Overcoming challenges and exploiting solutions for pulse management in the low rainfall zone

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Abstract
Profitable pulse grain production can be challenging in the low rainfall zone. To reduce production risk and increase profits, alternative end uses and novel agronomy opportunities are needed. There has been an expansion in lentil and vetch production and a growing interest in alternative end uses for both crops, including grazing and hay production. To explore lentil and vetch production potential and agronomic management opportunities, trials were established at four low rainfall environments on the Eyre Peninsula and Mid North regions of South Australia in 2020. Recommended seeding rates could be reduced by 25% without compromising on grain or biomass production potential, but it is important to not reduce rates too low as this can reduce production and leave crops exposed to weed and aphid infestations. Variety selection was important for grain production and optimal selection differed between environments. Alternative systems will enable growers to better manage their risk and optimise production potential.

Keywords
Lentil, vetch, hay, grain, alternative-use, low rainfall zone, novel management, risk

Introduction
Lentil and vetch production area has increased at the expense of sowing field pea over the last decade in the low rainfall cropping regions of South Australia (Figure 1). This increase in production area has coincided with high grain prices for lentil in 2015 and developments in breeding, particularly the release of varieties with improved herbicide tolerance characteristics and varieties better adapted to low rainfall environments. The majority of pulse management research is conducted in medium and high rainfall zones and strategies developed in these environments are often not viable or economical for growers in low rainfall regions. To improve grower confidence in pulse production there is a need for the development of pulse management strategies specifically for low rainfall zones, to overcome challenges associated with growing pulses in these environments.

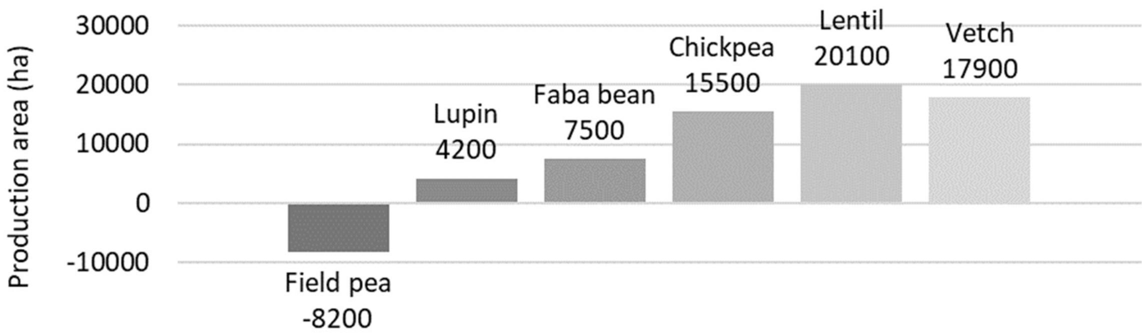

Figure 1. Change in pulse crop production (ha) across low rainfall cropping regions of South Australia, 2012-2020 (NB reduction in area sown to field pea and an increase in area sown to other pulse crops) (PIRSA 2012-2020).

This paper highlights and discusses agronomic management trials in vetch and lentil with a focus on novel management approaches, diversifying risk and identifying potential to reduce input costs without compromising production potential. The aim of the pulse end use trial was to identify optimum seeding rate and variety selection for vetch and lentil depending on target end use, either for grain or hay production. Gibberellic acid (GA) was applied to vetch with the aim of quantifying the effects on plant growth and dry matter production when applied at different growth stages.

Methods

Growing lentil for hay is rising in interest among low rainfall growers, which led to the initiation of research trials to compare biomass and grain production of vetch and lentil sown at multiple seeding rates, at four trials sites in South Australia (Table 1). The seeding rates compared the recommended target plant density (120 plants/m^2 for lentil and 60 plants/m^2 for vetch), with a target density of half and three-quarters of the recommended rate to assess whether inputs could be reduced without compromising production potential. Higher than recommended rates were not included, as high plant density increases the risk of disease infection and lodging, and reduces the resource efficiency due to larger canopies. Three varieties each of vetch (Volga, Timok, Morava) and lentil (PBA Jumbo2, PBA Blitz, PBA Highland XT) with varying phenology characteristics were included to refine variety selection depending on target end use. Measurements taken include site soil characteristics, biomass yield, feed analysis, grain yield, and crop height. Biomass measurements were taken at late vegetative and early podding growth stages to identify production potential for silage or hay production. Biomass samples taken at early pod development were tested for feed quality. Plots were arranged in a split plot design with three replicates, with crop species randomly assigned in blocks to the whole plot, and variety and plant density randomly assigned to the sub plot. The use of this design ensures that both crop types receive appropriate agronomic management. Data was analysed using a split plot ANOVA in Genstat 20th edition.

