Optimising
Irrigated Grains

Key Learnings (Faba Beans)

2020 and 2021

SOWING THE SEED FOR A BRIGHTER FUTURE

Faba Beans under irrigation

i) Crop structure and Plant population

Key Points:

- ***High yielding faba bean crops greater than 7t/ha are achievable under both overhead and surface irrigation systems.***
- ***The penalty for growing faba bean crops that are too thin is significant under irrigation.***
- ***Aiming for populations above the optimum is less risky, with little to no penalty for canopies that are above optimum.***
- ***With plot yields varying from 2.5t/ha to 8t/ha, the older variety Fiesta VF consistently out yielded the newer variety PBA Amberley by 8%.***
- ***Surface irrigation combined with growing season rainfall at both Finley and Kerang was at least 500mm in order to achieve 7t/ha plus. Overhead irrigation systems in 2020 associated with 400mm of GSR and irrigation combined produced only 4-5t/ha with lower pod numbers/m^2 and harvest dry matter.***

Cultivar and Population

Fiesta out yielded PBA Amberley by 8% across the two years of research trials under irrigation. This increased yield is consistent over plant populations that vary from low to high density, however at the high populations (plus 40 plants/m^2) PBA Amberley appears to drop in yield slightly.

Irrigated grain yield plateaus at around 30 plants/m^2 and there is little gained going above 25 plants/m^2. However, when plant populations start dropping below 20 plants/m^2 the yield loss can be significant. With higher yield potentials under irrigated cropping systems, the small drops in plant populations have a “magnifying” effect on grain yield loss (loss of approx. 1.5t/ha when dropping from 20 to 10 plants/m^2). In contrast, moving from 20-30 plants/m^2 increased yield by 0.5t/ha and whilst higher populations were rarely higher yielding, the risk of poorer performance was very slight in comparison to populations dropping below the optimum.

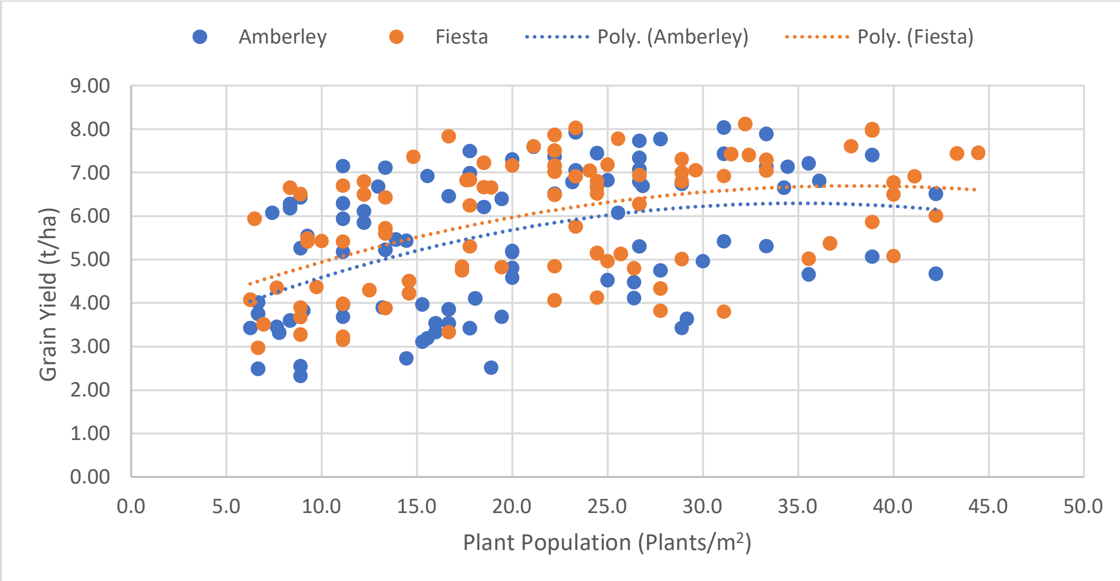

Figure 1. The influence of faba bean plant populations on grain yield (t/ha). Data points from 6 trials across 2 years and 2 sites.

