Faba bean seeding rates for central and southern NSW

P.W. Matthews [1], D.J. Carpenter [2], A. Smith [2] and N.A. Fettell [3]

[1] NSW Agriculture, Temora Agricultural Research & Advisory Station, Temora, NSW.
[2] NSW Agriculture, Wagga Wagga Research Institute, Wagga Wagga, NSW.
[3] NSW Agriculture, Condobolin Agricultural Research & Advisory Station, Condobolin, NSW.

ABSTRACT

The effect of seeding rate on the grain yield of faba beans (*Vicia faba*) was evaluated in 12 trials from 1996-1999 in southern and central NSW. The faba bean cultivars Ascot, Barkool, Fiesta VF, Fiord and Icarus were sown in a number of environments at a range of seeding rates from 60-270?kg/ha. A combined analysis of all data sets showed that there was no effect of location or season on the response of the different cultivars to seeding rate. There were, however, significant differences between cultivars and sowing times both in terms of the shape of the response to seeding rate and the absolute yield level. Our yield model suggested that for a mid May sowing, seeding rates of 150-180 kg/ha (30-35 plants/m^2) optimises yield for small seeded cultivars such as Ascot, Barkool and Fiord, and >200 kg/ha for larger seed cultivars such as Fiesta VF and Icarus. However, limitations imposed by seeding equipment and economics currently limits seeding rates across southern and central NSW to around 140 kg/ha.

KEY WORDS

Faba bean, seeding rate, southern and central NSW.

INTRODUCTION

Lupins and field peas have traditionally dominated pulse production in southern and central NSW. Over the past 5 years however, there has been an increased interest in faba beans as an alternative. Prior to this, faba bean production in this region was largely restricted to the southern irrigation areas, with few dryland crops. Accordingly, information on growing faba beans was transferred from outside areas such as northern NSW, Victoria and South Australia, with varying results. A major issue of this developing industry has been seeding rates and plant densities, given the relatively large seed size of this crop. Not only does this make seed costs high, much of the seeding equipment used by growers is unable to sow at the high rates recommended elsewhere. This raises the important question, does the seeding rate limit set by current seeding equipment impose any yield penalty?

The influence of seeding rate on faba bean yield has been documented across a number of Australian environments including Western Australia (3), South Australia (1), northern NSW (4) and irrigation areas in northern Victoria (2). These studies found that optimum plant population for the variety Fiord was 20-45?plants/m^2, depending on factors such as sowing time and seasonal moisture. However in southern/central NSW, there is no information on seeding rates for either Fiord or any of the more recent cultivars. We undertook this study to provide agronomists and growers with information on the response of currently grown faba bean cultivars to seeding rate in this environment.

METHOD

Yield response to seeding rates from 60 to 270 kg/ha was studied in 12 trials four years, from 1996 to 1999, at the locations in southern and central NSW (in Table 1). The cultivars studied were Ascot, Barkool, Fiesta VF, Fiord and Icarus. Ascot, Barkool and Fiord are small seeded types (average 45g/100 seeds, range 35-55), Fiesta VF a medium-large seeded type (average 65g/100 seeds, range 55-75) and Icarus a large seeded type (average 80g/100 seeds, range 70-90). Growing season rainfall ranged from 220 mm to 427 mm, and soil types varied from red brown earths (pH 4.9 $CaCl_2$), red clay loams (pH 5.1 $CaCl_2$) and grey clays (pH 5.2 $CaCl_2$).

Table 1: Thirty two treatment combinations of faba bean variety, seeding rate and sowing times were located at a range of sites across central and southern NSW during the four years 1996-99.