GALA growth regulator (100 g/L gibberellic acid) was applied to Volga vetch at two growth stages (6-8 weeks post-sowing and at early podding) and compared to an untreated Nil to quantify the effects of GA on vetch growth and dry matter production at Kimba and Booleroo, 2020. The maximum label rate for pasture of 80 mL/ha was applied to achieve maximum plant expression. Measurements included plant height at regular intervals post GA application, biomass dry matter production two weeks post-application, and grain yield. Plot arrangement was in a randomised complete block design with four replicates. Biomass and grain yield data was analysed using ANOVA in Genstat 20th edition. Plant height data was analysed using Repeated Measures ANOVA in Genstat 20th edition.

Results

At three of four sites, seeding rate reduced by a quarter did not compromise biomass or grain production, regardless of variety selection (Table 1). Reducing the seeding rate to half of the target density reduced production at some sites. There is the additional risk of a seeding rate that is too low exposes the crop to aphid infestation, weed establishment and increases harvest difficulty.

Table 1. Average biomass production (t/ha) at early podding and grain yield (t/ha) across six varieties of vetch and lentil in response to multiple seeding rates (response to seeding rate x variety was not significant (P>0.05)).

Seeding rate	Eudunda		Booleroo		Kimba		Stokes	
	Biomass yield	Grain yield	Biomass yield	Grain yield	Biomass yield	Grain yield	Biomass yield	Grain yield
Recommended	5.2	3.0	5.2	2.6	1.7	0.8	2.6	1.7
Three-quarter	4.8	3.0	4.8	2.7	1.6	0.7	2.2	1.6
Half	4.4	2.8	4.5	2.6	1.5	0.7	2.0	1.5
LSD (P<0.05)	*0.5*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*0.36*	*n.s.*

Key: LSD = least significant difference, n.s. = not significant at the 95% confidence interval

Similar levels of biomass were produced between varieties at Booleroo and Eudunda in 2020 (P>0.05, data not shown). Average biomass production was 0.99 t/ha at early flowering and 4.95 t/ha at early podding growth stages at Booleroo, with vetch producing more biomass than lentil at both growth stages that biomass was measured. Although there were no differences in biomass production between varieties, there were differences in crop height at the early podding growth stage (Table 2). Varieties with greater crop height, such as Morava vetch, have improved cutting ability for hay production. PBA Jumbo2 lentil had the highest grain yield of all lentil and vetch varieties at Eudunda in 2020 (Table 2).

Differences in grain production were observed between lentil varieties but not vetch varieties, indicating the importance of variety selection in lentil in this region. Conversely, variety selection was important in both vetch and lentil on the Eyre Peninsula, where Morava vetch was the highest yielding variety at both Stokes and Kimba.

Table 2. Plant height measured at podding (cm) and grain yield of lentil and vetch varieties, South Australia 2020. LSD = least significant difference.

	Plant height at podding (cm)		Grain yield (t/ha)		
Variety	**Eudunda**	**Booleroo**	**Eudunda**	**Kimba**	**Stokes**
Morava	40.44	44.11	2.96	1.10	2.03
Volga	33.84	25.89	2.87	0.52	1.46
Timok	34.53	34.20	2.93	0.56	1.31
PBA Highland XT	38.39	35.35	2.88	0.89	1.58
PBA Blitz	34.74	34.53	2.59	0.51	1.48
PBA Jumbo2	35.67	34.32	3.29	0.79	1.75
LSD (P<0.05)	*2.52*	*2.34*	*0.32*	*0.15*	*0.21*

There were no differences observed in metabolizable energy between crop species or variety (P>0.05). Metabolizable energy averaged across two sites and crops was 9.6 MJ/kg DM. There were differences in crude protein observed in response to an interaction between site and crop species (Figure 2), as well as in response to variety (Figure 3). Vetch samples contained a higher percentage of crude protein than lentil at both sites. There was a higher protein content in vetch samples collected from Booleroo than those from Eudunda. Morava vetch had the highest percentage of crude protein, followed by Volga and Timok vetch. All lentil varieties had the lowest percentage of crude protein, but no lower than Timok vetch.

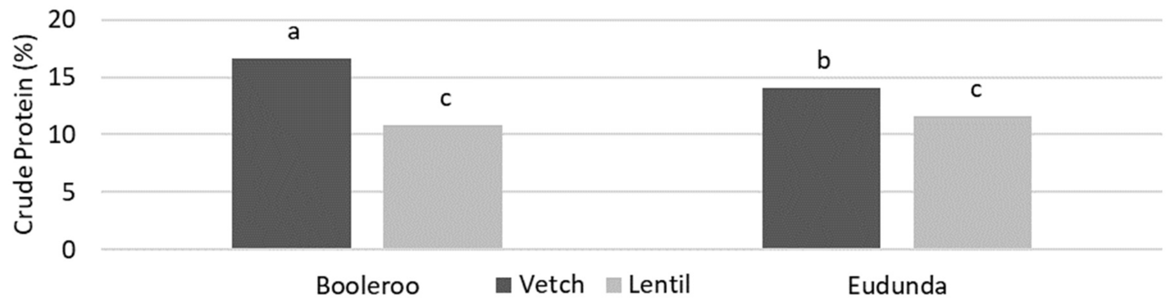

Figure 2. Crude protein (%) content of vetch samples taken at early pod development was greater than lentil samples taken at the same time, at Booleroo and Eudunda, 2020. Bars labelled with the same letters are not significantly different (site x crop P=0.046).

