PROMISING NEW GRAIN LEGUMES FOR WESTERN AUSTRALIA

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Summary. High value pulses are suitable for many fine-textured, neutral to alkaline soils where narrow leaf lupin is poorly adapted, however, they may not be suited to all soil types and regions. The growth and seed yield of vetch, narbon bean, *Lathyrus sativus*, *Lathyrus cicera* and *Lathyrus ochrus* were compared to field pea and faba bean at 11 sites throughout the Western Australian wheatbelt in the dry 1994 season. These new grain legumes showed considerable promise for farming systems. On average over all sites, field pea produced the greatest machine harvested seed yield (1.8 t/ha) followed by faba bean (1.4 t/ha), narbon bean (1.3 t/ha), vetch (1.2 t/ha) and the *Lathyrus* species (1.0 t/ha or less). These results are not surprising given the small amount of development that has been undertaken with these new species. The good biomass production of these species indicates their adaptation to fine-textured, neutral to alkaline soils, however, their late flowering time relative to faba bean and field pea is limiting their seed production. With further breeding and agronomic research, early flowering vetch, narbon bean, *Lathyrus* spp. could find niches in farming systems, providing a stockfeed, on and off-farm, and rotational benefits in situations where other grain legumes are not suitable.

INTRODUCTION

Domestication of the narrow-leafed lupin led to its rapid and widespread adoption by cereal growers with coarse textured, acidic to neutral soils, mainly in Western Australia (WA). Other soil types, in particular some neutral to alkaline, fine-textured or duplex soils, are not suitable for narrow-leafed lupin production and these occupy an estimated 6.5 million hectares throughout southern Australia. High value human consumption grain legumes known as pulses are suitable for many of these soils (4), however they may not be adapted to all soil types and regions, in particular the low rainfall areas. Other grain legumes, including vetches (*Vicia* spp., 4), narbon bean, (*Vicia narbonensis*, 6) and *Lathyrus* species (5) also deserve consideration.

Lathyrus sativus, also called grasspea, is grown in the Indian sub-continent and Africa for green feed and grain production for both animal and human consumption. Grasspea is grown on a wide range of soil types and is reputed for its drought and waterlogging tolerance. It contains the neurotoxin ?-N-oxalyl diamino propionic acid (ODAP) which causes paralysis of the lower limbs (lathyrism), if consumed as a major part of the diet. *L. cicera* and *L. ochrus* are grown as a stockfeed (both forage and grain) in West Asia, North Africa and southern Europe and also contain ODAP. Narbon bean is a close relative of faba bean, however, it is reported to be better adapted to low rainfall areas and has better resistance to fungal diseases. The seed is high in sulfur, containing 26-32% protein and glutamyl S ethyl cysteine (GEC), a sulfur compound which gives the seed an unpleasant taste. Vetches (*Vicia* spp.) make a nutritious hay when mixed with cereals and are also used as a green manure crop. Importation of the common vetch cultivar Blanchefleur as a cheap substitute for red lentils in India and Egypt was banned following reports that it contains unacceptable levels of an anti-nutritional factor. The aim of this study was to compare the growth and seed yield of the best available lines of these new grain legumes at a wide range of sites in WA.

MATERIALS AND METHODS

The growth and seed yield of vetch (*Vicia sativa* cv. Languedoc), narbon bean (SA26554), *Lathyrus sativus (*SEL453), *Lathyrus cicera* (SEL486) and *Lathyrus ochrus* (SEL540) were compared to field pea (cv. Dundale) and faba bean (cv. Fiord) at 11 sites throughout the WA wheatbelt and South Coast in 1994 (Table 1). These lines were selected from previous evaluations of a range of germplasm (2, 3, 4) as the best adapted material. Seeding rates were calculated according to seed size and germination percentage to achieve densities of 45 plants/m2 for field pea and 30 plants/m2 for the other species. The seed was inoculated with Group E rhizobium. Weeds were controlled with pre-sowing applications of 1.0 L/ha

Roundup (glyphosate) and 2.0 L/ha Bladex (cyanazine), and redlegged earth mite (*Halotydeus destructor*), pea weevil (*Bruchus pisorum*) and pod borer (*Helicoverpa* spp.) were controlled with appropriate insecticides. The experiments consisted of plots 20x1.44m (8 rows), in 3 randomised blocks. Dates of first flower were recorded at most sites.

