Fenugreek has a role in south-eastern Australian farming systems

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Abstract

Fenugreek has a role in the alkaline soil regions of south-eastern Australian farming systems as either a minor grain crop or a green manure crop. Fenugreek has a similar length of growing season to other pulses and legumes grown in the Wimmera (lentils, field peas, faba beans, chickpeas, vetch and annual medic). Fenugreek's growth pattern differed from vetch, field peas and lentils and an understanding of these differences is an important management consideration. Yields of fenugreek were similar to lentil, field pea and faba bean in seasons affected by below average rainfall and late season frosts. Based on commercial production statistics, the gross margin of fenugreek was lower than lentils, but higher than faba bean or field pea. Evaluation of fenugreek germplasm identified several cultivars (Might (A150292), Power (A150265, Wimmera Sungold (A150118) and A150147), with improved yield compared to the commonly grown cultivar (A150000). Current market size limits fenugreek to a role as a niche crop. Potential exists to further develop existing markets and create new opportunities, such as galactomannan gum production. An industry structure is required to facilitate further development.

Key Words

Trigonella foenum-graecum, pulses, legumes, rotation

Introduction

Farming systems in south-eastern Australia have evolved from a ley farming system with a pasture-fallow-cereal rotation to a more intensive cropping rotation including oilseeds, grain legumes (pulses) and green manured legumes. Pulses are generally considered high risk crops as their cost of production is higher, yield is less stable than cereals and the market size is smaller, less regulated and more volatile (Siddique and Sykes 1997). Recent examples of production risk in the Wimmera region included ascochyta blight in chickpea, botrytis grey mould in lentil and bacterial blight in field pea. A wider choice of pulses has been identified as one way to spread the risks associated with growing pulse crops (Siddique and Sykes 1997). Fenugreek (*Trigonella foenum-graecum*) is a multi-purpose legume that can be grown for the spice and pharmaceutical markets, or for green manure. In the Wimmera region it has been accepted by some growers as a useful green manure alternative to medic or vetch. It also has the potential to be added to the suite of pulse options and has been grown on a limited scale in Victoria and South Australia as a seed crop.

This paper defines the current and potential role of fenugreek in a Wimmera farming system on the basis of a systems and economic analysis of data from both field experiments and commercial production. It also describes the challenges that must be met for that role to be more prominent.

Methods

Field experiments, sown in a randomized complete block design, were conducted at Longerenong and Dimboola, Victoria on grey vertosols in 1998 and 1999. Several fenugreek accessions were compared to other commonly grown legumes, including faba bean (*Vicia faba*), field pea (*Pisum sativum*), lentil (*Lens culinaris*), vetch (*Vicia sativa*), barrel medic (*Medicago truncatula*), and chickpea (*Cicer arietinum*). The species were compared for early growth and development, flowering time, biomass, and yield. Nitrogen fixation (Pfix) was measured using the natural abundance technique. Wheat was sown over the legume plots in the following seasons to assess any rotational differences. A more detailed description of methods is provided in McCormick (2004).

In order to gain a commercial perspective, the experiences and challenges of commercial fenugreek growers were documented during the study period and commercial yield and commodity price data from the period 1994 to 2003 were sourced from the Australian Bureau of Statistics, The Lentil Company, Wimmera Grain Company, Pulse Australia and Wimmera fenugreek growers. These data were used to assess the relative risk and profitability of the various pulse crops.

Results

Field experiments (Table 1)

In 1998, growing season rainfall (GSR, April to October) was 285 mm at Longerenong and 276 mm at Dimboola. A late-season frost occurred on October 28, 1998. Estimated frost damage to grain yield were: lentil and vetch 50%; field pea 20%; faba bean 10%, and fenugreek 5%. The GSR at Longerenong in 1999 was 200 mm, compared to the long term average of 290 mm.

Table 1: Summary of flowering biomass, nitrogen fixation and yield data from three trials conducted in 1998 and 1999 at Longerenong and Dimboola.

Species-genotype	Flowering date (DAS)	Maturity type[4]	Biomass at early flowering (t/ha)	Biomass at late flowering (t/ha)	Pfix (%)	Total N fixed (kg/ha)	Grain yield (t/ha)	Seed weight (mg)
1998 (mean of two sites)								
Fenugreek-150000	98	M	1.2	3.8	66	90	1.1	13
Fenugreek-150265	100	ML	1.2	4.2	81	110	1.1	17
Fenugreek-mean	100	M	1.3	3.8	68	85	1.0	15
Faba bean - Fiord [1]	94	E	2.1	4.3	76	122	1.0	324
Field pea-Dundale[2]	108	E	3.6	7.3	83	229	1.7	139
Lentil-Digger,[2]	109	EM	1.5	4.0	79	102	0.7	33

