The response of lentil cultivars to sowing date and plant density in the southern Mallee of Victoria

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Abstract

Current recommendations for sowing of lentils in the southern Mallee of Victoria to attain maximum yield is to sow in mid - late May at a targeted plant density of 120 plants/m^2. However, with the introduction of new cultivars with different agronomic characteristics, sowing dates and plant densities may need to be altered to achieve maximum yield. During 2000, field experiments were conducted at two sites to study the effects of sowing date (early May, late May, mid June, early July) and in 2001 the effects of sowing date (early May, mid June, mid July) and plant density (60, 90, 120, 150 and 250 plants/m^2) on the growth and grain yield of lentil cultivars (Nugget, Northfield, Cassab and Digger). The optimum sowing dates for all cultivars in 2000 were mid June to early July and in 2001 mid May to mid June. Possible reasons for this difference were that in 2000 there was a significant unusual late rainfall event which benefited June and July sown plots but not May sown plots. In 2001, unusually cool spring conditions combined with adequate rainfall enabled June sown plots to perform best. In the plant density experiments, 120 plants/m^2 was not significantly different from the maximum yield obtained for each sowing date at each site.

Overall, the experiments indicate that in seasons with wet and/or cool spring conditions sowing dates later than currently recommended may be optimum. However, to ensure optimum yields when there is a more traditional hotter and/or drier spring in the southern Mallee, mid-late May sowing is still recommended for all cultivars.

Key Words

Lentils, sowing date, plant density, sowing rate

Introduction

Lentil production in southern Australia has expanded rapidly in the last 10 years. The area sown has increased from less than 1000 ha in 1993 to over 155,000 ha in 2001 with approximately 270,000 t of grain produced (K. Panagiotopoulos, pers. comm.). This expansion reflects the development of new cultivars better adapted to southern Australia, improved agronomic management and the development of export markets. Most of this increased production has been in the medium rainfall zones (375-450 mm p.a.) of the Wimmera of Victoria and Yorke Peninsula of South Australia. There have also been significant increases in area sown in the lower rainfall zones (< 375 mm p.a.), such as the southern Mallee of Victoria.

With the development of new cultivars having different morphology, physiology and disease resistance to previous cultivars, cultivar specific responses to agronomic practices have been noted (M. Materne, unpubl. data). For example, the cultivar Northfield is significantly less tolerant to the commonly used herbicide Brodal[?] (diflufenican) than other cultivars such as Digger and Cassab. Currently in Victoria sowing recommendations for lentils to attain maximum yield, based on limited studies in the southern Mallee and Wimmera, are to sow in mid - late May at a targeted plant density of 120 plants/m^2 (1; M. Materne, unpubl. data). There have been few published studies in Australia on the effect of sowing rate and sowing time in lentils (2, 3) and these have generally only focussed on one cultivar.

This study investigated the interaction between sowing date and plant density on the growth and grain yield of several recently released lentil cultivars in the southern Mallee of Victoria.

Methods

Experimental design

In 2000, field experiments were sown at Warne and Rosebery. At Warne, 4 cultivars and Rosebery 3 cultivars were compared across 4 sowing dates (Table 1). Both experiments were replicated 4 times in a randomised split-plot design with sowing date as the main plot and cultivar in subplots. All cultivars were sown to achieve a targeted plant density of 120 plants/m^2.

In 2001, field experiments were sown at Birchip and Beulah. Four cultivars were compared across 3 sowing dates and 5 plant densities (Table 1). Both experiments were replicated 3 times in a randomised split-plot design with sowing date as the main plot and cultivar and plant density in subplots.

All seed was inoculated with rhizobium prior to sowing. Plots (12m long with 8 rows at 19.5cm spacing) were sown with 80kg/ha of 'grain legume super + 2.5% Zn'(0:15:7). In all experiments, weeds, insects and fungal diseases were controlled by the application of suitable pesticides and fungicides at relevant stages of crop growth.

Table 1. Site and soil types (4) of field experiment sites in the southern Mallee of Victoria and experimental details of treatments applied (sowing dates, plant densities and varieties).

Site	Soil type	Sowing date	Plant density (plants/m^2)	Cultivars
		2000		
Warne 35?48'S, 143?02'E	Calcareous loam (pH[1] 8.5) over a sodic, calcareous medium clay (pH 9.0) at 20-40 cm	May 3 May 23 June 13 July 4	120	Nugget Digger Cassab Northfield
Rosebery 35?52'S, 142?30'E	Calcareous clay loam (pH 8.5) over a calcareous medium clay (pH 9.0) at 40 cm	May 2 May 24 June 13 July 4	120	Nugget Digger Northfield
		2001		
Birchip 36?04'S, 142?43'E	Calcareous loam (pH 7.8) over a calcareous medium clay (pH 8.5) at 40 cm	May 10 June 16 July 11	60, 90, 120, 150, 250	Nugget Digger Cassab Northfield
Beulah 35?57'S, 142?16'E	Calcareous sandy loam (pH 8.0) over a calcareous heavy clay at 40-60 cm (pH 9.5)	May 9 June 16 July 11	60, 90, 120, 150, 250	Nugget Digger Cassab Northfield

[1]pH - 1:5 water

Measurements and statistical analyses

Weather conditions (rainfall, air temperature, soil temperature and humidity) were recorded daily by automatic weather stations. Seedling emergence was recorded 6 weeks after sowing and grain yield at harvest.

