MANAGING EARLY SOWN WHEAT IN A DRY SEASON

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TAKE HOME MESSAGES

- Winter wheats sown early can match but not exceed yields of locally adapted spring wheats sown in their optimal window (eg. Scepter sown late April-early May).
- It is only advantageous to sow winter wheats early if they are replacing paddocks that would otherwise be sown too late, or used for dual purpose.
- In a very dry growing season sowing earlier than late April reduced yields when stored soil water was present after a long fallow.

BACKGROUND

An increase in farm sizes and more diverse cropping systems is putting pressure on sowing programs making it challenging to have all crops sown in their optimal windows. Having the ability to sow wheat earlier could be a useful tool to increase whole-farm wheat yield and capture value from late summer rains. Early sowing of spring varieties commonly grown in the region increases the risk of frost damage due to flowering occurring earlier than the optimal window. Winter wheats, however, can provide a wider sowing window while offering a more stable and suitable flowering period. This is due to one of the key drivers of maturity in winter wheat varieties – vernalisation. Vernalisation is a genetically determined requirement for a variety to experience a certain amount of low temperatures (0-16°C) before a switch from vegetative to reproductive growth is made.

The GRDC Early Sowing project (CSP00178) highlighted that winter cultivars were best suited to early sowing but that there was a lack of adapted winter cultivars to the Mallee region for growers to use. Since this time, germplasm has been identified and bred to potentially fit the early sowing window better in these more marginal environments (Eastwood *et al.* 2017).

Some of these new varieties are being trialled for their suitability to medium and low rainfall zones in a new project- GRDC Management of Early Sown Wheat. The aim of this current project is to look at three key areas in the management of early sown wheat including, what variety to sow when, how much rain is needed to establish and aid early growth of winter lines, and what sowing rate, nitrogen and grazing strategy best suits these winter lines. BCG is undertaking the first two of these experiments.

In 2017 BCG undertook two experiments at Curyo and Longerenong (Angel *et al*. 2017). One, looking at varieties and sowing time and the other assessing the response of varieties to different amounts of irrigation (simulating rainfall) for establishment through irrigation. These experiments were repeated in 2018 at Narraport and Rupanyup and are described below.

AIM

Experiment 1: To investigate the suitability of new and pre-release winter wheat varieties to the Wimmera and Mallee and define their optimal time of sowing.

Experiment 2: To investigate the amount of rainfall required to establish an early sown winter wheat crop in the Wimmera and Mallee.

PADDOCK DETAILS

Table 1. 2018 site details (both experiments were run at both sites).

Site details	Narraport	Rupanyup
Crop year rainfall (Nov-Oct)	200mm	310mm
GSR (Apr-Oct)	138mm	226mm
Soil type	Clay	Clay
Starting soil moisture (mm)	76	45
Paddock history	2017 fallow, cultivated	2017 lentils

Experiment 1 details

Crop type: Refer to Table 2

Treatments: Refer to Table 2

Target plant density: 150 plants/m^2

Seeding equipment: Knife points, press wheels, 30cm row spacing

Sowing date: Refer to Table 3

Replicates: Four

Harvest date: Narraport – 30 November 2018
Rupanyup – 6 December 2018

Table 2. Experiment 1 treatment outline and variety maturities for Narraport and Rupanyup.

Varieties	Maturity	Winter/spring
ADV13.1292 (Rupanyup only)	Mid	Winter
ADV15.9001 (Narraport only)	Fast	Winter
Cutlass	Mid	Spring
DS Bennett (ADV11.9419)	Slow	Winter
Illabo (V09150-01)	Mid-fast	Winter
Kittyhawk	Mid	Winter
Longsword (RAC2341)	Fast	Winter
LPB14-0392	Very slow	Spring
Scepter	Fast	Spring
Trojan	Mid-fast	Spring

Table 3. Sowing dates of experiment 1 and 2 at Narraport and Rupanyup.

Time of sowing (TOS)	Narraport	Rupanyup
TOS1	20 March	22 March
TOS2	3 April	6 April
TOS3	17 April	20 April
TOS4	1 May	2 May

Experiment 2 details

Crop type: Refer to Table 4

Treatments: Refer to Table 4

Target plant density: 150 plants/m^2

Seeding equipment: Knife points, press wheels, 30cm row spacing

Sowing date: As per Experiment 1 (Table 3)

Replicates: Four

Harvest date: Narraport – 30 November 2018
Rupanyup – 6 December 2018

Table 4. Experiment 2 treatment outline at Narraport and Rupanyup sites.

