Recovery following early water deficit in April sown wheat and canola

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Key messages

Early water deficit caused nearly 40% grain yield reduction in both canola and wheat but canola showed recovery with both winter and spring rainfalls in contrast to wheat which responded only to spring rainfall.

Under the given early water deficit conditions of 2013 at Merredin, irrigation equivalent to 15 mm rainfall in May produced an extra 400kg/ha of canola and about 1000kg/ha of extra wheat grain which is way more than the 300kg/ha wheat calculated assuming 20 kg/ha/mm rainfall in a French & Shultz equation. It seems unlikely that such a heavy shortfall in that early phase can be fully recovered with good growing conditions later in the season.

Seasons when crops could survive the early water deficit, canola seems to be a better candidate for dry sowing.

Aims

Early water deficit can reduce seed germination, seedling establishment and development and growth of all crops. Species differ in growth pattern and development of yield components and will have varying capacity to compensate and recover from damage after rainfall at the end of the dry period. This issue is particularly important for dry and early sowing as the risk of encountering damaging or lethal water deficit is higher than later moist sowings. The objective of this experiment was to compare wheat and canola for relative damage and recovery in a low rainfall zone (Merredin) so that growers can make an informed decision about the risks associated with early or dry sowing.

Method

Drip irrigation was used to impose differences in available soil water in rain-fed wheat and canola on a gravelly sandy loam soil at Merredin in 2013. Wheat variety Yitpi and canola variety Telfer were subjected to three timings of irrigation (establishment, mid vegetative and grain filling) and plant responses were recorded for plant establishment, crop growth, development and grain yield. Soil water was also measured in the top 20 cm layer.

The crops were sown in moist soil on 30 April. Irrigation dates were 28 May (Irri-1), 10 July (Irri-2) and 13 September (Irri-3). At each irrigation time, drip irrigation was used to apply systematically increasing amounts of water to sequential plots- creating a gradient of water availability with 11 steps. The gradient in Irri-1 ranged from nil to 15 mm in 1.5 mm increments while the other two were 0-30 mm in 3.0 mm increments. Fertiliser rate of 80 kg/ha of Agras at sowing followed by 25 kg/ha of urea on 24 July was used.

Results

Rainfall

Rain during March (48 mm, decile 8) and April (13 mm, decile 4) ensured good stored soil moisture at planting. By late May (29 mm decile 4) rainfed wheat and canola were showing symptoms of water deficit which persisted for June (8 mm, decile 1) and July (36 mm decile 3). August (43 mm, decile 6), September (50 mm, decile 9), and Oct (20 mm, decile 7) provided a soft finish to a challenging season.

Crop establishment

Crop emergence was good and uniform and seedling mortality was low across the trial. Seedling emergence and mortality were similar across the gradient of water availability imposed in late May.

Development

The development responses such as change in flowering date due to irrigation were too small to be of any significance and almost vanished by the time of anthesis.

Growth

Differences in biomass with Irri-1 treatment were evident in Canola at 40 DAS but were not evident in wheat until after tillering was complete (65 DAS) (data not shown).

Higher amounts of irrigation water applied on the 28 May resulted in higher crop biomass production measured at wheat anthesis (165 DAS). A clear increase in canola biomass production by this time was also evident in response to more applied water for this irrigation timing. In contrast, augmenting soil water availability in July (Irri-2) had little influence on canola biomass and only increased wheat biomass at the higher end of the treatment range (Figure 1).

