A survey of winter crop establishment in the southern and western regions

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Abstract
Establishment is a critical phase of crop growth. Poor establishment compromises early crop vigour and represents an economic loss from wasted seed. Currently little is known about the levels of crop establishment achieved by growers in commercial crops. One hundred and forty three paddocks were surveyed across the southern and western GRDC regions. A questionnaire was distributed to cooperating growers. Average establishment was 59% in canola, 82% in lentil and 64% in wheat. Separating seed and fertiliser delivery improved establishment in canola and lentil and using paired rows improved establishment in lentil. Other practices that affected crop establishment included time of sowing, depth of sowing, stubble cover and calibration method. The influences of these practices on establishment are described.

Key Words
Sowing techniques, canola, lentil, wheat

Introduction
Uneven crop establishment and variable sowing depth can compromise early growth, reduce competitiveness against weeds and in some cases, may limit grain yields (McDonald et al 2019). Poor establishment also is a financial loss especially in crops such as hybrid canola, where seed costs are high. Most growers now sow by the calendar rather than wait for opening rains. Consequently seed is sometimes sown when soil moisture is low or the crop is dry sown, which may increase the risk of poor establishment. However, current levels of establishment in winter crops are poorly documented. This paper summarises results from a survey of establishment in winter crops in the southern and western GRDC zones in a number of crops and considers some of the factors that have contributed to variation in establishment.

Methods
Commercial crops were surveyed in South Australia, Victoria, Tasmania and Western Australia in 2018. The crops targeted were canola, lentil and faba bean in the southern region and canola, lupin and wheat in the western region. This paper will only report on the results for canola, lentil and wheat.

In each paddock five sample sites were randomly selected. At each location, seedling numbers were counted in two adjacent rows along a 3 m length of row. The cumulative distance between 30 adjacent seedlings in each row was measured to estimate mean interplant distance. Seedling depth was measured by cutting seedlings at the soil surface, excavating the seed and measuring the vertical distance from the seed to the cut surface. The amount of stubble cover at each location was assessed by comparison with standard photographic charts. A sample of the seed used to sow the crop was collected to measure mean seed weight and germination percentage. A questionnaire was distributed to growers to gather information on the seeding equipment used, how it was set up and the agronomy of the crop. Crop establishment was estimated from the plants/m^2 and the seeds/m^2 sown.

Two statistics were used to analyse the results. Spatial variation in the field was assessed using a Poisson statistic (S_p) in each paddock to identify clustered or uniform distribution of seedlings based on the counts per 3 m row:

$$Sp = \frac{\frac{Variance\ plants/row}{Mean\ plants/row} - 1}{\sqrt{2}/9}$$

The value is compared against a critical value of 1.83. Extreme positive values indicate clustering among the samples in the field and extreme negative values indicate perfectly uniform distribution. Intermediate values indicate a random distribution.

Variation in interplant distance used the mean and standard error (SE) to calculate the standardised difference between the measured and the targeted values. Targeted values were calculated from the seeds/m^2 sown and the row spacing:

$$Diff = \frac{Mean\ interplant\ distance - Target\ interplant\ distance}{SE}$$

A critical value of 2.13 was used; when Diff is >2.13, there are large gaps in seedlings and seed loss and poor establishment has occurred and when Diff<-2.13, a clumping or clustered distribution occurs along the row. Intermediate values indicate a random distribution along the row.

Results and discussion

One hundred and forty three paddocks were sampled on 72 farms, 76 paddocks in the southern region and 67 in the western region. One hundred and seven questionnaires were returned (75% response rate) and 107 seed samples were received.

On average, growers sowed 60-70 seeds/m^2 for canola, 118 seeds/m^2 for lentil and 195 seeds/m^2 for wheat (Table 1). Average crop establishment ranged from 51% in canola in the western region to 82% in lentil. Wheat showed the least variation in plant number and interplant distance: median coefficients of variation (CV) for interplant distance were 109% in wheat, 145% in lentil and 160% in canola. The corresponding median CVs for plants/m^2 were 13% in wheat, 20% in lentil and 25% in canola.