Varieties	Irrigation at sowing (mm)
DS Bennett (ADV11.9419)	10
Kittyhawk	25
Longsword (RAC2341)	50

TRIAL INPUTS

Fertiliser: Granulock® Z + Impact® @ 60kg/ha at sowing and 100kg/ha of urea on 4 July (both sites)

Herbicide, insecticide and fungicide: Managed to best practice

Seed treatment: Gaucho® @240mL/100kg and Evergol® Prime @ 80mL/100kg

METHOD

Experiment 1 was a randomised block split plot design. Experiment 2 was a randomised block split-split plot design.

All plots received 10mm of water through drip irrigation immediately post sowing to guarantee emergence, with irrigation plots receiving further irrigation at the same time as required by treatment (Table 4). Assessments included emergence dates, establishment counts, NDVI, development staging to capture the start of stem elongation, head emergence dates (as a proxy for flowering which usually occurs a few days later), floret sterility, plant height, harvest index and plot harvest for yield and grain quality data.

Trials were analysed using mixed linear models.

RESULTS AND INTERPRETATION

EXPERIMENT 1 RESULTS

Establishment

Established plant numbers generally increased with later sowing at both sites except for the first TOS at Rupanyup (Figure 1). A similar trend was seen in 2017 at both Curyo and Longerenong and is thought to be the result of higher soil temperatures which can reduce coleoptile lengths of seedlings and rapidly dry the seed bed.

With only 10mm of irrigation at establishment and no follow up rain, the majority of plants in TOS1 at Rupanyup died due to severe moisture stress. No further data will be presented on this TOS due to very low surviving plant numbers.

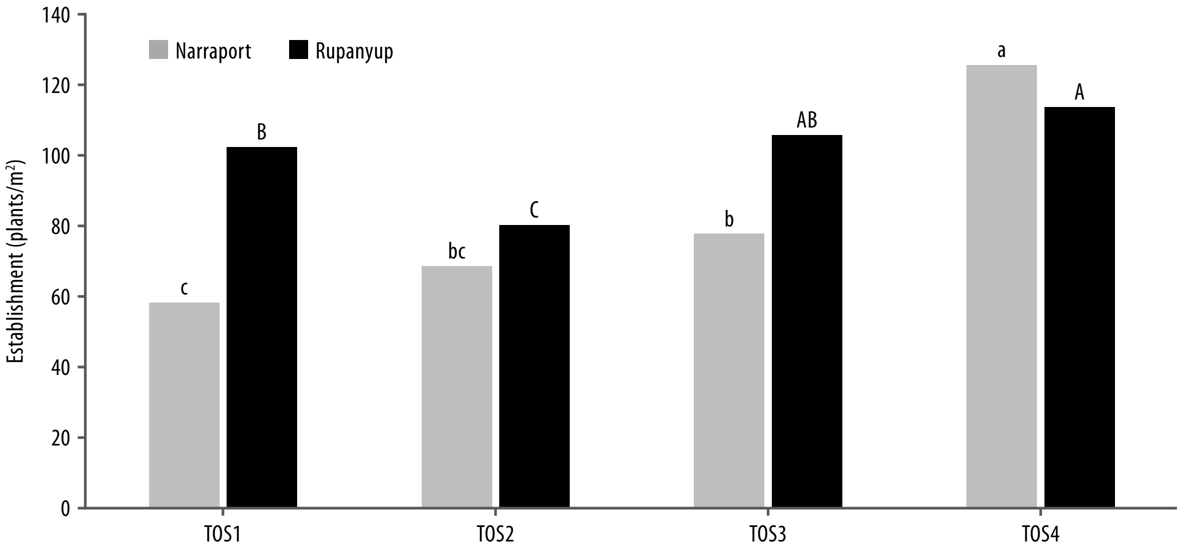

Figure 1. Mean plant establishment (plants/m²) of all varieties at different sowing times in experiment 1 at Narraport and Rupanyup. Letters represent significant difference.

Establishment followed a similar trend at Narraport to Rupanyup. However, at Narraport there was a variety by TOS interaction with establishment for some varieties. Illabo established the highest number of plants at the first TOS and established well along with Kittyhawk in the second TOS (data not shown).