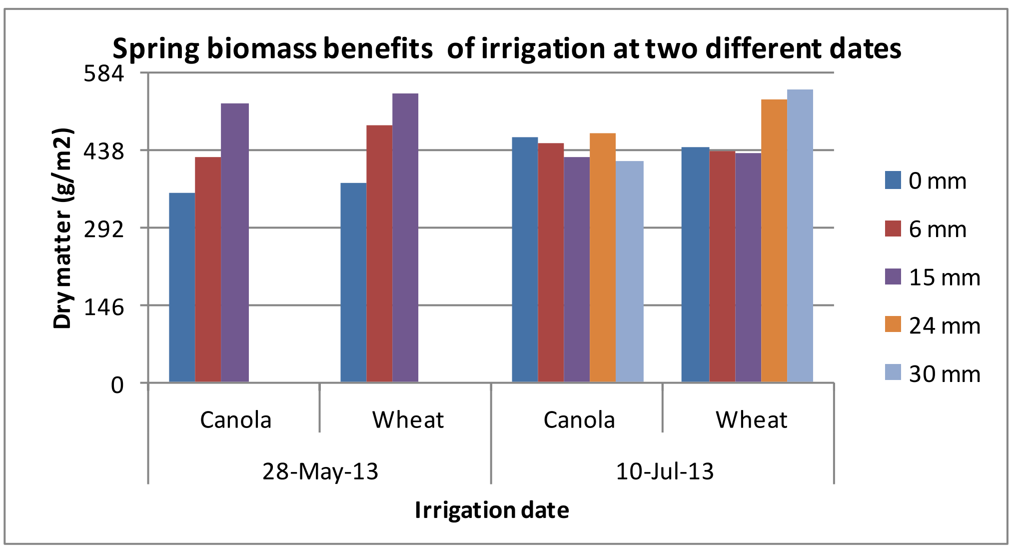

Figure 1 Biomass of canola and wheat in spring after application of irrigation gradients in May and July. Gridlines are one lsd apart.

Grain yield

Grain yield differences due to irrigation were significant for both the crops.

Yield in Irri-1 (Figure 2) increased at a slope of about 30 kg/ha/mm for canola compared to 70 kg/ha/mm for wheat. Using these slope values, the calculated advantage of 15 mm at early stage meant an extra 0.4 t/ha of canola and 1.0 t/ha of wheat. These values are way more than the expected benefits. For example, slope of 70kg/ha/mm for wheat is more than three times the maximum benefit of 20 kg/ha/mm used as the standard in French and Schultz's equation. Assuming an EPR of $530 for canola and $320 for wheat, the 15 mm additional water at Irri-1 resulted in an extra income of about $220/ha for canola and $340/ha for wheat. This experiment, therefore, has highlighted the relatively very high importance of moisture stress early in the lifecycle. Nevertheless, it may be noted that that the later irrigations were probably not so important in season 2013 because of its relatively soft finish.

However, a caution needs to be exercised when interpreting and using this information. The lsd values in this experiment are generally higher than expected.

