Break crop yields benchmarked against wheat in WA

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Key messages

Break crop yields decreased faster in areas with lower yield potentials (e.g. Low rainfall zone) compared with wheat, explaining the reluctance of farmers to grow break crops in such areas.

Low cost, profitable break crop options and agronomy packages need to be developed for WA (especially low rainfall areas).

Despite lower yields than wheat some break crop options may still be profitable due to high prices.

Introduction and aims

Break-crops can provide substantial yield increases in following wheat crops due to decreases in weeds, pests and diseases and increases in nutrient availability (Seymour et al., 2012). Despite this, the area of break crops in WA is still relatively small and in particular the area of legumes has declined substantially. The decision to grow a break-crop or not, and the choice of which break-crop to grow is a balance between future return (break-crop effect) and profitability of the break-crop in its own right. In reality farmers are strongly influenced by the immediate return of a break crop relative to a wheat crop. This is influenced by both price received and the expected yield. Farmers will not plant a new crop if the yields are unacceptably low and ultimately it is unprofitable. It is not only mean yield of a crop that is important but also risk. As such in WA farmers perceive that wheat is the hardiest crop to grow particularly in poor seasons (GRDC, 2017). The aim of this paper is to compare the yields of a range of break crops with wheat across a wide range of yield potentials, by utilising a combination of farmer and experimental data.

Method

Data sources

Six years (2011-2016) of on-farm break-crop and wheat yield data were sourced from the Planfarm-Bankwest benchmark survey. The 8 break-crops were: canola, lupin, field pea, chickpea, barley, oats, triticale and hay. Additional data were taken from published experiments in which break-crops and wheat were grown.

Comparison of break crop yields with wheat

Break crop yields were bench-marked against wheat yields using a linear regression (type II). The yield of wheat was used as a measure of environment and was therefore the x-axis.

Economic analysis

In order to determine the economic implications of these relationships calculated the partial gross margins of each break-crop compared to wheat were calculated. These calculations were performed across a range of predicted wheat yields and calculated the expected yield of each break crop from the regressions above. The break-even point of wheat yield from which growing a break-crop would be more profitable than wheat was calculated. Fixed values for cost of growing a crop ($/ha) and price received ($/t) were used. In reality the input costs of growing a crop and the prices received will vary from year to year. However, this analysis is not intended to be conclusive but to demonstrate the importance of these relationships. Two economic calculations were undertaken for each break-crop. The first only considered the input costs and returns for the current crop compared to wheat. The second also accounted for the extra yield in a following wheat crop (break-crop effect).

Results

For all crops the yields between on-farm data and published experiments were in complete accord (Figures 1 and 2). This confirms that the experimental results are relevant to on-farm situations.

Cereal yields

As expected, cereal yields were all comparable to wheat (Figure 1). In total there were 1040 yield comparisons of barley and wheat and a strong positive relationship between yields (r^2=0.63) (Figure 1a). Yields of barley and wheat were equal when the yield of wheat was 1.25t/ha. Below this wheat tended to yield more than barley. Above, this value barley tended to yield more than wheat. In extremely low yielding situations (<0.15t/ha) it was expected that there was no barley yield.

In total there were 49 yield comparisons of triticale and wheat, therefore the results need to be interpreted with caution. There was a strong positive relationship between yields of triticale and wheat (r^2=0.67) (Figure 1c). Triticale tended to yield less than wheat in most environments, but the difference became less as yield potential increased in low yielding environments. When wheat yield was less than 0.8t/ha it was expected that there was no triticale yield.

In total there were 505 yield comparisons of oats and wheat but only a weak positive relationship between yields (r^2=0.26) (Figure 1b). Yields of oats and wheat were equal when the yield of wheat was 2.04 t/ha. Below this wheat tended to yield more than oats, whereas above this value oats tended to yield more than wheat. In low yielding situations (<0.7 t/ha) it was expected that there was no oat yield.