Head emergence and yield

Narraport

All varieties yielded highest at the fourth TOS (30 April). Yields of Scepter, Cutlass, Trojan, Longsword, ADV15.9001 and LPB14-0392 at this TOS were the highest in the trial and not significantly different to each other. Illabo, Kittyhawk and DS Bennett yields were inferior to Scepter at TOS4 (best practice control). This is in part due to flowering later than mid-September which is the optimal flowering time in the Mallee (Figure 2).

Spring varieties sown early flowered prior to the optimum flowering window for the Mallee exposing them to a greater frost risk. However, they suffered very little frost damage with frost induced sterility being less than 10 per cent at all TOS (data not shown). Reduced yields of spring wheats sown at this time were likely due to reduced radiation interception.

The faster developing winters, Longsword and ADV15.9001 headed around the optimum window regardless of TOS. However, the yields of these varieties were substantially lower at earlier sowing times. This is an unusual result. In previous trials highest yields for winter cultivars are generally achieved when sown in early to mid-April. We speculate that in the extremely warm and dry autumn of 2018, crops at the three early times of sowing used too much of the stored fallow water too early in the season, growing greater vegetative biomass but then suffering greater drought stress during the critical period for yield formation (mid-August to late-September). This conclusion is supported by higher biomass at maturity for TOS4 (data not shown), and NDVI data from Experiment 2, which showed that whilst TOS4 had the lowest NDVI early in the season, it had the highest from August 9 onward (Figure 3). It was also the greenest treatment when late rains came on October 9.

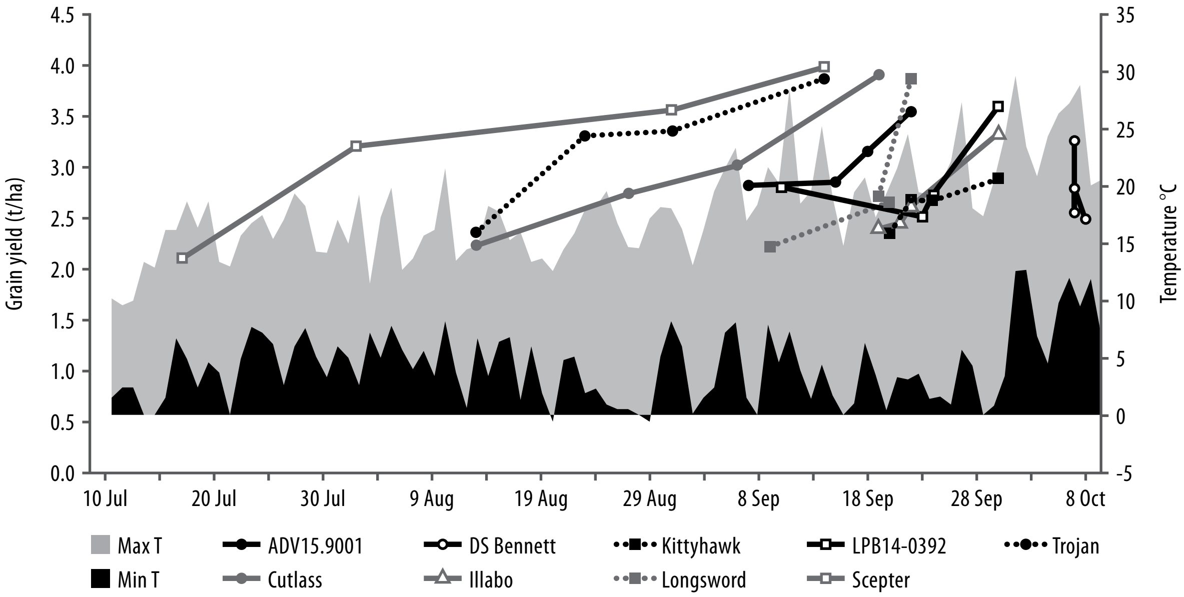

Figure 2. Temperature, heading date and yield for four times of sowing for Experiment 1 at Narraport. Note: Four positions on a single line indicate four times of sowing in sequence. Air temperature data obtained from weather station above canopy height. Frost events at canopy height would be expected at readings below 2°C. Stats: Cultivar x TOS P<0.001, LSD 0.5t/ha.