Medic-Mogul	104	E	1.2	3.4	72	86	-	-
Vetch-Morava [2,3]	130	ML	0.9	2.6	84	104	0.3	51
l.s.d (P< 0.05)	*3*		0.5	1.0	14	60	0.21	21
			1999 (mean of two sites)					
Fenugreek-150000	89	EM	1.7	5.6	75	155	1.9	13
Fenugreek-150265	92	ML	1.6	5.2	77	150	2.3	16
Fenugreek-mean	93	M	1.5	5.6	73	156	2.0	15
Faba bean - Fiord	84	E	2.3	7.9	85	277	3.7	458
Field pea-Dundale	97	E	1.5	6.6	92	222	2.8	175
Lentil-Digger	108	E	1.2	4.4	92	147	2.4	43
Medic-Mogul	102	E	1.5	5.6	76	133	-	-
Vetch-Morava	111	E	1.5	7.2	83	244	1.6	75
l.s.d (P< 0.05)	*1.7*		0.5	ns5	7	82	0.8	57

[1] Data for faba bean from 1 site only; [2] Yield affected by frost; [3] Yield affected by herbicide damage
[4] E = early; M = medium, L = late; [5] Not significant

Table 1 presents data comparing the performance of two fenugreek accessions and the mean of 21 elite fenugreek accessions to that of other pulses and legumes. The fenugreek accessions A150000 and A150265 were early flowering compared to the other species, with a flowering time between Fiord faba beans and Dundale field pea. The majority of fenugreek accessions had a ‘medium maturity’, ripening about 7 days after field pea. Fenugreek however was slow growing in the early stages, as indicated by its lower early flowering biomass compared to field pea and faba bean. Leaf development rate of fenugreek was found to be more temperature dependant than that of vetch, lentil or field pea (data not shown). Levels of nitrogen fixation (Pfix) observed for fenugreek were generally similar to the other legumes, although total N fixed for fenugreek was similar to lentil and medic, but less than vetch, field pea and faba bean. These species differences can largely be attributed to differences in biomass production. Biomass was strongly related to total N fixed (r = 0.95 P< 0.001). Fenugreek seed yields were similar to lentil and faba bean in 1998, and less than field pea, but lentil yields were frost affected. Fenugreek appeared the least frost affected species. In 1999, fenugreek produced similar yields to lentil and field pea and lower yields than faba bean. Overall, fenugreek yields were similar to the other commercially grown species. In rotational studies, wheat grown after fenugreek had root disease incidence and N uptake similar to wheat after other legumes (data not shown).

Comparison with other legumes: Commercial Survey

Tables 2 compares commercial yield and price data for 1993-2001 and 2003 and Table 3 compares productions costs and income based on commercial production statistics. The 2002 year was excluded due to the price distortion of commodities caused by the nation-wide drought. Fenugreek was a higher priced commodity than field pea and faba bean and similar to lentil. Fenugreek had a similar range of commercial yield compared to the other species. Fenugreek gross margins were less than lentil, but higher than the other commodities. The recent development of ascochyta resistant chickpeas has reduced costs, improved the potential profitability and reduced the risk of growing chickpeas. Lentil and fenugreek were lower risk crops because their production costs were low, compared to their gross income. This analysis shows that fenugreek can be grown at a relatively low financial risk and can be a profitable crop.

Table 2: Price and yield of commercial pulse crops in the Wimmera (1994-2001 and 2003).

	Farm gate price ($/t)		Yield (t/ha)		Variable cost $/ha	Gross income $/ha	Break even yield t/ha	Variable costs as a percentage of gross income%	Gross margin $/ha
Crop	Range	Mean	Range	Mean					
Chickpea-desi	270-500	390	0.3-1.8	1.0	314[1]	390	0.80	80	**76**
Chickpea-kabuli	420-1000	650	0.3-1.8	1.0	394[1]	650	0.57	60	**256**
Faba bean	230-280	240	0.5-2.0	1.4	198	336	0.83	59	**138**
Fenugreek	350-530	450	0.5-2.2	1.2	168	540	0.37	31	**372**
Field pea	180-280	230	0.4-1.8	1.1	175	253	0.76	69	**78**
Lentil	400-550	450	0.5-2.0	1.4	185	630	0.41	29	**445**

Sources: ABARE, Pulse Australia, Wimmera Grain Company, The Lentil Company
[1] Includes a cost of a fungicide program for *Ascochyta rabei*.

Discussion

Fenugreek was comparable to other legumes in terms of yield, profit and adaptation. However, successful commercial production requires an understanding of crop management to ensure production requirements and also requires available markets to ensure an adequate price.

In terms of disease, it is an advantage that it suffers less from foliar fungal pathogens than lentil, faba bean and chickpea (McCormick 2004). This reduces the reliance on foliar fungicide. However, fenugreek is susceptible to bacterial blight and the lack of effective control measures for bacterial blight is a disadvantage that may deter some growers from adopting fenugreek.

