Canopy densities and their interaction with pollination

Background
To assess the effect of canopy densities on pollination in dryland Faba Beans. Three trials were set up in Warooka, Penneshaw, and Riverton. This report focuses on the Penneshaw results only.

What was done
These trials were established to demonstrate the effect of crop canopy densities on pollination. Trial sites were established to investigate the effect of seeding rate and row spacing on pollination. Farmer standard fungicide and insecticide regimes were implemented at the sites.

The Penneshaw site was sown with a small plot seeder on 7 inch row spacings and using a chain as a covering device. There was minimal disease. However, there was some grub damage during grain fill.

Past trials investigating the effects of bees as pollinators on crop yields have placed the bees inside a cage. The yield differences inside and outside the cages is then compared. This affects the behaviour of the bees as they spend more time trying to get out of the cage than foraging. In this trial we have done the opposite by placing the bees in the crop and excluding them from a small area by using exclusion tents. This has allowed the bees to forage as they naturally would. The exclusion tents, made from a coarse shade cloth material specifically designed to allow small insects, wind and rain to enter but exclude bees from entering, were placed in the crop.

At the Warooka site an exclusion tent was erected 2 kilometres away from the trial site to assess the tent effect. There was a 13% difference in yield inside the tent compared to outside the tent. However, this result was not statistically significant. There was no significant difference in pods or seeds per stem when comparing inside the tent to outside the tent. It is inconclusive as to whether the yield effect is from 'feral bees' from the nearby scrub pollinating the crop or if the tent impedes the growth of the beans. This yield difference has not been added to the Warooka or Penneshaw in-tent yields and must be considered when analysing yields.

Treatments
Three seeding rates (80kg/ha, 120kg/ha, and 160kg/ha) and three row spacings (7 inch, 14 inch and a paired row (every third tyne removed) were trialled.

Assessments were carried out to measure the number of pods and the number of seeds on each stem to determine where the yield increase was being created. These assessments were carried out on a total of 20 stems per plot at harvest.
In both of the trials the bees were introduced to the crop when 10% of the crop had commenced flowering and removed near the end of flowering.

Results
The 100 grain weights (average of 456 grams per thousand seeds) indicate that moisture may have been a limiting factor at this site. The site showed no increase in seed per pods but significant increases in pods per stem (153%).

Table 1: Yield results form the Penneshaw site.

Trt	Row spacing	Seeding rate	Yield with bees	Yields without bees	% increase
1	Standard	160 kg/ha	2.27	1.99	14
2	Standard	120 kg/ha	2.61	1.50	74
3	Standard	80 kg/ha	3.03	1.44	110
4	Skip Row	160 kg/ha	2.15	1.29	66
5	Skip Row	120 kg/ha	2.18	1.50	45
6	Skip Row	80 kg/ha	2.51	1.29	94
7	Paired Row	160 kg/ha	2.49	1.87	33
8	Paired Row	120 kg/ha	2.79	2.12	32
9	Paired Row	80 kg/ha	2.28	1.39	64
	LSD		0.45	NR	
	Average		2.48	1.60	55

* NR = Not Replicated

The site showed a clear benefit on decreasing the crop canopy in terms of percentage yield increase. In both the standard and the skip row treatments, the lower seeding rate was the highest yielding. This may be due to the increased soil moisture at the site, allowing the plants to bear more seeds per stem and not rely on increased stems per metre.

The yield potential determined by seed and pods per stem indicated that the potential yield increases from decreasing the canopy density may not have been realised in this trial due to the drought.

Another trial was established at Penneshaw to demonstrate how improved pollination can be used on a commercial scale. The site used two row spacings and the same seeding rate to improve canopy structure.

Exclusion tents were used to establish bean yields in the absence of pollination. When compared to the standard row spacing, the wider row spacing in the absence of pollination decreased yields by 31%. Where bees were introduced, the yield increase was 20% higher in the wider row spacing than the standard row spacing.

Table 2: Yields from KI

Treatment	Row spacing	Yield t/ha
Bees present	Standard	2.24
Bees excluded	Standard	1.48
Bees present	Skip Row	2.73
Bees excluded	Skip Row	1.13
LSD		0.62

By decreasing the density of the crop canopy the bees have been able to access flowers lower in the canopy that otherwise would not have been pollinated. This has resulted in a 140% yield increase in the wider rows and a 51% yield increase in the standard row spacing.

Comments:

- All of the sites had hives scattered throughout the trials. The trial sites were located within a large paddock of beans.
- This trial method causes the bees to disperse and the bee densities cannot be maintained within the trial. This results in selective pollination, where the bees forage on the easiest to access flowers, leaving a lot of flowers un-pollinated.

- The hives were not maintained during flowering to the appropriate standard, which may have also resulted in poor pollination of the crops.

Conclusions and into the paddock

Currently we sow beans at high seeding rates. This creates very dense canopies and as this trial clearly shows this limits the amount of pollination that can occur. By creating the thick canopies, growers are limiting the potential yield of the bean crop as demonstrated at Penneshaw.

By creating the dense canopies and then spraying insecticides regularly we substantially reduced the amount of native and feral pollinators in-crop. To create a pollinator friendly environment growers will need to consider the effects of insecticides, the time of day they are sprayed, and the canopy structure on pollinating insects.

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Summary

Bees by nature, will not pollinate a crop with a dense canopy as the bee can damage their wings by knocking them against leaves and stems. This can limit the amount of pollination that occurs in a crop like faba beans. Growers need to consider the effect of canopy densities on pollination effectiveness.

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Take home message

- High seeding densities create dense canopies. Pollinating insects are unable to penetrate the dense canopy
- There is a clear benefit for managing canopy densities when using bees for pollination