Rupanyup

The Rupanyup site experienced greater moisture stress than Narraport resulting in lower yields (Table 5). Due to severe moisture stress causing extensive plant death in the first TOS, these data have been excluded. Due to a high level of vegetative drought stress and frost damage, heading dates were not able to be reliably scored. DS Bennett at TOS2 was the only winter wheat that yielded similar to Scepter at TOS4. All other winter wheats yielded less than Scepter at TOS4.

Table 5. Grain yield (t/ha) of varieties for three times of sowing at Rupanyup.

Variety	TOS2	TOS3	TOS4
ADV13.1292	0.9	0.7	0.5
Cutlass	1.2	1.2	1.0
DS Bennett	1.6	1.4	1.4
Illabo	0.9	0.5	0.4
Kittyhawk	1.1	0.7	0.6
Longsword	1.4	1.3	1.0
LPB14-0392	1.0	0.7	0.8
Scepter	1.5	1.5	1.9
Trojan	1.4	1.4	1.7
P-value **LSD (P=0.05)**	P=0.008 0.4		

EXPERIMENT 2 RESULTS

As with Experiment 1, there was a yield increase at Narraport for consecutive TOS from 2.8t/ha at TOS1 to 3.6t/ha at TOS4 (P<0.01, LSD=0.3t/ha). As mentioned prior, this is likely due to excessive vegetative growth earlier in the season by earlier sown crops depleting soil moisture reserves. NDVI data captured substantiates this theory (Figure 3).

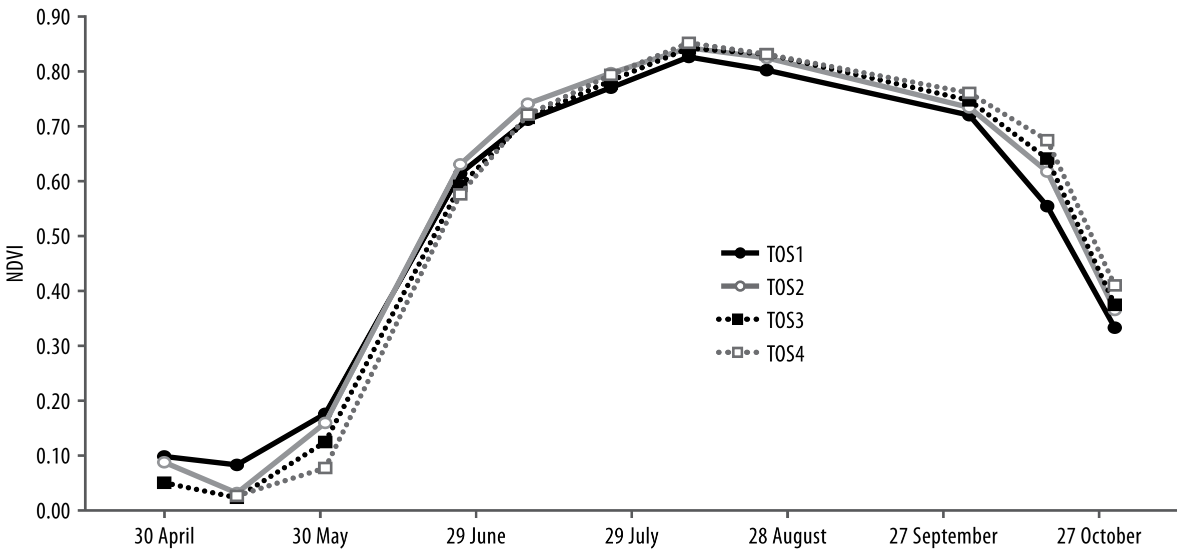

Figure 3. Mean NDVI of all varieties with only 10mm of irrigation at the four sowing times in Experiment 2 at Narraport.

At Narraport, there was a significant TOS x irrigation interaction with 25 and 50mm of irrigation *reducing* yields at the first TOS relative to 10mm (Figure 4). TOS2 showed no significant effect of irrigation. At TOS3 there was an increase in yield at 50mm relative to other irrigation rates and at TOS4 25mm and 50mm of irrigation increased yield relative to 10mm at sowing.

