Constraints to canola yield in central and southern NSW

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Abstract

- A comparison of CropCheck records has demonstrated that the grain yield of dryland canola crops has declined by 9% and irrigated crops by 17% between 1991 and 2001.
- Most significant changes during this period have been the widespread adoption of TT canola varieties and reduced/no till techniques and an increased frequency of canola in crop sequences.
- Dryland farming practices that had a significant impact on grain yield were crop sequence, canola variety, and amount of sulphur applied, sowing date, tillage practices and the growing season rainfall (GSR).
- Irrigated farming practices that had a significant impact on grain yield were both the canola type (conventional or TT lines) and variety, amount of N fertiliser applied, the length of growing season and the growing season water used to grow the crop.
- Further research is required to identify the impact of these practices on canola grain yield and to further refine best management.

Key words
canola, yield, crop rotation, tillage, nutrition, growing season rainfall

Introduction

The value of canola as an integral component of farming systems in the central and southern winter crop zone caused the average area to increase from 84 000 ha (1991/95) to 270 000 ha in 1998/2002 or almost 20% of total winter cropping area. Despite this rapid growth there was widespread concern that canola had become less profitable due to an apparent grain yield decline since 1996. Since 2000 the area allocated to canola has decreased from 20% to 12% in 2003.

This shift in grower attitude away from canola prompted a review of canola paddock records collected by farmers and agronomists between 1991 and 2001. The project funded by GRDC, aimed to quantify any decline in canola yields and to identify the constraints to production of both dryland and irrigated canola crops.

A total of 2151 records were analysed comprising 1658 dryland crops and 493 irrigated crops. The study assessed the impact of rainfall and irrigation, crop rotation, soil management, seeding system, variety, sowing time, seeding rate, crop nutrition, harvest date and growing season length on grain yield. The data was analysed using step-wise regression and chi-square test.

CROP PERFORMANCE

Dryland crops

Long-term grain yield of dryland crops decreased by 9% (P=0.018) between 1991 and 2001. The weighted[1] mean yield for the top 20% of dryland canola paddocks was 30% higher, at 2.45 t/ha, than the weighted mean yield of 1.89 t/ha for all dryland crops. The weighted mean yield of the bottom 20% of canola paddocks was 32% lower at 1.29 t/ha than the weighted mean yield of all dryland crops (1.89 t/ha).

[1] Weighted mean grain yields were calculated by averaging the dryland and irrigated crop mean yields for each year between 1991 and 2001.
[2] GSW is the total application of water and includes in-crop rainfall plus irrigation water.

Factors that were found from the regression analysis to contribute significantly to higher grain yield of dryland crops were:

- ***Crop sequence*** The sowing of canola after a legume based pasture produced the highest average yields (2.17 t/ha). Canola that followed a grassy pasture produced an average of 2.11 t/ha of grain and when sown after a previous cereal crop produced an average of 1.94 t/ha. Canola sown after fallow produced higher yielding crops when growing season rainfall was below average, but showed a reduced grain yield when rainfall was above average.

- ***Poor grain yield response to applied fertiliser*** The application of 120 kg S/ha increased average grain yields by 0.13 t/ha. Applied phosphorus and nitrogen did not provide a consistent increase in yield.

- ***Sowing date*** Early sowing (20April) increased average yields by 0.25 t/ha compared to sowing late (10 June).

- ***Variety selection*** Rainbow, Oscar, Pinnacle, Dunkeld, Grouse and Ripper were the best performing varieties for dryland canola production. Pinnacle produced yields similar to the more popular conventional varieties. The long-term yield trend of Oscar, which was the most popular variety in the dryland zone between 1991 and 2000, did not show yield decline in either the farmer crops or NSW Agriculture S4 variety analysis.

- ***Water use efficiency*** The largest proportion of canola crops had a WUE between 6 – 8 kg grain/ha.mm. The multiple linear regression analysis predicted grain yield was highest at a WUE of 6.2 kg grain/ha.mm. Subsoil compaction may be restricting the uptake of soil water as cultivation with a chisel plough followed by conventional tillage produced higher WUE than conventional tillage or direct drill practices when growing season rainfall (GSR) was less than 360 mm.

Irrigated crops

Long-term yields of irrigated canola crops decreased by 17% over the 11-year period ($P<0.001$). The weighted[1] mean yield for the top 20% of irrigated canola paddocks was 37% higher, at 3.06 t/ha, than the weighted mean yield of all crops at 2.24 t/ha. Whereas the yield of the bottom 20% of irrigated crops was 41% less than the overall weighted average of 1.37 t/ha.

Factors found to contribute significantly to higher grain yield in irrigated crops were:

- ***Irrigation water*** High applications of GSW water[2] (6 ML/ha increased grain yield by 38% when compared with 1ML/ha).