Table 1. The mean number of seeds sown, establishment % and seedling depth for canola, lentil and wheat in the southern and western regions. The values are shown as mean ± standard error of the mean (SEM) and the number of paddocks in the sample is shown in parentheses

	Canola	Lentil	Wheat
Seeds/m^2 sown			
Southern	61 ± 4.1 (30)	118 ± 4.5 (18)	
Western	71 ± 9.9 (6)		195 ± 10.4 (10)
Establishment (%)			
Southern	67 ± 4.1	82 ± 5.0 (17)	
Western	51 ± 5.8		64 ± 5.9 (8)
Seedling depth (mm)			
Southern	22 ± 1.3 (38)	35 ± 2.4 (24)	
Western	19 ± 1.3 (9)		37 ± 1.9 (19)

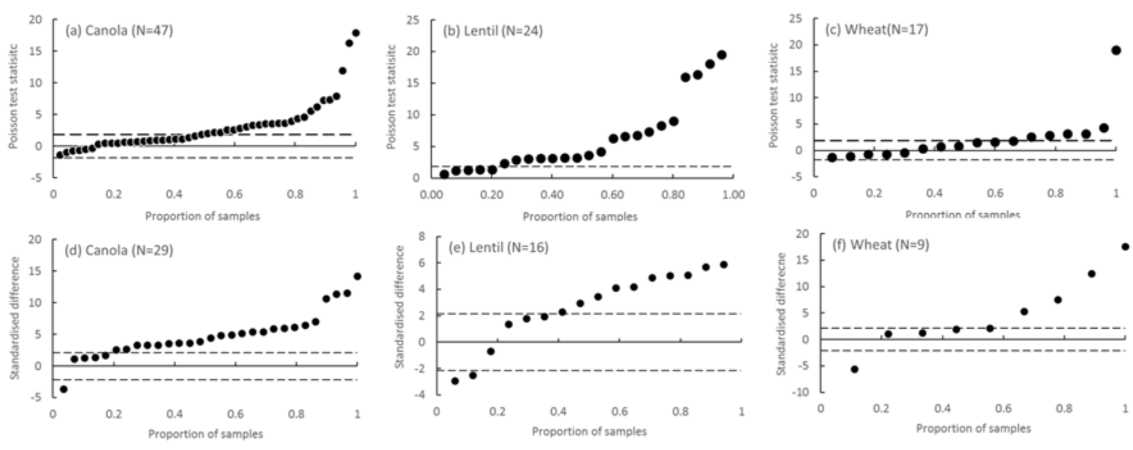

Figure 1. The distribution of the Poisson statistic ((a)-(c)) and the standardised difference for interplant distance ((d)-(e)) in commercial paddocks of canola, lentil and wheat in the Southern and Western regions. The critical values (±1 .83 for the Poisson statistic and ± 2.13 for the standardised difference) are shown by the dashed lines

No paddocks showed a uniform plant distribution (Fig 1a-c): there was a high level of clustering in the canola and lentil paddocks whereas wheat was predominantly randomly distributed. The low establishment across all crops was reflected in the high values for the standardised difference for interplant distance, especially in canola (Fig 1 d-f), but many paddocks of lentil also showed large gaps even though mean establishment was high.

Comparisons between different practices were sometimes limited by a small sample size and high variability in the data; nevertheless there were some trends suggested by the results. Inter-row sowing significantly reduced plant establishment in wheat, had no significant effect in canola and tended to improve establishment in lentil (Table 2). Separating the delivery of seed and fertiliser improved establishment in canola and lentil, while paired rows improved establishment in lentil.

