New lentil varieties allow reduced sowing rates and earlier sowing

Jason D Brand and Sundara MMR Mawalagedera

Agriculture Victoria, Department of Jobs, Precincts and Regions, Grains Innovation Park, 110 Natimuk Rd, Horsham, Victoria 3400, Email: https://agriculture.vic.gov.au/home, jason.brand@agriculture.vic.gov.au

Abstract

New lentil varieties with improved agronomic traits including early vigour, biomass development, canopy structure, disease resistance, herbicide tolerance, maturity and pod retention offer opportunities to lower planting densities, particularly when combined with earlier sowing. Here, we focused on identifying potential advantages of lower seeding rates for these new varieties and its interaction with sowing date in southern Australian medium and low rainfall zones in 2016. Early sowing increased yield by 10-20%. However, in susceptible lines early sowing caused significant botrytis grey mould infection and yield losses. In comparison, the resistant variety, PBA Jumbo2, showed no symptoms and no yield loss from disease. Reducing sowing rate to 80-100 plants/m^2 from 120 plants/m^2 maintained yield and increased profitability. Combining early sowing, reduced seeding rates, with a resistant variety increased gross returns by approximately $400/ha.

Keywords

Plant density, profitability, botrytis grey mould

Introduction

Lentil area in southern Australia has increased to 408,000 ha in 2017-18 from a less than 1000 ha in 1993, driven by the development of improved varieties and agronomic management (ABARES 2020; Brand et al., 2001). The new varieties have improvements in a range of agronomic traits including biomass development, canopy structure, disease resistance, herbicide tolerance, maturity and pod retention.

There is potential opportunity to reduce sowing rates with early sowing, maximizing the economic grain and yield potential of lentil. Current recommendations are to sow mid to late May at a rate of 120 plants/m^2, based on studies of several older conventional cultivars that were more susceptible to disease, lodging and pod drop (Brand et al., 2001). Further, growers are sowing crops earlier in modern no-till farming systems to maximise yield potential and to avoid heat and terminal drought stress. Thus, we investigated effects of sowing date on the growth and yield of 16 recently released varieties and sowing rate on a subset of 4 varieties differing in disease resistance.

Methods

Experimental site and design

Field experiments were conducted in commercial paddocks at Curyo and Rupanyup, Victoria in 2016. The soils were characterised as sandy loam at Curyo and black cracking clay at Rupanyup. Each sowing date (Curyo: 04 May (early) and 02 June (late), and, Rupanyup: 13 May (early) and 15 June (late)) was sown as a separate block at a trial site. Within a sowing date block 16 varieties sown at 120 plants/m^2 were compared (Figure 1). In addition, four of the varieties differing in resistance to botrytis grey mould (BGM) and aschochyta blight (AB); (Table 1) were sown at four additional densities (40, 80, 160 and 200 plants/m^2). Time of sowing blocks were laid out in randomised complete block design with three replications.

Table 1 Botrytis grey mould and aschochyta blight resistance ratings for lentil varieties

	Botrytis grey mould	Aschochyta blight
PBA Jumbo2	R	R
PBA Ace	MRMS	R
PBA Flash	MRMS	MS
CIPAL1301	MS	MR

R- Resistant, MR-Moderately Resistant, MS-Moderately Susceptible, S-Susceptible

Experimental procedure

The crop was sown in 8.00 m × 1.44 m experimental plots in between the previous years' standing cereal stubble rows at 36 cm inter-row spacing at both sites. At sowing all plots were fertilized with monoammonium phosphate (N-9.2, P-20.2, K-0, S-2.7 %) and zinc (2.5 %) (80 kg/ha at Rupanyup and 60 kg/ha at Curyo). Seed was treated with appropriate fungicide and insecticide dressings and sown with 5 kg/ha of Group E/F granular inoculant in a band 5 cm below seed. Weeds and insect pests were managed throughout the season according to industry standards. No fungicides were applied to ensure maximum disease expression.

Data collection and analysis
Visual disease symptoms (BGM) were rated on a plot basis during October at the peak of the epidemic. Plants were harvested at physiological maturity and oven dried at 70°C for three days and weighed to determine biomass. Each plot was harvested with a small plot harvester and grain yield recorded. All data was analysed using ANOVA (P<0.05) using GenStat 18.0 (VSN International, Hemel Hempstead, UK).

Results
Seasonal conditions
Growing season rainfall (356 mm at Curyo and 384 mm at Rupanyup) was approximately 35% greater than long term average. This meant that disease, particularly botrytis grey mould became a major epidemic in susceptible varieties like PBA Bolt and CIPAL1301.