If aiming for 20 plants/m^2, there are greater negative consequences if populations fall below that target than where populations are higher than the target, even up to 35-40 plants/m^2. Therefore, there is less risk of losing yield if aiming for higher populations (25-30 plants/m^2) than falling short.

What makes a 7-tonne crop?

When growing faba beans under irrigation plant populations is one of many components making up the yield achieved at the end of the season. Other yield drivers include biomass production, stem numbers, pod numbers, seeds per pod and thousand weight (TSW).

Two years of achieving high yielding irrigated faba beans has allowed us to estimate some matrix figures around what makes up a 7+ t/ha faba bean crop. When achieving 7t/ha at our Finley irrigated research site a minimum established population of 20 plants/m^2 was the establishment foundation required. From this point, at least 60 stems are required and approximately 8 pods per stem to reach the target of 7t/ha.

Table 1. Yield components of a high yielding (+7t/ha) irrigated faba bean crop.

	Population (plants/m^2)	Harvest Dry Matter (t/ha)	Stems/m^2	Pods/m^2	Grain Yield (t/ha)
Amberly 2020	20	13.59	60	453	7.45
Amberley 2021	21	11.66	60	490	7.18
Fiesta 2020	27	15.15	70	557	7.06
Fiesta 2021	23	13.68	60	624	7.23
Amberley 2020	32	9.05	61	351	5.17

Despite achieving +20 plants and +60 stems/m^2 in one trial in 2020, a yield of only 5t/ha was achieved due to lower biomass and pod numbers. In this example irrigation was provided by overhead and the GSR and irrigation combined fell below 400mm, whilst in 2020 the only crops to achieve 7t/ha plus had surface irrigation of approximately 500mm at Finley (Red Duplex) and 580mm at Kerang (Grey Clay).

ii) Nitrogen Fixation

Key Points:

- ***Using current estimates, high yielding faba bean crops are removing more nitrogen in the grain than they are supplying in nitrogen fixation.***

Current rules of thumb (for dryland bean crops) for nitrogen fixation are 20kg of N fixed per tonne of dry matter biomass at flowering and estimates of nitrogen removal are 40kg of N per tonne of grain.

Using these estimates, our irrigated faba bean crops are removing up to 300kg N/ha while only supplying 110-190kg N through fixation leaving a large N deficit.

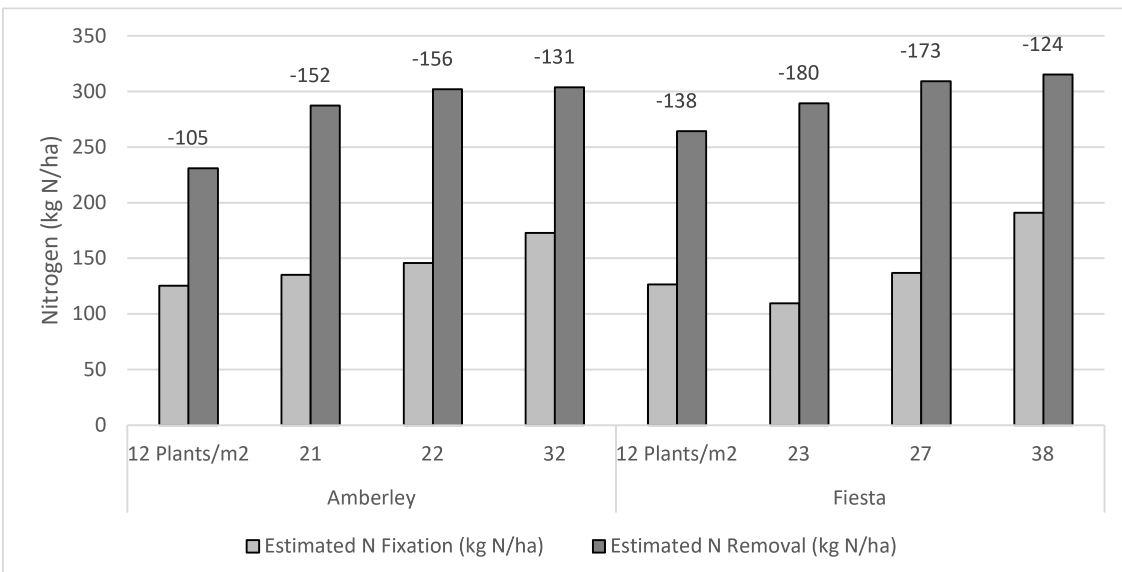

Figure 2. Estimates of nitrogen fixation and removal from high yielding irrigated faba bean crops. Data labels show the nitrogen deficit.