RESULTS

Weather conditions

Overall, 1994 was one of the driest seasons in WA for many decades, with sites receiving between 58-93% of their average growing season rainfall (Table 1). Only Mullewa received any significant summer rainfall, while all other sites relied on growing season rainfall. The wettest site, South Stirlings, received 295 mm between May and October. The driest site, Merredin, received only 165 mm during the May to October period, compared to an average growing season rainfall of 212 mm. The probability of this type of season at Merredin is about 10% (decile 1). In general, mean daily air temperatures were slightly above average in 1994, however two frosts in early October damaged field pea and the *Lathyrus* species at the Kondinin site.

Table 1. Soil type, sowing dates and growing season rainfall (May to October, M-O) in 1994 and long-term average rainfall at the experimental sites.

Site	Soil description and pH (in 0.01M CaCl2)	Sowing Date	1994 M-O Rain (mm)	Average M-O Rain (mm)
Mullewa	Deep red silty clay loam (8.0)	4 June	201	249
Three Springs	Reddish brown sandy loam (7.3) over heavy red clay at 15 cm (7.2)	6 June	237	303
Watheroo	Deep red-brown sandy loam (7.0)	13 June	197	336
Northam	Red-brown loam (5.0) over reddish brown clayey sand at 25 cm (6.1)	6 June	256	368
Merredin	Reddish brown sandy loam (6.0) over red clay at 30 cm (7.8)	25 May	168	212
Kondinin	Reddish brown sandy loam (6.2) over red clay at 25 cm (7.5)	8 June	231	247
Dumbleyung	Brown loam (5.3) over a grey sandy clay at 15 cm (6.0)	26 May	209	255
Gnowangerup	Grey-brown sandy loam (4.6) over a grey loamy clay at 25 cm (8.0)	3 June	242	281

Sth. Stirlings	Grey loamy sand (5.2) over gravelly sandy loam at 10 cm (5.8)	4 June	295	356
Jerramungup	Reddish brown sandy loam (6.2), over red sandy clay at 15 cm (7.0)	31 May	198	324
Salmon Gums	Grey loamy sand (5.2) over heavy grey clay at 10 cm (6.5)	29 May	175	204

Growth and seed yields

Both field pea and faba bean produced rapid growth early in the season and flowered earlier (70-80 days after sowing) than the other species. Under the dry conditions of 1994, fungal diseases in field pea and faba bean did not limit their growth or yield. At most sites, field pea produced significantly ($P<0.05$) more machine harvested seed yield than the other species with > 2.0 t/ha at 5 sites (Table 2). The seed yields of faba bean were comparable to field pea at Watheroo, Northam, Merredin and Dumbleyung, however the mean faba bean yield across all sites was 1.4 t/ha compared to 1.8 t/ha for field pea.

While Languedoc vetch was slow growing in the early seedling stages, its growth accelerated rapidly in late winter and early spring, and it produced impressive biomass at maturity. On average, machine harvested seed yields were 1.2 t/ha, including 2.5 t/ha at Northam. Narbon bean and faba bean were the only species not to lodge at maturity, although some pod shattering and harvesting losses were evident in narbon bean at the drier sites. Narbon bean growth was noticeably poor at South Stirlings and Salmon Gums where the surface soils were sandy and relatively infertile. At other sites, its growth was good but it was about 10 days later flowering than faba bean. Narbon bean yields were comparable or better than faba bean at 5 sites, and on average across all sites, it produced 1.3 t/ha. Of the *Lathyrus* species, *L. sativus* and *L. cicera* appeared the most drought tolerant with good biomass production and mean seed yields of about 1.0 t/ha. As with vetch, some pod shattering was noted, particularly in *L. sativus* and *L. ochrus. L. cicera* was the earliest flowering species, but was still about 20 days later flowering than faba bean.

Table 2. Machine harvested seed yields (t/ha) of grain legume species in 1994.