To test for significant differences a three-way analysis of variance between cultivar, sowing date and plant density was conducted. The results for each trial site have been analysed separately because of differences in trial design, soil types and seasonal conditions. Other measurements were taken including: detailed soil physical and chemical properties, date of flowering and maturity, and above ground dry matter at flowering and maturity; but are not presented in this paper.

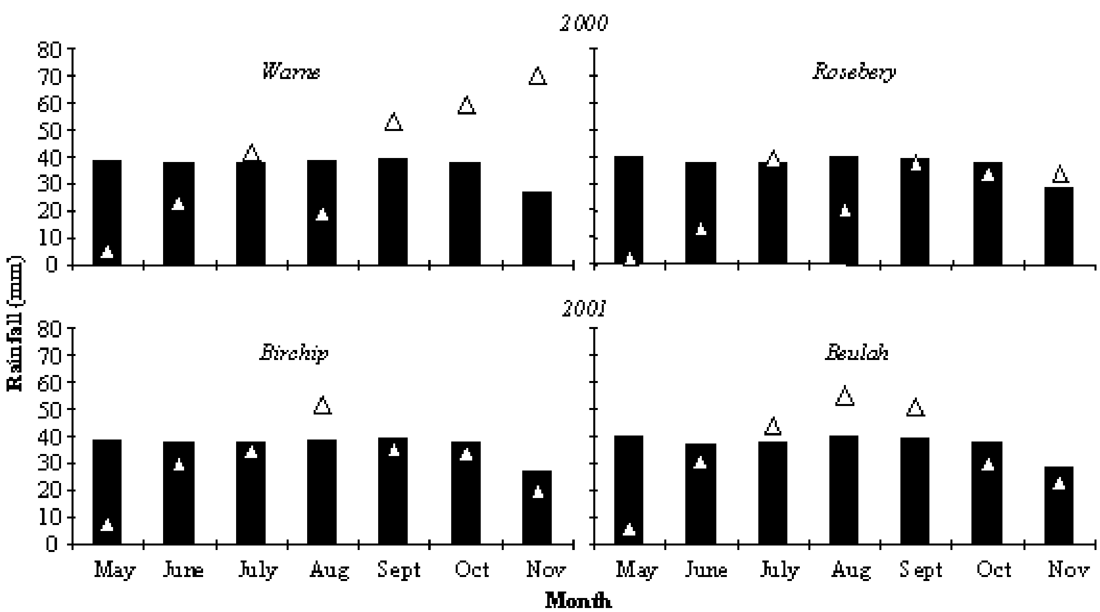
Results

Weather

In 2000 the growing season rainfall (GSR: May to November) was below the long-term average at both Warne (201 mm c.f. 230 mm) and Rosebery (147 mm c.f. 230 mm) (Figure 1). Rainfall in May, June and August was less than half of the long-term average. From 18 October to 11 November, 125 mm of rainfall was recorded at Warne (125 mm). Temperatures were close to long-term averages for each site (data not shown).

In 2001 GSR was slightly below the long-term average at both Birchip (194 mm c.f. 230 mm) and Beulah (217 mm c.f. 230 mm) (Figure 1), with May rainfall well below average. During the rest of the growing season adequate rainfall fell at regular intervals. Winter temperatures were warmer than average and in spring less than average at both sites (data not shown).

Figure 1. Monthly rainfall at trial sites in 2000 and 2001 (triangles) compared with the long-term average (histogram).



Emergence and crop growth

In both 2000 and 2001 at all sites seedling emergence for all cultivars was similar (data not shown). During 2000 seedling emergence at both sites was less at later sowing dates (approximately 120 plants/m^2 at the May sowing dates and 90-100 plants/m^2 at the June and July sowing dates; data not shown). During 2001 seedling emergence at both sites was generally higher than targeted densities at the June sowing date and was similar to targeted densities at the May and July sowing dates (Table 2).

Table 2. The effect of plant density and sowing date on the emergence (plants/m^2) and grain yield (t/ha) of lentils at Beulah and Birchip in 2001. The three-way interaction between cultivar, sowing rate and sowing date was not significant. The l.s.d. (*P*=0.05) for the interactions and for comparison within a sowing date are shown.