Pre irrigation – it's not just 'add water' and enjoy the high yields

Key Learnings:

- **Water savings can be made with improved irrigation infrastructure such as overhead sprays.**
- **Irrigation districts have varying access to water during the winter season, with some irrigators having no access from mid-May to mid-August.**
- **Not having sufficient soil moisture going into winter may leave the crop susceptible to 'winter drought', that can have a negative impact on yield.**
- **Similarly, having a full soil profile at the beginning of winter may increase the risk of waterlogging, particularly with surface irrigation in systems that don't drain well.**
- **Soil type, location and appetite for risk all play a part in irrigators' decisions regarding pre-irrigation.**

Two years of GRDC's Optimising Irrigated Grains (OIG), on top of research conducted under the 'Smarter Irrigation for Profit' project, have highlighted the irrigation decisions that need to be made by irrigators on how and when to use their irrigation water to set up their irrigated crops to be the most profitable.

The changing irrigation environment has seen irrigation water become an input where the price can be highly variable based on seasonal conditions and allocations. Efforts to make irrigation more efficient has seen investment in improved layouts and infrastructure such as overhead sprinklers or fast flow surface irrigation, giving irrigators flexibility in the amount of water applied and the choice of crops.

Pre-irrigation (where fallow paddocks are irrigated prior to the sowing of a crop) has always been a judgment call by irrigators, based on timing to enable timely sowing and adequate moisture for the crop to develop over winter. Using surface irrigation, this could mean using anywhere between 0.75 to 2.0 Mega litres/ha (75-200mm/ha) to wet up the soil profile. The timing of pre-irrigation must be considered in order to allow the paddock to dry sufficiently to enable sowing on time, but not to dry too much and then be at the mercy of 'the autumn break' for sowing similar to a dryland grower. Many irrigators have a story about the pre-irrigation that went badly – where it rained, and sowing couldn't proceed or winter waterlogging was detrimental to the crop as the soil profile was full going into winter. However, pre-irrigation does provide soil moisture over winter as some irrigation regions do not have access to water between 15 May and 15 August to allow the water authorities to service and repair the water delivery network.

Irrigators have installed overhead irrigation as a means to be able to have more control over the amount of water applied. Instead of the large volume of water applied via surface irrigation as a pre-irrigation, irrigators can apply enough water to ensure timely establishment of their crop. This can be a considerable saving of water but does then run the risk of a 'winter drought' if the winter period is dry and winter rainfall is inadequate to meet the needs of the crop. In these cases, yield potential is lost before the irrigation water becomes available in the spring. In shorter season crops or in warmer regions where spring growth occurs earlier (before mid-August) yield potential starts to be reduced since crops are stem elongating but without the water reserve to sustain this period of rapid development.

The OIG project, with its geographically diverse project partners, has illustrated the different thinking that drives irrigators decision making on irrigation. Higher rainfall regions are unlikely to pre-irrigate due to the risk of autumn irrigating leading to waterlogging if they go into winter with a full profile.

Similarly, those in the east of the Murray and Murrumbidgee valleys are more confident of a timely break for sowing and follow-up winter rainfall to get the crop through to the spring when irrigation can commence. Those to the west who have soils (e.g. grey clays) that require more water to fill the profile, are less confident of the break being in late April/early May and have lower winter rainfall to tide them over until the irrigation season opens in the spring. Depending on the crop type, restoration of yield potential with spring irrigation following a winter drought can be more limited with early maturing wheat, since it has already started developing rapidly whilst the crop is under spring drought conditions. In some cases, the restoration of yield potential is adequate (e.g. faba beans) but this does depend on whether heat stress was additional to the lack of soil moisture and becomes part of the yield equation. These geographical differences also manifest themselves in the responses to disease management where irrigation does not appear to favour conditions that promote the fungal diseases compared to the naturally more disease prone high rainfall zones.

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