Year	Location	Seeding rates kg/ha	Sowing times #	Cultivars
1996	Gunningbland	60,100,140,180,220,260	E	Ascot
1996	Condobolin	60,100,140,180,220,260	E	Ascot, Fiord
1996	Thuddungra	70,110,150,190,230,270	E,M,L	Ascot
1996	Boree Creek	70,110,150,190,230,270	E,M,L	Ascot
1997	Thuddungra	60,100,140,180,220	E,M	Barkool, Icarus
1997	Gunningbland	60,100,140,180,220,260	E	Ascot, Barkool
1997	Condobolin	60,100,140,180,220,260	E,M,L	Barkool
1998	Condobolin	60,100,140,180,220,260	E,M,L	Barkool
1998	Alectown	60,100,140,180,220,260	E	Barkool, Fiord
1998	Temora	60,100,140,180,220	E	Barkool, Icarus, Fiesta
1998	Milbrulong	60,100,140,180,220	E	Barkool, Icarus, Fiesta
1999	Temora	60,100,140,180,220	E	Barkool, Icarus, Fiesta

Note # : E early - 1st & 2nd week May, M mid - 1st & 2nd week June and L late - 3rd & 4th week June

RESULTS

Response by cultivars

To determine if there was a significant difference between seeding rate response at different sowing dates or under varying environmental conditions, the 12 trials were combined using the individual replicate yields to form a single data set. A total of 32 treatments (trial by cultivar by sowing time combinations) were present in the data (see Table 1). The incomplete nature of the data (not all treatments were in all trials) necessitated the use of mixed model methodology for analysis. The yield response to seeding rate for each treatment was modelled using cubic smoothing splines which provide a flexible class of non-linear models (5). There was no significant interaction between the trials and the treatments (32) in the determination of the shape for the response curves. This left us with 10 treatments of variety by sowing time combinations (see Table 2).

Table 2: Estimated yields for each treatment at 5 seeding rates together with the probabilities that true yields exceeds that of Barkool-E

	Seeding Rate (kg/ha)									
	60		100		140		180		240	
	Yield (t/ha)	Probability	Yield (t/ha)	Probability	Yield (t/ha)	Probability	Yield (t/ha)	Probability	Yield (t/ha)	Probability
1. Barkool-E	1.88		2.14		2.41		2.61		2.77	
2. Barkool-M	1.14	<0.01	1.64	<0.01	2.12	0.03	2.47	0.17	2.75	0.46
3. Barkool-L	0.79	<0.01	1.27	<0.01	1.72	<0.01	2.07	<0.01	2.33	0.01
4. Ascot-E	1.75	0.29	2.06	0.35	2.37	0.43	2.59	0.45	2.62	0.26
5. Ascot-M	1.24	0.02	1.48	0.01	1.71	0.01	1.86	<0.01	1.90	<0.01
6. Ascot-L	0.95	<0.01	1.05	<0.01	1.17	<0.01	1.28	<0.01	1.36	<0.01
7. Fiesta VF-E	1.70	0.16	2.14	0.49	2.54	0.8	2.84	0.92	3.08	0.93
8. Fiord-E	2.21	0.88	2.50	0.92	2.79	0.94	3.02	0.95	3.18	0.94
9. Icarus-E	1.35	<0.01	1.68	<0.01	1.99	<0.01	2.23	<0.01	2.36	0.01
10. Icarus-	1.28	0.01	1.52	<0.01	1.80	<0.01	2.05	0.01	2.27	0.02

M

There were significant differences between treatments both in terms of the shape of the response curves and the intercepts or absolute yield. The estimated curves are shown in Figure 1. The early sown Barkool (Barkool-E) treatment was used as a basis for comparison as it was the most commonly occurring treatment. To aid with these comparisons, probabilities were added to Table 2 to indicate the likelihood of yields of other treatments being different to Barkool-E at specified seeding rates. Thus, probabilities near one/zero indicate a strong likelihood that the yield of the treatment is higher/lower than that of Barkool-E respectively. For example there is little evidence of a difference between the true yield of Fiesta VF-E and that of Barkool-E at 60, 100 and 140 kg/ha, whilst at 180 and 240 kg/ha there is strong evidence (92% and 93% chance respectively) that Fiesta VF-E out-yields Barkool-E. There is also strong evidence that Ascot-M and Ascot-L have lower yields than Barkool-E at all seeding rates under study.