Effects of sowing date on disease intensity
At Rupanyup and Curyo, BGM scores were generally higher in the plots sown early compared with those sown late (Figure 1). PBA Jumbo2 did not show symptoms of disease at either site or sowing date consistent with its resistance rating of 'R'. PBA Blitz, PBA Greenfield and the CIPAL1422 also showed little or no disease consistent with their 'MR' rating for BGM. The susceptible varieties, PBA Bolt and CIPAL1504 were the worst affected.

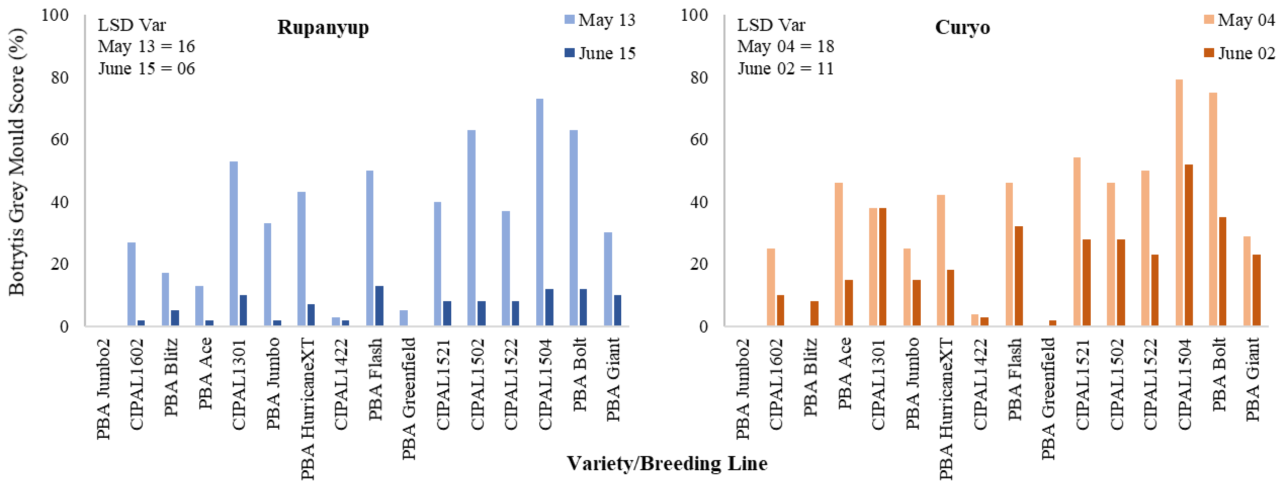

Figure 1. Effect of date of sowing on botrytis grey mould (BGM) disease scores (0: no disease; 100: crop death) of lentil varieties at Rupanyup and Curyo, 2016. *Varieties ranked left to right from highest to lowest average grain yield.*

Effects of sowing date on biomass at maturity
Varieties produced considerable biomass that ranged between 8.12 and 12.89 t/ha at Curyo, and, 8.75 and 15.16 t/ha at Rupanyup (Figure 2). Sowing early increased biomass by 2.64 t/ha (28%) at Curyo and 1.18 t/ha (12%) at Rupanyup on an average across varieties. Although there were some notable trends, relative rankings of varieties varied between sites and sowing dates. The varieties and breeding lines more susceptible to BGM (e.g. CIPAL1301 and CIPAL1504), generally showed a lower reduction in biomass from delayed sowing than the more resistant varieties and breeding lines such as PBA Jumbo2, PBA Blitz and CIPAL1422.