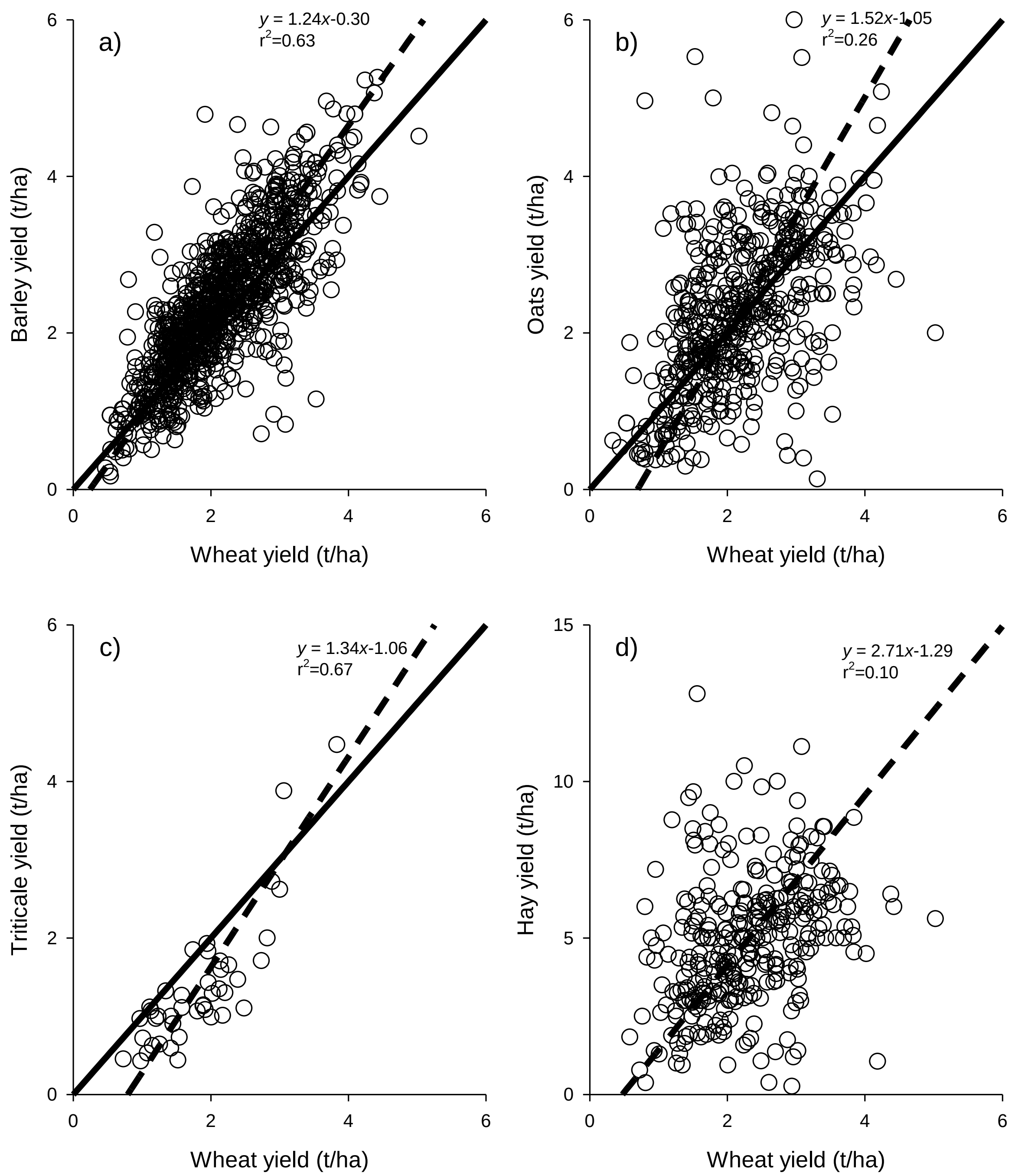

Figure 1 Relationship between WA cereal (barley, oats, triticale and hay) and wheat yields. Open circles are on-farm data and red circles are published experimental data. In each panel the dotted line is the regression line and the solid line is the 1:1 line provided for comparison.