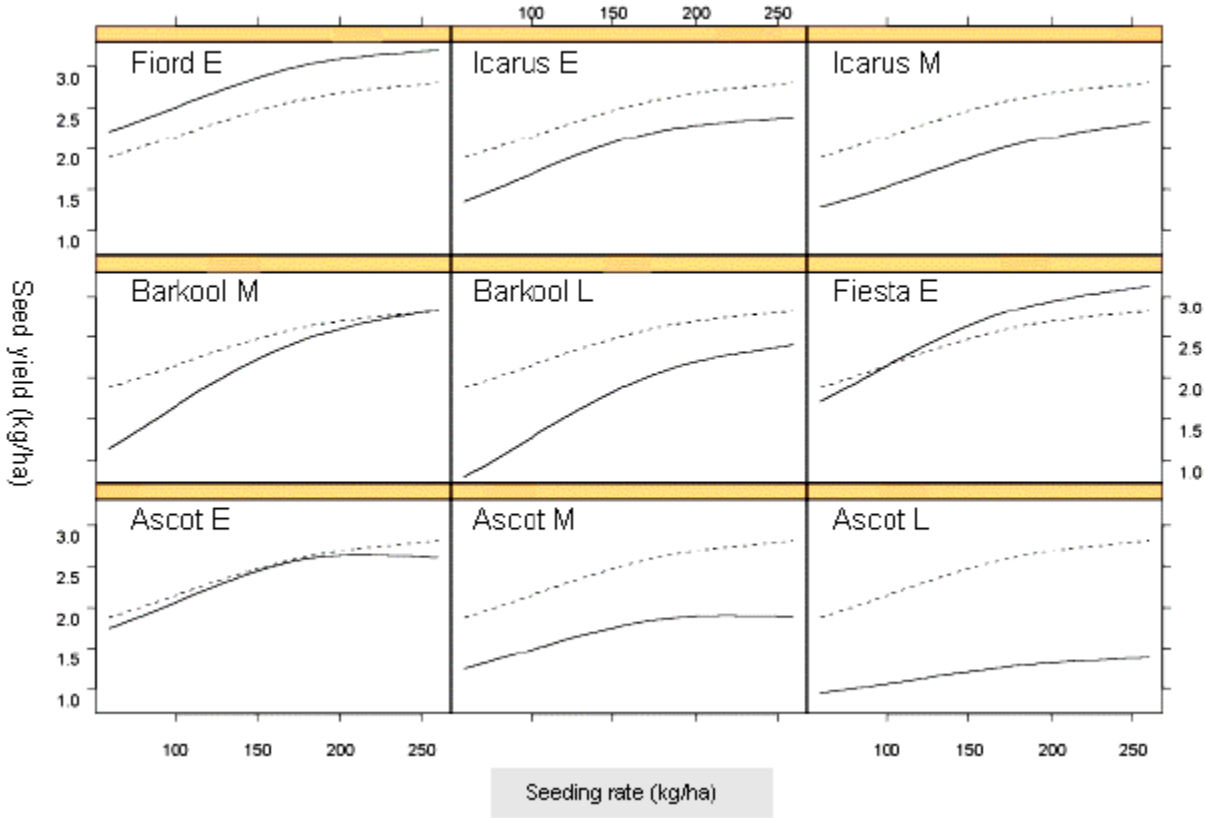

Figure 1. Fitted yield response curves of each treatment (solid line) to increasing seeding rates. The fitted yield response curve for Barkool-E (dashed line) has been added to each graph for comparison.

Table 3. Average plant densities for each seeding rate and cultivar.

Seeding Rate (kg/ha)	Cultivars
	Plant density (plants/m^2)

	Ascot	Barkool	Fiord	Fiesta VF	Icarus
60	14	16	20	13	10
70	17				
100	24	23	40	15	16
110	26				
140	30	30	41	20	18
150	34				
180	36	36	50	26	24
190	43				
220	46	42	53	26	28
230	50				
260	52	51	59		
270	57				

Response by seeding rate

The average plant density for each cultivar across the range of seeding rates is shown in Table 3. Densities of the smallest seeded types (Ascot, Barkool and Fiord) ranged from 14-20 plants/m2 at the lowest seeding rate rising to 51-59 at the highest seeding rates. As expected, corresponding figures for the larger seeded varieties Fiesta VF and Icarus were significantly lower : 10-13 up to 26-28 respectively.