Table 2. Crop establishment (%) in three crops classified by sowing method. Crops were either sown between (inter-row) or not between (non inter-row) previous crop rows, with a separate or single seed/fertiliser delivery system or in single or paired rows. The values are shown as the mean ± SEM and the number of paddocks in the sample is shown in parentheses

	Canola	Lentil	Wheat
Sowing			
Inter-row	62 ± 4.1 (17)	85 ± 5.9 (14)	54 ± 2.8 (4)
Non inter-row	67 ± 8.2 (15)	73 ± 3.2 (2)	74 ± 9.3 (4)
Shoot type			
Separate	70 ± 7.2 (17)	92 ± 6.2 (11)	
Single	57 ± 4.0 (15)	65 ± 1.4 (5)	
Seeding rows			
Paired	74 ± 10.7 (2)	76 ± 1.6 (2)	
Single	64 ± 6.7 (19)	68 ±2.6 (6)	

Mean germination rates for the seed samples were (mean ± SEM) 88 ± 1.6% in canola, 90 ± 2.1% in lentil and 96 ± 1.3% in wheat. Growers who indicated they adjusted their sowing rate for seed size and/or germination percentage did not achieve significantly better establishment than growers who didn't (Table 3). However, the method of calibration appeared to be important, with manual calibration showing consistently poorer establishment compared to using the seeder's control system. Among the canola paddocks, establishment was higher in hybrid varieties (72 ± 5.9%, n = 20) than in open pollinated varieties (60 ± 6.9%, n=14).

Table 3. Crop establishment (%) in three crops classified according to whether the sowing rate was adjusted for seed size or germination percentage, and the method of seeder calibration. The values are shown as the mean ± SEM and the number of paddocks in the sample is shown in parentheses

	Canola	Lentil	Wheat
Seed size adjustment			
No	61 ± 4.3 (16)	89 ± 12.4 (4)	61 ± 7.6 (6)
Yes	68 ± 7.6 (16)	82 ± 5.9 (12)	73 ± 0.1 (2)
Germination % adjusted			
No	58 ± 3.5 (20)	86 ± 8.0 (11)	64 ± 7.8 (6)
Yes	79 ± 9.4 (11)	84 ± 7.8 (9)	66 ± 7.7 (2)
Calibration method			
Control system	72 ± 9.2 (12)	99 ± 11.2 (4)	75 ±13.1 (2)
Manually	63 ± 5.1 (15)	79 ±6.1 (9)	62 ± 1.0 (3)

Time of sowing was an important influence on establishment in canola and wheat. Establishment improving with later sowing into May (Figure 2). This effect may be caused by the dry autumn over the southern and western region in 2018 which resulted in many crops being sown dry or under marginal soil moisture. There was no effect of sowing date in lentil.

Although variable, sowing to about 30 mm improved establishment in canola in both the southern and western regions (Figure 3). It is likely that with the dry autumn in the survey area, there was insufficient moisture in the surface soil for high germination rates and growth of seedlings. In contrast, lentil establishment benefited from shallower seed placement, but the range of sowing depths was greater than that in canola. There was no relationship between depth of seed placement and establishment in wheat.

Larger amounts of stubble at sowing reduced emergence of canola and wheat (Figure 4). There was no effect of stubble cover on emergence in lentil. Establishment was lower when wheat was sown in wide rows up to 38 cm (data not shown). The trend was less evident in canola, but establishment was consistently below 65% when a 38 cm row spacing was used. Establishment in lentil was not associated with row spacing.