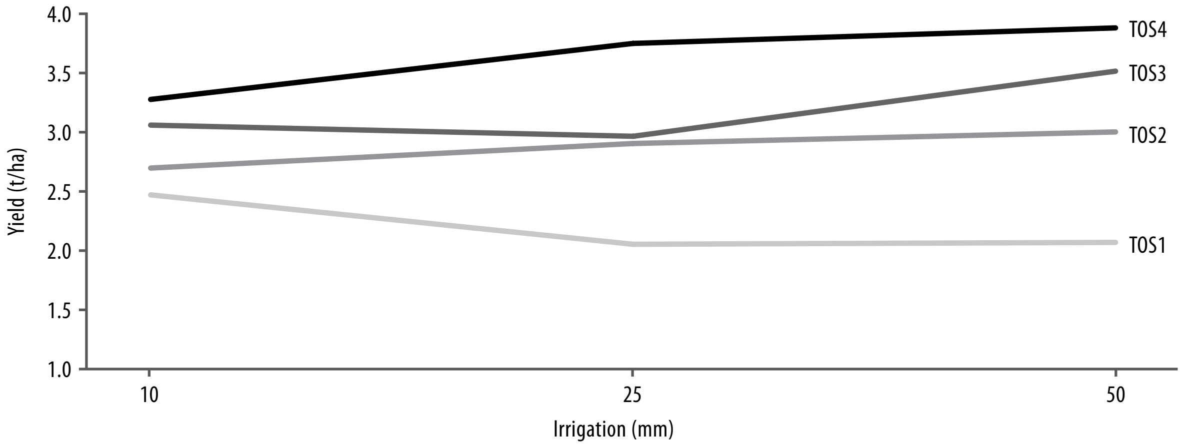

Figure 4. Mean of yield (t/ha) of all varieties at different times of sowing under different irrigation rate at Narraport. Stats: P=0.011, LSD=0.4.

It was somewhat unexpected to find a yield reduction due to irrigation in a dry year. This may have been the result of treatments receiving above 10mm of irrigation being able to grow enough to be able to access stored soil moisture early and use it inefficiently during vegetative growth stages while conditions remained warm and dry.

The 10mm treatment struggled to access the fallow moisture and suffered significant vegetative drought stress and reduced growth early but was able to preserve fallow water for use later in the season when yield is determined. This is supported by NDVI data showing that the 10mm treatment of TOS1 had the highest NDVI (greenest canopy) later in the growing season (Figure 5).

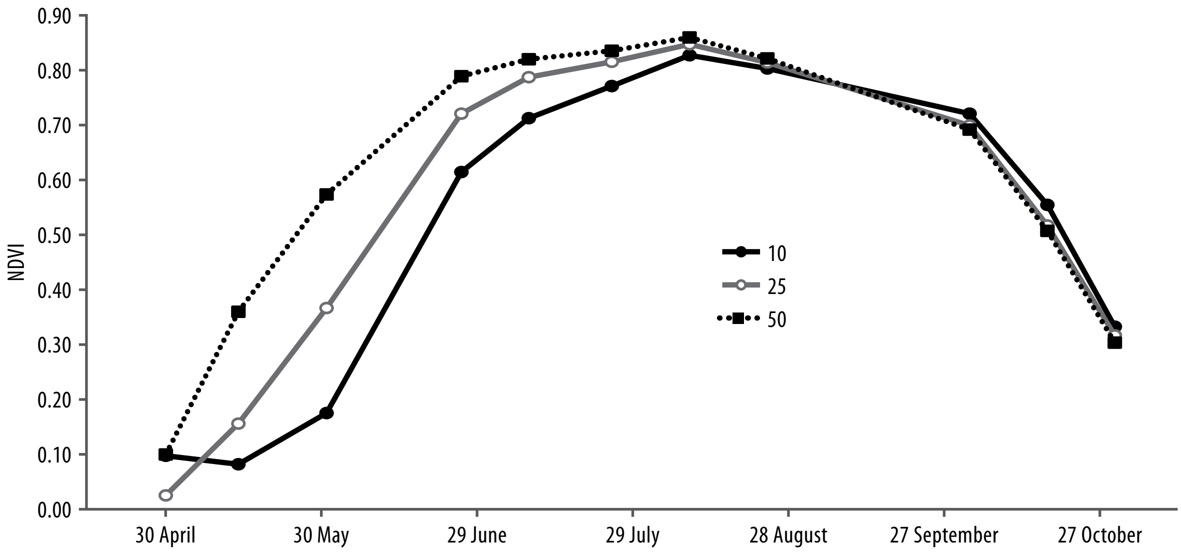

Figure 5. Mean NDVI of all varieties at TOS1 with different irrigation rates at Narraport.