Grain yield of all cultivars rose as seeding rate increased in the range of 60-270 kg/ha at all sowing times (see Figure 1). The rate of increase varied among cultivars – for Barkool, Fiord, Fiesta VF and Icarus, yield was still increasing at the highest seeding rate 220 kg/ha. However, for Ascot, maximum yield was reached at approximately 180 kg/ha, or 36?plants/m^2 (see Figure 1).

DISCUSSION

The response of cultivars to increasing seeding rate was similar across the range of environments sampled in these experiments (ranging in growing season rainfall from 220-427mm) and across a range of site mean yield from 1.0 to 4.1 t/ha. This suggests seeding rate and plant population need not vary as production moves from wetter to drier regions across central and southern NSW. This is in general agreement with Adisarwanto & Knight (1) and Marcellos & Constable (4) who concluded 20-35 plants/ m^2

was the optimal density range across the eastern states. However, these findings do conflict with those from Western Australia (3) where higher plant densities (>45 plants/ m^2) were required in lower rainfall environments to support similar yields.

The data show that seeding rates of Barkool, Ascot and Icarus need to be increased if sowing date is delayed beyond mid May in any environment. However, there is also a danger of establishing excessively high populations with early sowing as witnessed from farmer experiences in this region and demonstrated by Adisarwanto and Knight (1). These authors found that increasing seeding rates from 20 to 50 plants/m^2 in early sown crops (24th April) resulted in a reduction in yield, presumably due to excessive growth, lodging, inefficient pod set and increased disease.

Seeding rates expressed as kg/ha rather than seeds/m^2 were used in this study to provide direct relevance to commercial growers, particularly as the majority of their sowing equipment can not handle seeding rates of 140kg/ha or higher. This has presented significant problems with the recently released cultivar Fiesta VF, which because of its larger seed has come with a seeding rate recommendation of at least 140 kg/ha. Seed costs at these high rates also become prohibitively high. The comparison between Barkool-E and Fiesta VF-E in this experiment therefore becomes of particular interest. The model response (Figure 1) shows that the expected genetic yield benefit of Fiesta VF over Barkool-E is expressed only when seeding rates exceed 100kg/ha, equivalent to 15 and 23 plants/m^2 of Fiesta VF and Barkool, respectively. Therefore, if growers wish to realise the full yield potential of the new variety Fiesta VF, they need to establish 23 plants/m2 or preferably more (>140kg/ha), and for many, this is beyond the capacity of their sowing equipment. If the future of our faba bean industry is dependent on markets that require large seeds and on new varieties that achieve true genetic yield potential only at high seeding rates (>140 kg/ha), then high priority should be directed to developing equipment that can efficiently deliver these rates.

Anecdotal evidence suggests that lowering plant density reduces the risk and pressure of diseases such as Chocolate spot (*Botrytis fabae*) and Ascochyta blight (*Ascochyta fabae*), even though no such evidence was seen in these experiments. To the contrary, it would appear far more logical and profitable to realise maximum yield potential through optimising seeding rate and implementing an effective disease management program using fungicides rather than opting for the “alternative” approach to disease control of reducing seeding rates at the expense of yield.

Our yield model used here suggests that a seeding rate of 150-180 kg/ha (30-35 plants/m^2) optimises yield for small seeded cultivars such as Ascot, Barkool and Fiord. It also shows that the yield of Fiesta VF (and to a lesser extent Icarus) continues to increase at a seeding rate of 220 kg/ha. However, seeding equipment and economics will limit the amount of seed that can be sown. Therefore a realistic and practical seeding rate for Fiesta FV across southern and central NSW is a minimum of 140 kg/ha or 20 plants/m^2 when sown in mid May.

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