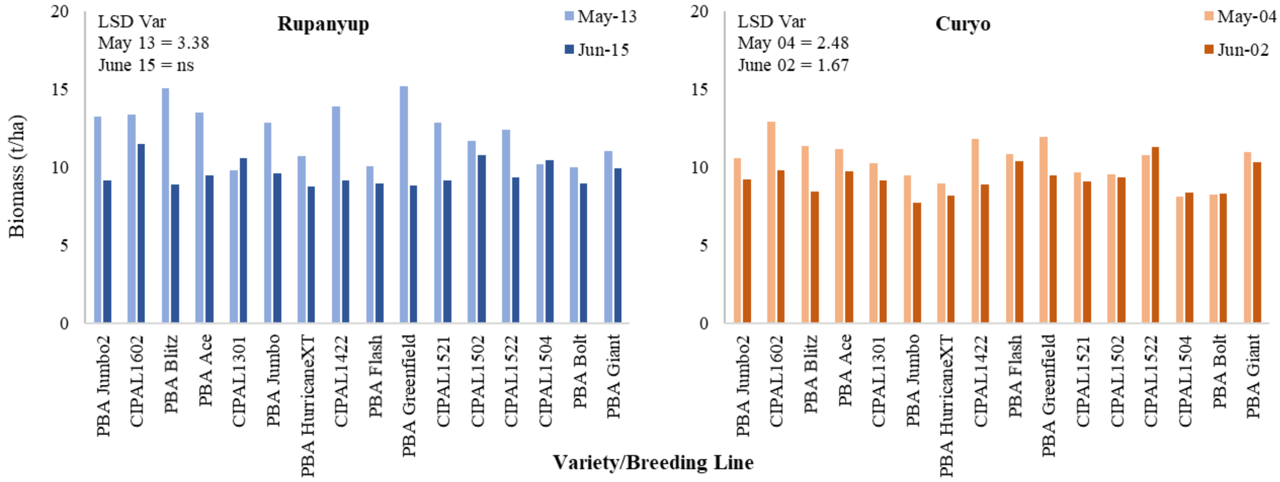

Figure 2. Effect of date of sowing on biomass at maturity of lentil varieties at Rupanyup and Curyo, 2016. *Varieties ranked left to right from highest to lowest average grain yield.*

Effects of sowing date on grain yield

Grain yields ranged between 1.75 and 4.04 t/ha at Curyo, and, 2.47 and 4.19 t/ha at Rupanyup (Figure 3). Relative rankings of varieties varied between sowing dates. For example, at Curyo, PBA Jumbo2 was the highest yielding variety, whether sown early (4.04 t/ha) or late (3.40 t/ha). Conversely, CIPAL1504 was the lowest yielding line producing 1.75 t/ha when sown early and 2.37 t/ha when sown late indicative of its BGM susceptibility. PBA Bolt also performed relatively poorly due to its BGM susceptibility, with yields 50% and 22% less than PBA Jumbo2 at Curyo when sown early and late, respectively. At Rupanyup, similar trends to Curyo for grain yields were observed.

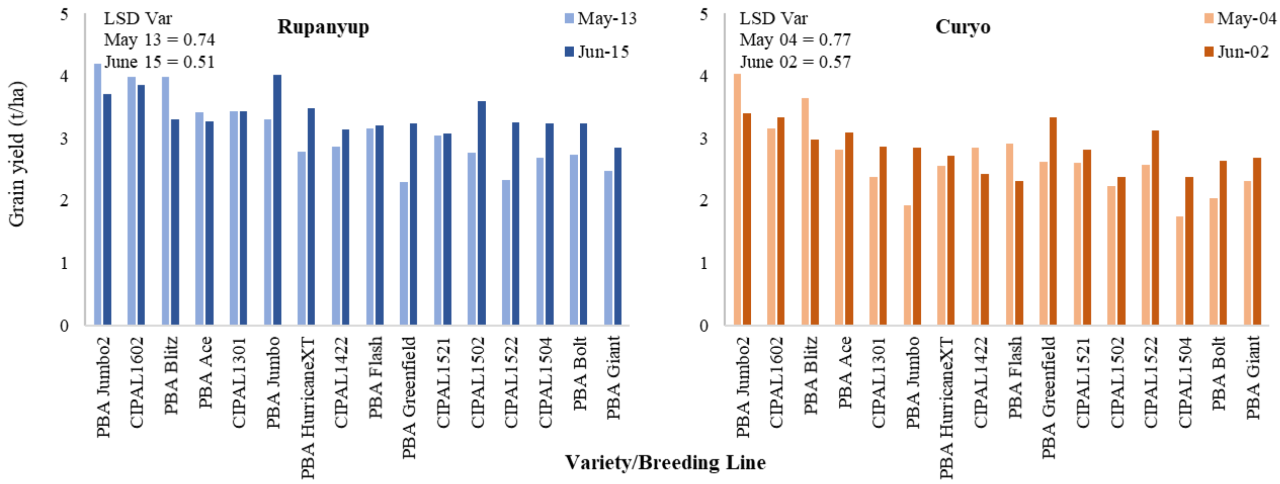

Figure 3. Effect of date of sowing on grain yield of lentil varieties at Rupanyup and Curyo, 2016. *Varieties ranked left to right from highest to lowest average grain yield.*

Effects of sowing rates on disease intensity at Rupanyup & Curyo

There was a significant interaction between sowing rate and BGM intensity at both the sites (Figure 4; only PBA Jumbo2 and CIPAL1301 shown for clarity). When sown early the moderately susceptible breeding line CIPAL1301 showed increasing levels of disease and yield losses as sowing rate increased. In comparison, the resistant variety, PBA Jumbo2, showed no disease and had a smaller reduction in yield at the highest sowing rates. Late sown, CIPAL1301, showed much lower levels of disease, but still an increase in symptoms as sowing rate increased, but unlike early sown, this did not cause significant grain yield losses. PBA Jumbo2 showed no disease with highest yields in the 120 and 160 plants/m^2 treatments.

