, medics or chickpea PRR
- there is no yield penalty in the absence of PRR associated with varieties with improved resistance to PRR

### Varietal resistance to Phytophthora root rot

*Phytophthora medicaginis*, the cause of Phytophthora root rot (PRR) of chickpea is endemic and widespread in southern QLD and northern NSW, where it carries over from season to season on infected chickpea volunteers, lucerne, native medics and as resistant structures (oospores) in the soil. Although registered for use on chickpeas, metalaxyl seed treatment is expensive, does not provide season-long protection and is not recommended. There are no in-crop control measures for PRR and reducing losses from the disease are based on avoiding risky paddocks and choosing the right variety.

Detailed information on control of PRR in chickpea is available at:
http://www.pulseaus.com.au/pdf/Chickpea%20Phytophthor%20Root%20Rot%20Management.pdf

Current commercial varieties differ in their resistance to *P. medicaginis*, with Yorker⏀ and PBA HatTrick⏀ having the best resistance and are rated MR (Yorker⏀ slightly better than PBA HatTrick⏀), while Jimbour is MS - MR, Flipper⏀ and Kyabra⏀ are MS and PBA Boundary⏀ has the lowest resistance (S). PBA Boundary⏀ should not be grown in paddocks with a history of PRR, lucerne, medics or other known hosts such as sulla.

From 2007 to 2014 PRR resistance trials at the DAFFQ Hermitage research Facility, Warwick QLD have evaluated a range of varieties and advanced PBA breeding lines. Each year the trial is inoculated with *P. medicaginis* at planting. There are two treatments, (i) seed treatment with thiram, thiabendazole and metalaxyl and regular soil drenches with metalaxyl and (ii) seed treatment with thiram + thiabendazole only with no soil drenches. The first treatment has prevented infection by the PRR pathogen in all of these trials. The difference in yield between the metalaxyl-treated plots and untreated plots are used to calculate the yield loss caused by PRR i.e. % loss = 100*(Average yield of metalaxyl-treated plots – Average yield of nil metalaxyl plots)/ Average yield of metalaxyl-treated plots.

Yields in metalaxyl-treated plots were relatively high for the 2014 season with the lowest yielding varieties (CICA1328, CICA1007, PBA Boundary(PBR)) yielding close to 2.8 t/ha (Table 1). The highest yielding variety, CICA0912, produced 3.2t/ha.

In 2014 the level of PRR in the trial was less than those of previous 2012 and 2013 seasons. However, the 2014 trial again confirmed the Yorker(PBR)>PBA HatTrick(PBR)> PBA Boundary(PBR) variety resistance ranking order (Table 1), which has been consistent across previous trials.

Results for this low disease pressure season showed that susceptible varieties still sustain substantial yield loss from PRR and that varieties with moderate resistance have reduced losses. For example, although disease pressure was less than that of previous seasons PBA Boundary(PBR) still had a very high yield loss of 74%. These losses were approximately 10% lower than the previous two seasons (85% in the 2012 trial and 82% in the 2013 trial). In contrast, Yorker(PBR) which has moderate PPR resistance had a yield loss of 10% in 2014 but had respective losses of 35% and 66% in 2012 and 2013.

The 2014 trial again confirmed the superior PRR resistance of the PBA breeding line CICA1328 which is a cross between a chickpea (*Cicer arietinum*) line and a wild *Cicer* species.

CICA1211 was included in the trial for the first time in 2014. Results were promising with a good yield where PRR was controlled (3 t/ha) and a yield loss from PRR of only 12%.

**Table 1.** Yields of commercial chickpea varieties and breeding lines protected from phytophthora root rot, and % yield losses from PRR in a 2014 trial at Warwick QLD. (P Yield<0.05; LSD Yield = 0.80)

| Variety/line[A] | Yield (t/ha) in absence of *Phytophthora* infection | Yield (t/ha) in presence of *Phytophthora* infection | % yield loss due to *Phytophthora* infection |
|---|---|---|---|
| CICA1328[A] | 2.76 | 2.71 | 1.8 |
| Yorker(PBR) | 3.01 | 2.69 | 10.4 |
| CICA1211 | 3.01 | 2.66 | 11.6 |
| D06344>F3BREE2AB027[A] | 2.93 | 2.13 | 27.4 |
| PBA HatTrick(PBR) | 2.94 | 1.98 | 32.8 |
| CICA0912 | 3.23 | 1.79 | 44.6 |
| PBA Boundary(PBR) | 2.79 | 0.73 | 73.8 |

[A] These lines are crosses between chickpea (*C. arietinum*) and a wild *Cicer* species

We believe that the lower yield losses recorded in the 2014 trial compared to the 2012 and 2013 trials were due to lower in-crop rainfall between July and November. For the 2014 season at Warwick there were three months where the monthly total was ≤ 20mm (July 7mm, September 20mm and October 15mm). In the 2013 season when PRR was severe, there was only one month (August 9mm) when rainfall was ≤ 20mm. In 2012 when PRR severity was between the 2013 and 2014 seasons, there were two months when rainfall was ≤ 20mm. In 2014 immediate post-sowing conditions were cooler than normal with 17 days in July having a minimum temperature ≤ 1°C. The combination of low soil temperatures and low rainfall early in the season may have reduced the number of primary infections from the inoculum applied at sowing, and so reduced the capability of further disease development later in the season despite good rainfall in August (45mm).

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