There were 316 yield comparisons of oaten hay and wheat, and a negligible positive relationship between yields (r^2=0.10) (Figure 1d). Hay yields increased by 2.7t/ha for each 1t/ha increase in wheat yield. When wheat yield was less than 0.5t/ha the expected hay yield was 0 t/ha. The poor relationship between wheat and hay yields was probably because hay yield is cut at an immature stage and does not depend as strongly on the end of season rainfall to complete grainfilling. This poor relationship between hay and wheat yields is a strength of hay as an income diversification option. This is because when wheat yields are low the yields of hay are not necessarily low.

Broadleaf break-crop yields

In general the yields of the broad-leaf break-crops were all less than wheat (Figure 2). In total there were 973 yield comparisons of canola and wheat and a strong positive relationship between yields (r^2=0.54) (Figure 1a). In extremely low yielding situations (<0.15t/ha) it was expected that there was no canola yield. Above this canola yield increased by 0.56 t/ha for each 1 t/ha increase in wheat yield (Figure 2a). This relationship is consistent with a yield ratio of 0.4-0.6 t/ha canola to wheat (Holland et al. 1999). However, at low yield levels the ratio will be smaller. Of all the broad-leaf break-crops analysed canola had the lowest wheat yield that was required to produce a canola yield and a high r^2. This indicates that with current varieties and practices it was the lowest risk option.

In total there were 913 yield comparisons of lupin and wheat and a moderate positive relationship between yields (r^2=0.44) (Figure 2b). In low yielding situations (<0.37 t/ha) it was expected that there was no lupin yield. Above this lupin yield increased by 0.77 t/ha for each 1 t/ha increase in wheat yield (Figure 2b).