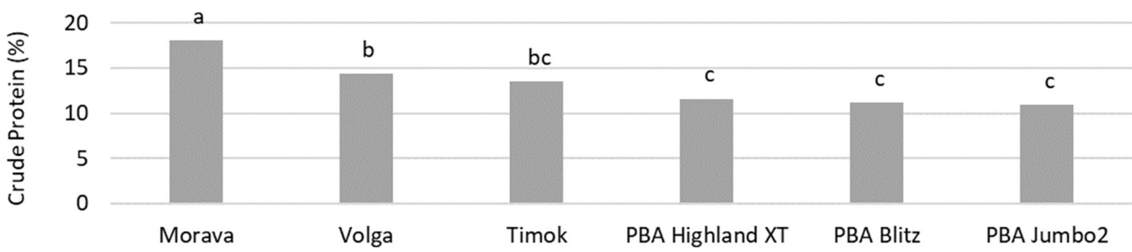

Figure 3. Crude protein (%) content of vetch varieties Morava and Volga was greater than all lentil varieties, when samples at early pod development from two sites, 2020. Bars labelled with the same letters are not significantly different (variety P=0.046).

The application of GA at the late vegetative growth stage increased vetch plant height by 3.8 cm at Kimba, and by 5.4 cm at Booleroo compared to the Nil plots (Table 3). However, the early podding GA application reduced plant height by 6.8 cm compared to the Nil treatment at Booleroo. It is important that when GA is applied there is adequate soil moisture and nutrition to support and sustain the rapid growth. Following dry seasonal conditions in winter, it is likely that soil moisture levels were not adequate to support the late growth of vetch when GA was applied at early podding. Although GA did increase vetch plant height, there was no biomass production response to GA. Vetch biomass production was 0.2 t/ha at late vegetative and 6.7 t/ha at the early podding growth stage at Booleroo. Production potential was much lower at Kimba, with 0.18 t/ha biomass at late vegetative and 2.3 t/ha at early podding. There was no phenology or grain yield response to GA application in 2020. However, a negative grain yield response has been observed in previous research trials from the application of GA (data not published).

Table 3. Mean plant height (cm) response to the application of gibberellic acid (GALA applied at 80 mL/ha) applied at late vegetative and early podding growth stages at Booleroo and at late vegetative growth stage at Kimba, 2020. LSD = least significant difference. Different letters in the same column indicate a significant difference.

Site	**Kimba**		**Kimba**		**Booleroo**			
Treatment	**Late vegetative** *Plant height (cm)*		**Early podding** *Plant height (cm)*		**Late vegetative** *Plant height (cm)*		**Early podding** *Plant height (cm)*	
Nil	8.6	b	16.5	a	11.3	b	82.8	a
GA @ 6-8 weeks	12.4	a	18.2	a	16.7	a	84.4	a
GA @ early podding	9.0	b	19.0	a	11.5	b	76.0	b
LSD (P<0.05)	*1.34*		*n.s.*		*0.66*		*5.95*	

Key: LSD = least significant difference, n.s. = not significant at the 95% confidence interval

Conclusion

Growing a profitable pulse crop can be challenging in the low rainfall zone. Alternative end-uses, novel agronomy, and agronomic management strategies developed for the low rainfall zone improve confidence, reduce production risk and increase profitability.

Lentil can be a versatile pulse option where vetch is not favoured, or where lentil crops grown for grain are severely drought or frost effected. Seeding rate of lentil and vetch can be reduced without compromising production potential but it is important to not reduce rates too low as this can impact production and will leave crops exposed to weed and aphid infestations. Further research is required in this space to assess the response of lentil and vetch sown in varying soil types, but also to study the water and nutrient use efficiency, nitrogen fixation and crop residue remaining after harvest between the two crops and under different seeding rates. Variety selection is important for grain yield but less so for biomass production, with rainfall and soil type key factors in selection.

Novel management approaches, such as the use of gibberellic acid, are used in vetch production to increase plant height, promote growth and production, and delay the onset of flowering. While an increase in plant height was observed in trials in response to an application of GA at vegetative stage, there was no response in plant production (biomass or grain production) or in flowering time. Further research is required to quantify the growth, production and phenology response to gibberellic acid in vetch.

References

PIRSA (2012-2020). Crop and Pasture Reports South Australia. G. o. S. A. D. o. P. Industries.