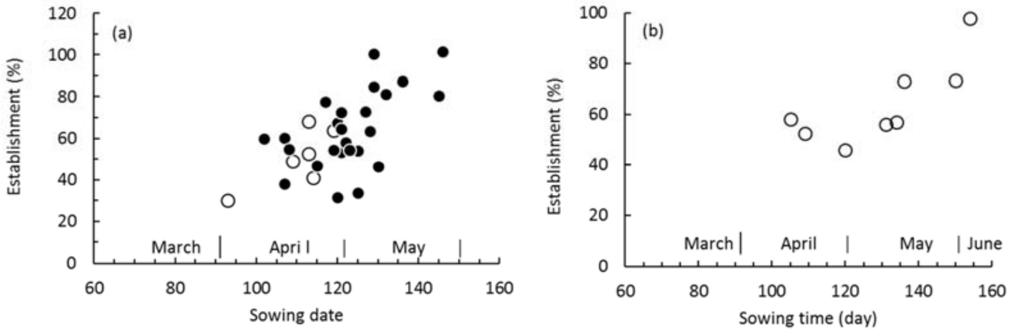

Figure 2. The relationship between sowing time and crop establishment in (a) canola and (b) wheat in the southern region (●) and the western region (○)

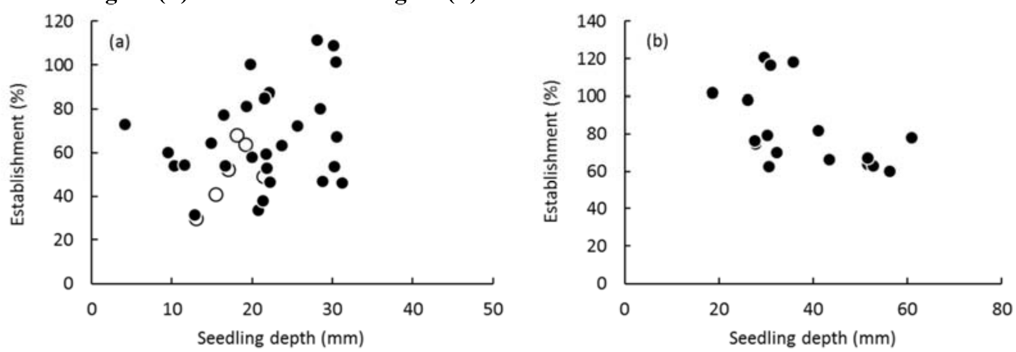

Figure 3. The relationship between seedling depth and establishment in (a) canola and (b) lentil in the southern region (●) and the western region (○)**.**

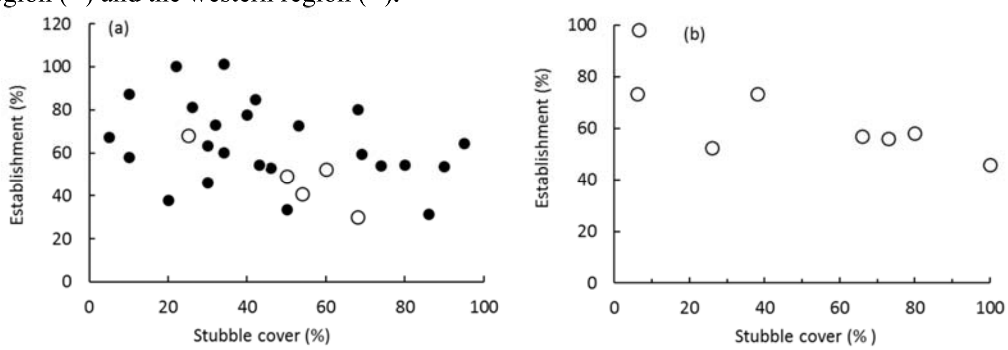

Figure 4. The relationship between the visual assessment of stubble ground cover and establishment in (a) canola and (b) wheat in the southern region (●) and the western region (○).

Conclusion

Establishment was low and variable in the crops surveyed in 2018. Lentil was the most robust of the three crops: it had high establishment which was little affected by time of sowing or stubble cover. There may be opportunities to improve establishment by improvement in seeder set up and management practices such as calibration method, fertiliser and seed placement and depth of sowing.

References

McDonald GK, Browne C, Noack S, Schmitt S. (2019). Precision planting in canola and lentil: Proceedings of the 19th Agronomy Australia Conference, Wagga Wagga, Australia, 25-29 August 2019.

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