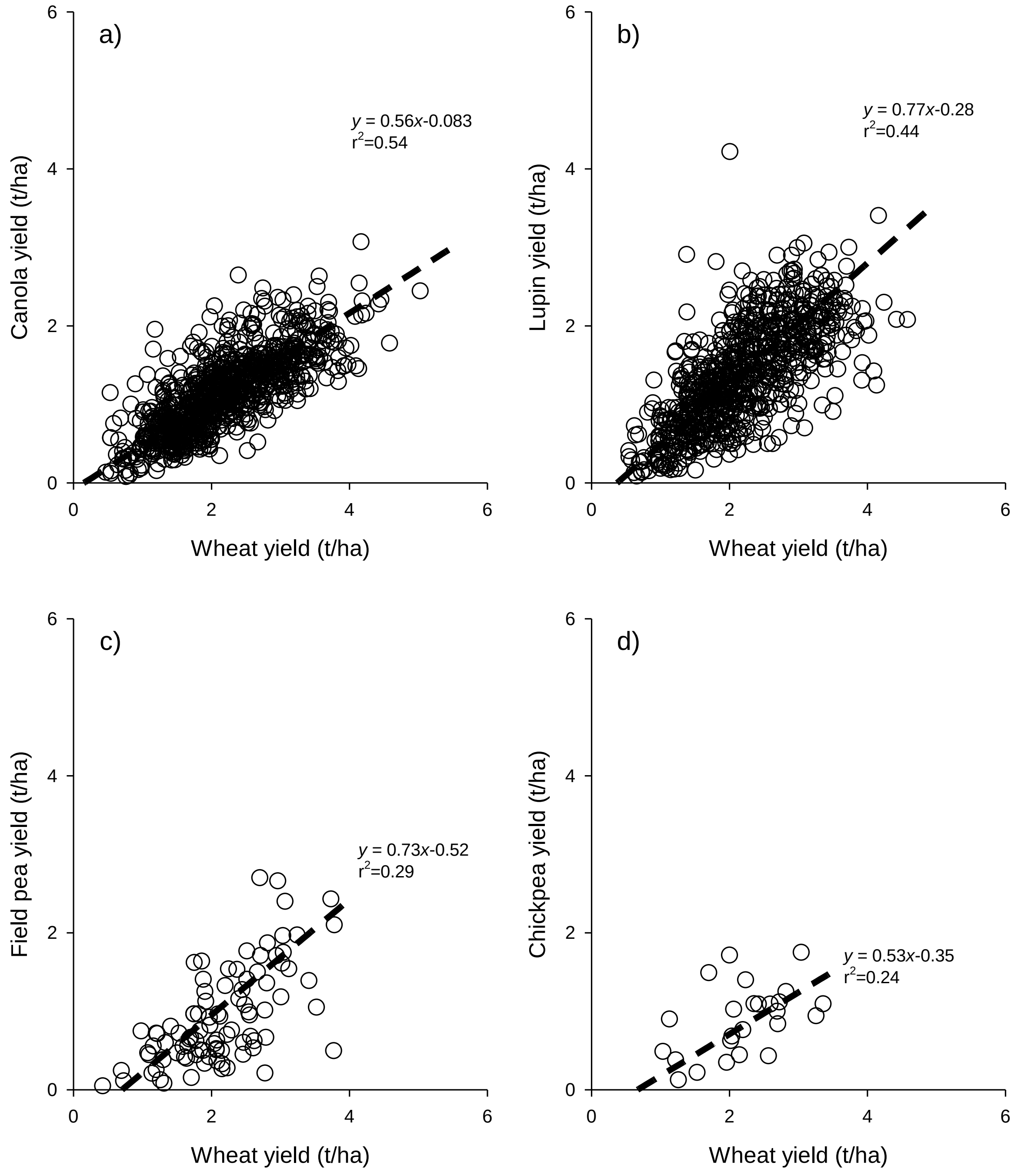

Figure 2 Relationship between WA broadleaf break-crops (canola, lupin, field pea, and chickpea) and wheat yields. Open circles are on-farm data and red circles are published experimental data. In each panel the dotted line is the regression line.

In total there were 138 yield comparisons of field pea and wheat and a weak positive relationship between yields (r^2=0.29) (Figure 2c). In low yielding situations (<0.70 t/ha) it was expected that there was no field pea yield. Above this field pea yield increased by 0.73 t/ha for each 1 t/ha increase in wheat yield (Figure 2c). There were a large number of field pea crops that yielded much higher than this average relationship. However, the low r^2 represents the higher risk of failure when growing this crop compared to wheat. The low yielding field pea crops occurred throughout the range of wheat yields (in both experiments and on-farm). This indicates that many of these failures were not due to environmental risk (rainfall). Research needs to identify the underlying factors leading to these crop failures.

In total there were 39 yield comparisons of chickpea and wheat, therefore the results need to be interpreted with caution. There was a weak positive relationship between yields (r^2=0.24) (Figure 2d). In low yielding situations (<0.65 t/ha) it was expected that there was no chickpea yield. Above this chickpea yield increased by 0.53 t/ha for each 1 t/ha increase in wheat yield (Figure 2d). Similar to field pea, the low r^2 represents the higher risk of failure when growing chickpea compared to wheat.

Economic analysis of break-crops

An example of economic analysis is provided in Figure 3 for canola. This shows that if only the current years return and input costs are taken into account, canola will be more profitable than wheat when wheat yields exceed 3.2t/ha, for yields less than this wheat would be more profitable. If a yield benefit to a following wheat crop of 0.4 t/ha is taken into account canola will be more profitable than wheat when wheat yield exceeds 1.2 t/ha.