Fenugreek had a slow pattern of early growth and is a poor competitor of weeds. Pre-emergent herbicide control options are limited, compared to lentils, faba bean, field pea and chickpea, which all have a range of pre-emergent and post-emergent broadleaf weed control options. The lack of weed control options in fenugreek may deter growers from adoption. Fenugreek's slow early growth was followed by a rapid increase in growth rate during the flowering period. This "gear change" often takes growers by surprise and the opportunity to apply post-emergent herbicides prior to flowering is missed. An understanding of the growth pattern of fenugreek would improve the level of weed control in commercial crops.

The slow early growth of fenugreek could be counteracted by sowing earlier, when the soil is still warm (>10^{o}C), however this could increase the risk of bacterial blight infection. Currently, there is a need to compromise between bacterial blight risk and the desire for early plant growth.

The harvesting ability of fenugreek is better than field pea or lentil and similar to faba bean or chickpea. It is of sufficient height for mechanical harvesting and is generally non-shattering, although some of the earlier maturing varieties may shatter more than A150000. Some of the taller, vine-type accessions, such as A150000, can lodge and be tough to thresh (Table 3). Fenugreek appeared to be more frost tolerant than the other legumes, particularly compared to lentils and vetch, which further reduces the risk profile of the crop.

Further improvement in yield and adaptation is possible due to variation exhibited among the fenugreek accessions evaluated. Table 3 describes four cultivars that have been commercially released as a result of this study. As well as understanding the general management requirements of fenugreek, the differences among fenugreek cultivars must be considered. The new cultivars are very diverse and may have different management requirements to each other and to A150000, the commonly grown cultivar. A150147 matures earlier than A150000 and would need to be harvested earlier. A150147 has a smaller seed size than A150265, so the optimum sowing rate will be less for A150147. Cultivar specific agronomic packages are required to optimise the production of the new cultivars.

Table 3: Characteristics of commercial significance for high yielding and high biomass accessions identified in trials between 1997 and 2000 compared to the check line A150000 (mean of three sites 1998-1999).

Category	Check		Grain production		Multi-purpose	
Accession Number	A150000	A150265	A150147	A150118	A150292	lsd P<0.05
Commercial cultivar name	Fenugreek	Power	-	Wimmera Sun Gold	Might	

Yield (t/ha)	1.4	1.5	1.7	1.5	1.4	0.21
Yield rank[1]	7	3	2	4	5	
Flowering date (days after sowing)	95	98	93	97	97	0.95
Late flowering height (cm)	47	41	35	40	49	2.2
Late flowering biomass (t/ha)	4.4	4.5	4.3	4.8	5.5	0.62
Early Vigour (1= poor, 5 = excellent)	2.3	3.8	1.9	3.6	3.2	0.47
Lodging [2]	MS	MR	MR	MR	S	
Shattering[2]	MR	MR	MS	MR	MR	
Resistance to bacterial blight[2]	S	MS	MS	MS-MR	MS	
Seed colour	Yellow	Yellow	Yellow	Gold	Yellow	
Seed size	Small	Medium	Small	Large	Large	

[1] Rank of yield performance from three sites in 1998and 1999.
[2] Ratings derived from visual assessments in 1997 and 1998. VS, very susceptible; S, susceptible; MS, moderately susceptible; MR, moderately resistant; R, resistant.

Grain markets

Fenugreek has a small world market volume of around 30000-50000 t, mainly for spice production. It is also used in pharmaceuticals and there may be potential to develop a fenugreek galactomannan gum industry. At least 3000 t of seed gum is imported annually (Cunningham and Walsh 2001). Replacing half of the imported gum with fenugreek gum could provide a new market for 7000 ha of fenugreek annually. Unless new markets are developed, its role will be as a minor niche crop for a limited number of growers who have the ability to store grain in times of market lows.

Industry development

Fenugreek is a displaced commodity, as it is not widely regarded as a pulse crop. Fenugreek is regarded as a spice crop and sometimes as an aromatic and medicinal plant, but in Australia, these industries seem small and poorly structured. For future development, it is proposed that fenugreek becomes a leviable species under the auspice of the Grains Research and Development Corporation (GRDC). A Fenugreek Industry Association needs to form to provide direction and support for future development. This association could be managed by Pulse Australia. The combined resources of Pulse Australia and GRDC would provide a vehicle for effective communication with fenugreek growers.

Conclusions

Yields and profitability of fenugreek are similar to other pulses. Unless new markets are developed, fenugreek could not feasibly replace high-market-volume pulses to a large degree, without causing oversupply. However, fenugreek could be included as part of the pulse component within a farming system to spread both price and production risk. It is relatively inexpensive to grow. The availability of improved cultivars and an understanding of crop management requirements reduce the production risk of fenugreek. A coordinated industry approach would assist further development.

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