- ***Fertiliser application*** Higher fertiliser applications of 150 kg N/ha/yr produced a 22% increase in yield; 60 kg P/ha/yr produced an 11% increase in yield.

- ***Growing season length*** A long growing season of 220 days resulted in 22% higher yields than a shorter growing season of 130 days.

- ***Variety selection*** Variety selection was important with Hyola 42, Ripper, Charlton, Rainbow, Oscar and Pinnacle being the best performers. TT varieties increased in popularity in recent years but tended to produce 20% less yield than the regular varieties. The long-term yield of Oscar, which was also the most popular variety in the irrigated zone between 1991 and 2000, showed a decreased yield in both the irrigated crops and NSW Agriculture irrigated S4 variety trials. This pattern of yield decline could implicate disease as a factor contributing to this decline, however no disease data was collected.

Comparison of highest and lowest yielding crops

A comparison of average yields and inputs for the highest and lowest yielding 20% of dryland and irrigated crops is presented in Table 1. The average yield of the highest yielding 20% of **dryland** crops was 105% higher than the average yield of the lowest yielding 20% of crops. Similarly, the average yield of the highest yielding 20% of **irrigated** crops was 156% higher than the average yield of the lowest yielding 20% of crops.

Table 1. Yield and inputs of highest and lowest yielding dryland and irrigated canola crops

Parameter	Dryland crops		Irrigated crops	
	Highest 20%	Lowest 20%	Highest 20%	Lowest 20%
Yield (t/ha)	2.55	1.25	2.92	1.14
Day sown (Day)	14 May	15 May	2 May	6 May
Growing season (days)	-	-	207	206
WUE (kg grain/ha/mm GSR)	11.2	5.4	10.5	4.4
Irrigation (ML/ha)	na	na	1.6	1.1
Nitrogen (N) kg/ha	47	52	105	68
Phosphorus (P) kg/ha	21	21	32	23
Sulphur (S) kg/ha	26	23	54	27

The difference in fertiliser inputs of dryland crops was negligible with the higher yielding crops receiving 9% less N and 10% more S. In contrast, the highest yielding irrigated crops had 46% more irrigation water, 140% higher water use efficiency (WUE), 54% more applied N, 39% more applied P and 100% more applied S when compared with the average inputs of the lowest 20% of crops.

CHANGES IN FARMING PRACTICES

The most noticeable changes in farming practices over the 11-year period were:

1. More intensive cropping programs, resulting in more canola crops being sown after a cereal crop (64% in 2001) than following a pasture phase (35%). The frequency of canola as the second last crop during the same time increased from 2% to 32%.
2. The release and rapid adoption of TT varieties resulted in the area sown to these varieties account for 33% of the total canola grown.
3. There was a major shift from numerous cultivation (66% of crops in 1991/93) operations to no-till and reduced tillage systems (51% of crops in 1999/2001). This was accompanied by a large increase in the use of herbicides rather than tillage for land preparation. There has since been a return to one tillage operation prior to seeding.
4. A shift from full tillage (90% of crops in 1991/93) operations to minimal soil disturbance for seeding (58% of crops in 1999/2001).
5. Increased rates of S from 1991/1993 to 1999/2001 in both dryland crops 25 to 31 kg S/ha and irrigated crops 27 to 107 kg S/ha.
6. Increased rates of N from 1991/1993 to 1999/2001 in both dryland crops 42 to 50 kg N/ha and irrigated crops 62 to 82 kg S/ha.
7. Average P applications increased between 1991/1993 to 1999/2001 to 18 to 24 kg P/ha.

FUTURE DIRECTIONS

Analysis of the canola check data showed there are considerable opportunities to increase commercial canola crop yields by focusing on the following issues:

- Increased water use efficiency through deeper tillage to improve water management of both dryland and irrigated crops by reducing sub-soil constraints.
- N, P and S fertiliser studies to match supply with crop demands when subsoil constraints are not limiting.
- Reliable early crop establishment for both dryland and irrigated crops.

- The breeding of cultivars with a similar maturity to Hyola 42 for the irrigated zone.
- The use of simple crop recording forms that have an additional focus on soil management and pest occurrence for entering canola paddock records into the Cropcheck database at Finley.
- The use of the Cropcheck program based at Finley to undertake an annual review of crop performance across zones so that farmers and farmer groups have better feedback on canola performance.
- A review, at five-year intervals, of the past decade of canola paddock records to document shifts in canola cultural practices and impacts on production.
- Although information on disease of canola crops was not specifically collected under the crop check programs, it is recommended that a disease survey, especially of irrigated crops be undertaken as these crops exhibited the greatest yield decline in both farmer crops and NSW Department of Primary Industries S4 variety trials.

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