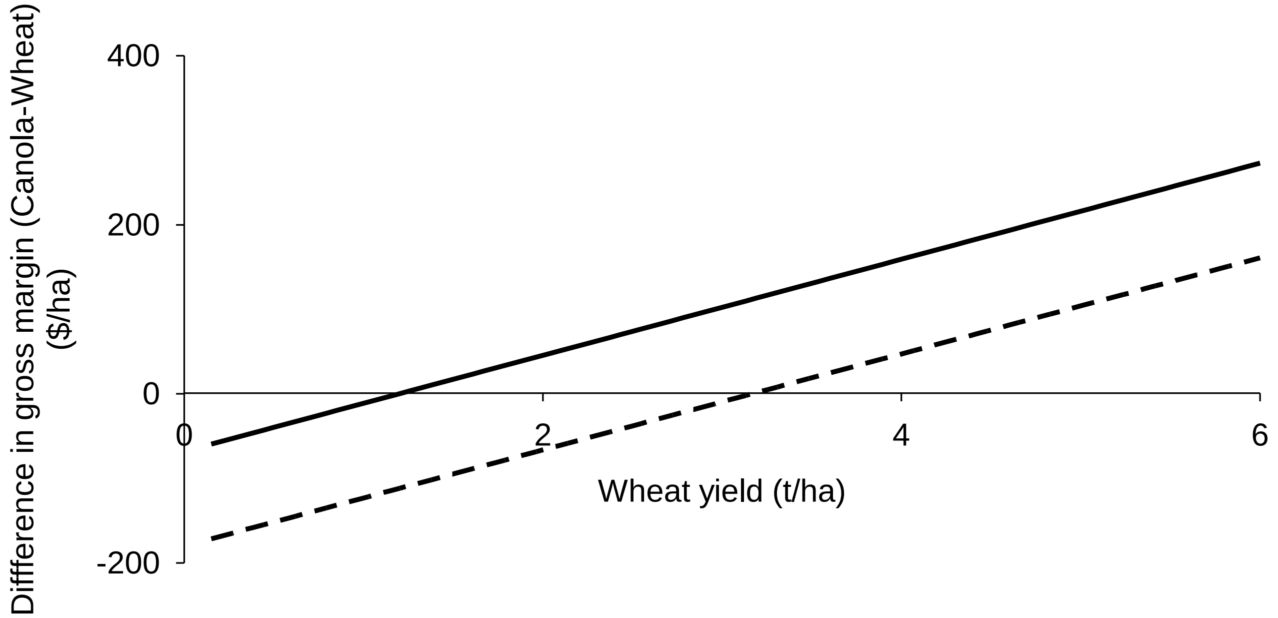

Figure 3 Example of gross margin for canola compared to wheat. The dotted line is for this years returns and costs only, the solid line accounts for a yield boost in a following wheat crop of 0.4 t/ha.

A similar pattern was found for all other crops except triticale and lupin. With the assumed costs and prices in Table 1 triticale was never more profitable than wheat, due to low yields (Figure 1c) and low prices received. For lupin if only the current years return and costs are taken into account lupin was never more profitable. If a yield boost to a following wheat crop of 0.6 t/ha is taken into account lupin will be more profitable than wheat when wheat yield is less than 1.8 t/ha. When wheat yield exceeds 1.8t/ha it will be more profitable.

Table 1 Assumed input costs, prices and the calculated yield when break crops is more profitable.

Crop	Variable costs ($/ha)	Price ($/t)	Yield benefit for following wheat crop (t/ha) [1]	Yield of wheat when break crop is more profitable	
				In-season only	Allowing for yield benefit
Wheat	280	280	-	-	-
Barley	280	250	0	2.9	2.9
Triticale	280	220	0	Never	Never
Oats	280	265	0.35	2.5	0.5
Hay	350	210	0.2	1.1	0.9
Canola	320	520	0.4	3.2	1.2
Lupin	280	310	0.6	Never	1.8[2]
Field pea	250	390	0.45	5.2	2.7
Chickpea	300	700	0.6	2.3	1.6

[1] (Seymour et al. 2012), (Angus et al. 2015), (French et al. 2015), (Malik et al. 2015)
[2] Lupin is more profitable when wheat yield is less than 1.8 t/ha, above this wheat is more profitable.

Conclusion

The decision to grow a break crop is at least partly determined by the yield of that crop relative to wheat. For all break crops in this analysis their yields were more sensitive in low yielding environments compared to wheat. This indicates that they were all more risky than wheat, particularly in these environments (low rainfall). This explains the reluctance of farmers to grow break crops in low yield areas. Despite these low yields break-crops were still profitable in many situations due to high grain prices, particularly when the future yield benefit to wheat was taken into account.

Canola was the most consistent break-crop in low yielding environments. Lupin was also profitable in low yielding years due to a large benefit to a following wheat crop. However as wheat yields increased it became less profitable due to low yields and prices. Low, cost, profitable break crop options and agronomy packages need to be developed for low yielding areas of WA

Key words

Crop choice, break crop, yield, economics

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