Profitability

Lentils were highly profitable ($900/ha - $2600/ha) even at severe levels of disease (data not shown). However, the calculations did not include additional fungicide costs associated with varieties that are more susceptible as sprays were not applied.

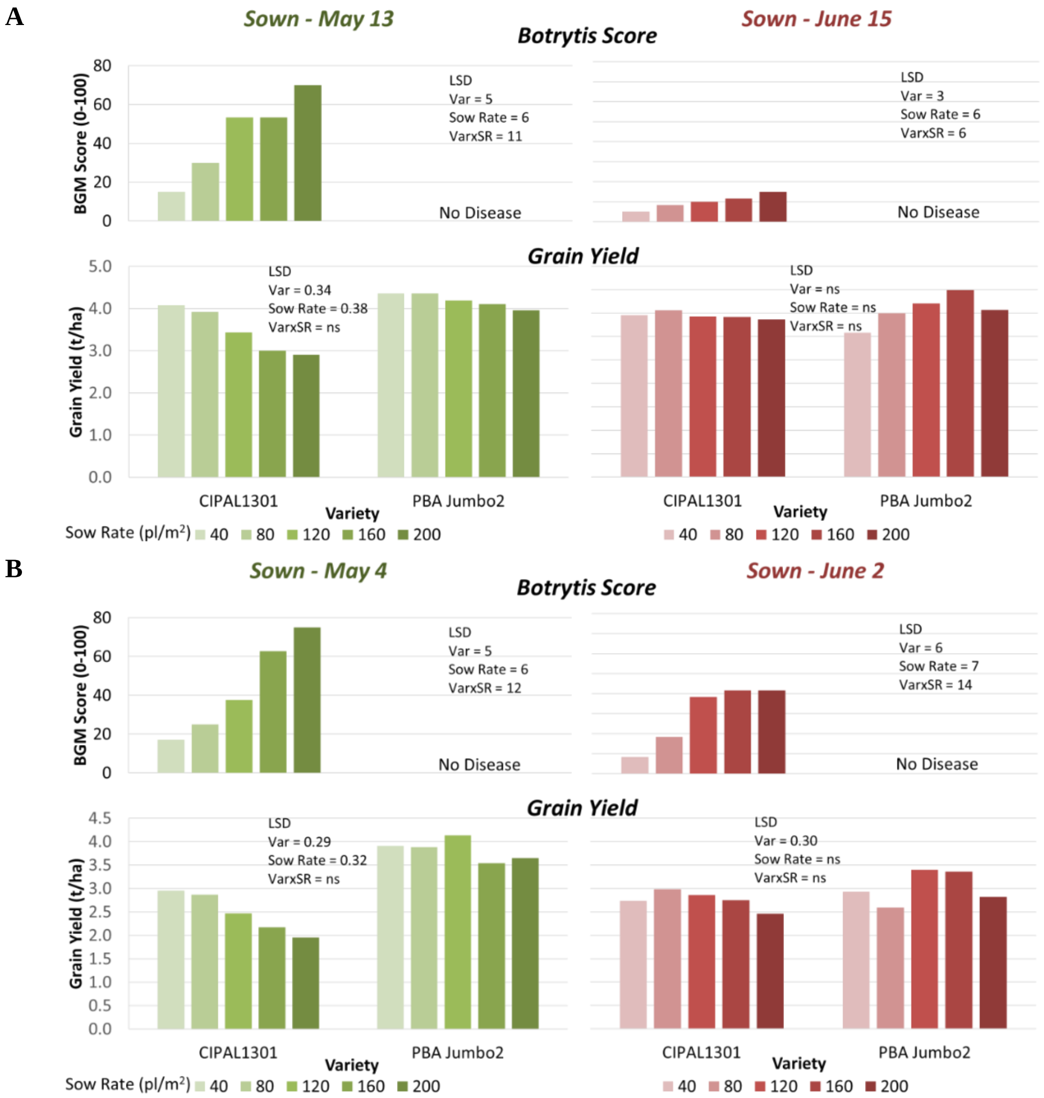

Figure 4. Effect of date and rate of sowing on botrytis grey mould (BGM) disease scores (0:no disease; 100: death) and grain yields of CIPAL1301 and PBA Jumbo2 at (A) Rupanyup and (B) Curyo, 2016.

Conclusions

In new varieties (PBA Jumbo2 and PBA Ace) decreasing sowing rate from 120 plants/m^2 to 80-100 plants/m^2 relieved disease pressure while maintaining yield and increasing profitability. In new resistant varieties, sowing early increased yield by 10-20%. However, in susceptible lines in the absence of disease control, early sowing caused significant BGM infection and yield losses. Sowing a resistant variety early at lower seeding rates increased gross returns by approximately $400/ha.

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