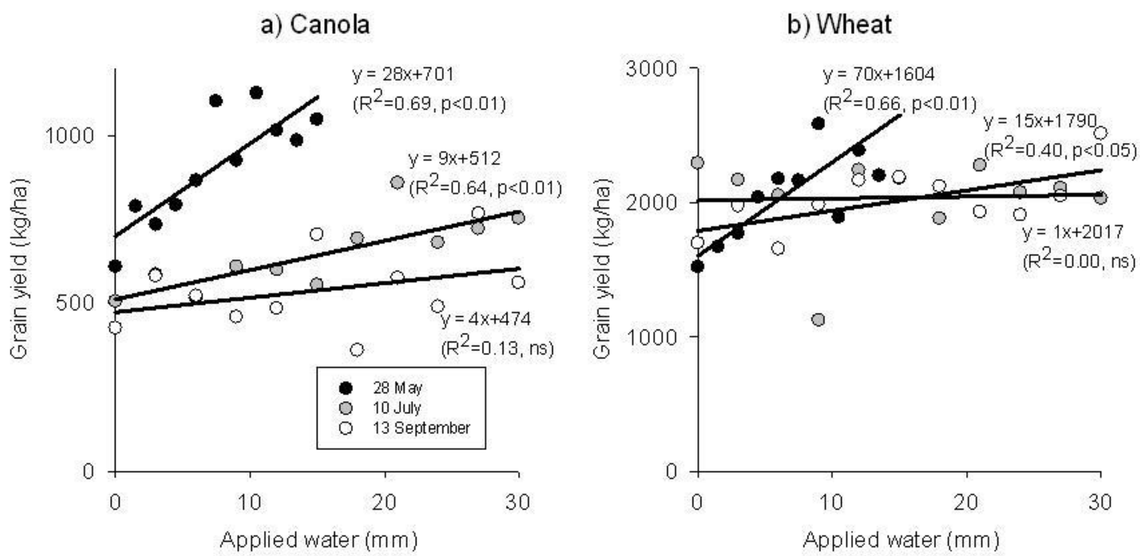

Figure 2 Grain yield benefit of irrigation in May, July and September.

Yield benefit due to later irrigations was relatively less conspicuous. The rate of response at these timings might have been masked by good spring rains.

Yield components

Additional amounts of water applied at Irri-1 resulted in an increase in the number of fertile spikelets/head which in turn led to larger spikes and a significantly greater number of grains/m^2. Likewise, the yield benefit in canola also came through an increased number of grains per unit area which was associated with an increased number of pods.

Practical situations

A summary of the comparable effects is shown in Table 1.

The damage (%) due to early water deficit is about the same for both wheat and canola but unlike wheat, canola has more chances to recover. Canola showed a positive response to both the winter and spring irrigations although the level of benefit declined as the season progressed (52% winter irrigation, 30% spring irrigation). In contrast, although wheat suffered a similar percentage of yield loss due to early water deficit, winter rains hardly caused any response (2%); but then, the spring rains produced a good 27% yield response. These observations are in line with what we anticipated from the patterns of yield component development in the two crops.

Hence, if the seasonal forecast, initial soil water status and stubble cover are good enough to suggest that a reasonably good plant population can be established, canola might be a better candidate for dry sowing in the wake of early water deficit.

Table 1 A comparison of results for different possible combinations of the parts of a season. Yield response was calculated on the estimated values using linear slopes of grain yield on irrigation amounts and expressed as percentage of the watered treatment against the nil treatment within same timing of irrigation.

	Part of the season			**Treatment in our Expt.**	**Yield implication[3,4]**		
	Early	**Winter**	**Spring**		**Canola**	**Wheat**	**Comment**
Moisture condition 2013	Deficit	Deficit	Good				
Possible combinations of parts of the season	Deficit	Deficit	Deficit	None[1]			
			Good	0-0-0	<u>% recovery of the initial damage with spring irrigation</u>		
			Good+30 mm	0-0-30	45	39	Yield response to spring irrigation about 30% for both crops
		Good	Deficit	None[1]	<u>% recovery of the initial damage with winter irrigation</u>		
			Good	0-30-0	76	3	Yield response to winter irrigation 52% for canola compared to only 2% for wheat
	Good	Deficit	Deficit	None[1]	<u>Yield damage due to Early Water Deficit</u>		
			Good	15-0-0	40	41	About 70% yield response to May irrigation
		Good	Deficit	None[1]			
			Good	None[2]			

[1] No treatment corresponds to this situation as precluded by good spring rains
[2] No treatment corresponds to this situation as precluded by lack of supplementary irrigation on earlier sets
[3] Yield damage= (Yield 15mm May irrigation - Yield 0mm May irrigation) / (Yield 15mm May irrigation) x 100
[4] % recovery = (Damage 0mm May irrigation - Damage despite 30mm late irrigation) / (Damage 0mm May irrigation) x 100

Conclusion

Water deficit early in the season can be more damaging than generally perceived.

Between the two crops, canola showed greater flexibility to recover from early water deficit when water availability improved as it could use additional water to develop more pods anytime from first appearance of pods until mid spring.

Late irrigation had less benefit but that was probably due to combined effect of good late rains and a reduced yield potential due to early water deficit.

The crop comparison presented in this paper is based on only one experiment and these relative responses can vary with crop cultivar, disease management and fertiliser regimes.

Key words

Dry seeding, early water deficit, yield components, yield compensation, rainfed

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