There was also a significant variety x irrigation interaction, with Longsword not increasing yield in response to irrigation whilst Kittyhawk and DS Bennett did (Table 6). This was in-part explained by increasing rates of sterility in Longsword, which was another unexpected result but consistent with sterility in Longsword observed in 2017 during a higher yielding season.

Table 6. Mean grain yield (t/ha) and floret sterility (FS) (%) of varieties across all times of sowing at different irrigation rates at Narraport.

Irrigation (mm)	Yield (t/ha)			Floret sterility (%)		
	10	**25**	**50**	**10**	**25**	**50**
DS Bennett	3.0	3.2	3.4	6	6	5
Kittyhawk	2.8	2.8	3.4	7	10	7
Longsword	2.8	2.7	2.6	9	19	15
P-value		P=0.045			P=0.01	
LSD (P=0.05)		0.3			4	

At Rupanyup there was a significant TOS x variety x irrigation interaction. Irrigation increased yield of DS Bennett and Kittyhawk at all TOS but less so in Longword at the early TOS (Table 7). DS Bennett showed the greatest stability in yields across times of sowing and irrigation rates, Kittyhawk and Longsword showed greater variation with sowing times.

Table 7. Mean grain yield (t/ha) of varieties at different times of sowing and at different irrigation rates at Ruapnyup.

Variety	Irrigation (mm)	TOS1	TOS2	TOS3	TOS4
DS Bennett	**10**	1.9	1.9	1.5	2.2
	25	2.5	2.5	2.5	2.6
	50	3.3	3.2	3.3	3.1
Kittyhawk	**10**	1.1	1.0	0.8	1.0
	25	1.8	1.8	1.6	2.5
	50	2.3	2.8	2.1	2.9
Longsword	**10**	1.3	1.3	1.3	1.2
	25	2.0	2.1	1.9	2.0
	50	2.1	2.2	2.4	3.0
Sig. diff.			P=0.028		
LSD (P=0.05)			0.6		

COMMERCIAL PRACTICE

Results from the GRDC Management of Early Sown Wheat project (eight sites across SA and Vic, including the two sites reported here) shows that the best winter wheats can match but not exceed yields of the best spring wheats sown in their optimal window. Therefore, there is only an advantage to sowing winter wheats early if;

1. They can replace paddocks of spring wheat (or another crop) that would have otherwise been sown too late
2. Growers have stock and plan to graze them for dual purpose.

Optimal sowing times for mid-fast spring wheats, barley and most pulses in the Wimmera and Mallee is ~25 April to 10 May. If a farm program can be sown during this period, then there is no advantage to using winter wheats to sow early. However, if sowing is occurring after 10 May, then whole farm yields can be increased by planting winter wheats early.

Although the results at Narraport in 2018 show otherwise, in the other 14 site years of data obtained from the project, highest yields of winter cultivars have come when sown in April. Yields decline when they are sown in mid-March (too hot and dry and water is used inefficiently), and in early May (flowering is too late).

The best performing winter variety varies with yield environment, and need to be selected accordingly. At low yields (<3t/ha), Longsword is the best performing variety at the majority of sites, with DS Bennett sometimes outperforming it if there were substantial frost events. At mid yield levels (3-5t/ha), DS Bennett and Illabo perform best. At high yields (>5t/ha) DS Bennett is consistently the best performing cultivar. Unfortunately, neither Longsword (Feed) or DS Bennett (ASW) have particularly good grain quality.

Establishing crops early in dry seasons can be difficult. However, this research shows that there is little advantage in establishing crops in March and that even in the very dry April of 2018, 10mm of irrigation was enough to establish crops and keep them alive until rains came at the end of May. If March sowing is desired for dual purpose, the Rupanyup site shows that at least 25mm of rain is required to guarantee survival up to winter. A surprising finding from the Narraport site is that more establishment rain may in fact reduce yields in very early sown crops if stored soil water is present (eg. on long fallows) in a very dry year.

REFERENCES

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