Target plant density	Sowing date					
(plants/m^2)	May 9		June 16		July 11	
	Emergence	Grain yield	Emergence	Grain yield	Emergence	Grain Yield
			Beulah			
60	63	2.16	80	2.45	65	2.22
90	88	2.35	105	2.64	97	2.15
120	118	2.36	135	2.53	123	2.32
150	146	2.36	174	2.59	155	2.40
250	233	2.23	283	2.35	260	2.43
Emergence: l.s.d.$_{(interaction)}$ = 13; l.s.d.$_{(within\ sowing\ date)}$ = 14						
Grain yield: l.s.d.$_{(interaction)}$ = 0.21; l.s.d.$_{(within\ sowing\ date)}$ = 0.17						
			Birchip			
60	63	0.86	76	1.11	69	0.69
90	92	1.02	107	1.07	97	0.85
120	107	1.05	155	1.07	138	1.06
150	147	1.08	178	1.01	148	0.92

250	219	1.09	272	0.94	263	0.85

Emergence: l.s.d.$_{(interaction)}$ = 13; l.s.d.$_{(within\ sowing\ date)}$ = 13
Grain yield: l.s.d.$_{(interaction)}$ = 0.20; l.s.d.$_{(within\ sowing\ date)}$ = 0.17

Grain yield

At Rosebery the highest grain yields were obtained at the June 13 or July 4 sowing dates (Table 3). Nugget generally had the highest grain yield. At Warne, the highest grain yields were obtained at the later sowing dates, although differences between sowing dates were not as pronounced as at Rosebery (Table 3).

At both Beulah and Birchip there was no interaction between sowing date, plant density and cultivar. However the interaction between sowing date and plant density, and the main effects of sowing date, plant density and cultivar were all significant except sowing date at Birchip. At Beulah, for the May 9 and June 16 sowing dates, the lowest grain yields were at target plant densities of 60 and 250 plants/m^2 (Table 2). All other sowing rates produced similar grain yields. For the July 9 sowing date grain yield generally increased at higher plant densities. At Birchip, for the May 9 sowing date, grain yields were lowest at the target plant density of 60 plants/m^2 and similar at all other densities (Table 2). For the June 16 sowing date grain yields decreased with increased plant densities. For the July 11 sowing date the grain yield was highest at the target plant density of 120 plants/m^2 and significantly lower at target plant densities of 60, 90 and 250 plants/m^2 (Table 2). It was notable that for all sowing dates at both sites the target plant density of 120 plants/m^2 was not significantly different from the highest grain yield within that sowing date (Table 2). Northfield was the lowest yielding cultivar at both sites, ranging between 10% and 20% less than other cultivars (data not shown).

Table 3. The effect of sowing date on the grain yield (t/ha) of lentil cultivars grown at Rosebery and Warne in 2000. The l.s.d. (*P*=0.05) for the interaction and for comparison within a variety are shown.

Sowing date	Cassab	Digger	Northfield	Nugget
		Rosebery		
May 2		0.74	0.64	0.71
May 24		0.98	1.02	1.35
June 13		1.50	1.60	1.58
July 4		1.20	1.67	1.87

l.s.d.$_{(interaction)}$ = 0.28; l.s.d.$_{(within\ variety)}$ = 0.24

Warne

May 3	1.00	1.25	1.21	1.50
May 23	1.40	1.29	1.18	1.09
June 13	1.70	1.60	1.20	1.36
July 4	1.62	1.67	1.22	1.67

$l.s.d._{(interaction)}$ = NS; $l.s.d._{(within\ variety)}$ = NS

Conclusion

The cultivars used in these trials generally responded similarly to changes in sowing date and plant density. This was expected, as all cultivars are medium maturity types with similar growth habits. In our study the optimum sowing date was mid-June to July in 2000 and mid May to June in 2001. In 2000 late rainfall events benefited late sown plots which had not fully matured and were able to continue producing new pods and seed (data not shown). The early sown plots were ready to harvest when the rain event occurred in October, causing them to lodge severely, further contributing to their relative yield loss. In 2001, adequate rainfall combined with mild conditions in spring enabled June and July sown plots to perform similar to May sown plots. In the plant density experiments, a target density of 120 plants/m^2 was not significantly different from the highest yield obtained within each sowing date at each site. There were different responses to plant density at each sowing date, however further work is required to confirm findings.

In conclusion, our trials indicate that in seasons with wet and/or cool/mild spring conditions later than currently recommended sowing dates may be optimum. However, to ensure optimum yields when there is a more traditional hotter and/or drier spring in the southern Mallee, mid-late May sowing is still recommended for all cultivars. Although 2001 data indicates that growers may be able to achieve optimum yields with target plant densities less than 120 plants/m^2, further testing across a range of seasons is required.

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