Site	Grain Yield (kg/ha)							
	Field pea	Faba bean	Vetch	Narbon bean	*L. sativus*	*L .cicera*	*L. ochrus*	lsd 5%
	Dundale	Fiord	Languedoc	SA26554	SEL453	SEL486	SEL540	
Mullewa	1.86	1.17	1.26	1.61	1.09	0.94	0.72	0.23
Three Springs	1.99	1.45	1.34	1.85	1.94	0.99	0.91	0.44
Watheroo	2.48	2.45	1.30	2.22	1.62	1.30	0.75	0.34

Northam	2.34	2.25	2.54	1.42	2.01	2.20	1.08	0.42
Merredin	0.99	0.76	0.28	0.76	0.39	0.29	0.14	0.25
Kondinin	1.19	0.99	0.43	0.80	0.33	0.49	0.36	0.15
Dumbleyung	1.60	1.65	1.29	1.13	0.58	0.98	0.96	0.44
Gnowangerup	2.51	1.94	1.58	1.42	1.45	1.38	1.04	0.36
Sth. Stirlings	2.11	1.52	1.33	0.95	0.20	0.46	0.48	0.29
Jerramungup	1.51	0.33	0.98	-	0.44	1.00	0.52	0.17
Salmon Gums	1.09	0.56	0.74	0.60	-	0.21	0.40	0.16
Mean	1.79	1.37	1.19	1.28	1.01	0.93	0.67	

DISCUSSION

The new grain legumes tested in this study show considerable promise for WA farming systems. While the seed yields produced by vetch, narbon bean and *Lathyrus* were generally less than field pea and faba bean, this is not surprising given the small amount of breeding and agronomic development that has been undertaken with these new species. Also, fungal diseases that normally limit field pea and faba bean were not evident in the dry 1994 season. The good biomass production of all these species confirms their adaptation to near neutral to alkaline, fine-textured soils, however, early flowering is critical for high yields in short season, mediterranean environments of WA. The seed production of all these species could be improved considerably by selecting for early flowering.

Although vetch, narbon bean and *L. sativus* are consumed in small quantities by people from various parts of the world, their use in Australia will be almost exclusively as stockfeed, producing both forage and grain. It has been estimated that the volume of stockfeed manufactured in Australia is 5.5 million t/year, with a potential grain legume content of 1.0-1.5 million t (1). The new grain legumes could be used to replace some of the lupin, faba bean and field pea used domestically, while allowing greater export of the higher value grain legumes. The value of the new grain legumes to ruminants and monogastrics requires urgent attention if suitable markets are to be developed.

There are small lucrative export markets for vetch as seed for grazing and green manure crops, and bird feed in Europe. The export of Blanchefleur vetch as a substitute for split red lentil could damage the reputation of our developing lentil industry as a supplier of quality products, and should be re-evaluated. Vetches contain an anti-nutritional factor and imports into India and Egypt have been banned. The immediate potential for *Lathyrus* in Australia is as a stockfeed, however, if suitable pulse markets were to emerge, there is scope for developing *L. sativus* as a food legume. In this case it will be essential to produce lines with less than 1.0 mg/g ODAP content to avoid the risk of lathyrism in consumers. In a recent assessment of more than 400 *L. sativus* lines from ICARDA, Bangladesh, Pakistan and India, we have identified several lines with early flowering, good dry matter production and seed yield, and low ODAP content (2). Many lines also produced similar or greater seed yield than field pea. In addition, we have recently received 4 somaclonal lines of *L. sativus* from India with very low ODAP content (< 0.2

mg/g). The unpalatable flavour of the narbon bean seed will limit its acceptance as a stockfeed unless the GEC compound can be removed through breeding or processing. Before releasing these crops to commercial growers agronomic packages need to be developed.

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REFERENCES

1. Edwards, A. 1994. ACIAR Tech. Rep. 29, Canberra.

2. Hanbury, C., Sarker, A., Siddique, K. and Perry, M. 1996. CLIMA Occ. Pub. 9, pp. 14.

3. Siddique, K., Walton, G. and Seymour, M. 1993. Aust. J. Agric. Res. 33, 915-922.

4. Siddique, K., and Loss, S. 1996. Aust. J. Exp. Agric. (submitted)

5. Siddique K., Loss, S., Herwig, S. and Wilson, J. 1996. Aust. J. Exp. Agric. 36, (in press).

6. Siddique, K., Loss, S. and Enneking, D. 1996. Aust. J. Exp. Agric. 36, (in press).