ADAPTATION OF FABA BEAN TO MEDITERRANEAN ENVIRONMENTS OF WESTERN AUSTRALIA

S.P. Loss and K.H.M. Siddique

Centre for Legumes in Mediteranean Agriculture, University of Western Australia, Nedlands, WA 6009 and Agriculture Western Australia, Baron-Hay Crt., South Perth, WA 6151

Summary. Faba bean was thought unsuitable for most of Western Australia because of its susceptibility to moisture and heat stresses. Faba bean (cv. Fiord) was sown at 4 dates at 7 sites in 1993 and 5 sites in 1994. In 1993, seed yields varied from 2.0-4.2 t/ha from the first sowing times. 1994 was one of the driest seasons in decades and yields varied from 0.8-1.8 t/ha from the first sowing times. In both years, yields declined with delayed sowing at rates of 14-56 kg/ha/day. Faba bean produced its first flowers earlier than other crops in this environment (63-90 days after sowing), tolerated mild spring frosts and had consistently high harvest indices (37-62%). Faba bean can produce impressive dry matter and seed yields in a range of dryland mediterranean environments, however early sowing is critical for high seed yields in low rainfall conditions.

INTRODUCTION

The Western Australian (WA) wheat belt experiences a mediterranean-type climate and contains large areas of fine-textured, neutral to alkaline and duplex soils that are unsuitable for narrow-leaf lupin (*Lupinus angustifolius* L.) production. In contrast to other grain legumes, faba bean (*Vicia faba* L.) has a shallow root system, little osmoregulation and is sensitive to high temperatures and water stress, particularly during anthesis and pod filling (3, 9). Hence, faba bean was only considered suitable for high rainfall (>400 mm/annum) regions of WA (10). However, recent improvements in disease management and commercial rhizobium inoculant have increased faba bean yields. A recent comparison of a range of grain legumes indicated that the faba bean cv. Fiord has immediate potential for WA (8). This study examines the adaptation of faba bean to the dryland mediterranean-type environments of WA by studying its growth, phenology, dry matter production and seed yield from a range of sowing times.

MATERIALS AND METHODS

Faba bean cv. Fiord was sown at four dates ranging from early May to early July at 7 sites in 1993 and 5 sites in 1994. Time of sowing was used as a treatment in these experiments to create a range of conditions at each site and season. Seeding rates were calculated using percentage germination and mean seed weight to achieve the density of 30 plants/m2. The seed was treated with rhizobial inoculum (Group E) prior to sowing. Plots were generally 1.44 m wide (8 rows, 18 cm apart) and 20 m long, and the trials included 4 replicates in a randomised block design. The first times of sowing at Dongara in 1993 and Dongara, Gnowangerup, Northam and Lake Grace in 1994 were sown into dry soil 7-14 days before the first autumn rains. All other treatments were sown after the first rains. The trials at Merredin were sampled every 2 weeks for dry matter and green area index in both years. In 1993, some ascochyta blight (*Ascochyta fabae)* was observed at Gnowangerup and Scaddan, and a fungicide was applied. Minor infections of chocolate spot (*Botrytis fabae)* that did not warrant a fungicide application became evident late in the 1993 season at most sites. Fungal infections in 1994 season were minor.

RESULTS

In 1993, May to October rainfall was within 25 mm of the long-term average at most sites. 1994 was one of the driest seasons in decades and rainfall from May to October was below average at all sites. In both years, nearby chickpea (*Cicer arietinum*), field pea (*Pisum sativum*) and wheat (*Triticum aestivum*) plots were damaged by frosts at several sites. Crop establishment and nodulation were not affected by date of sowing even in the case of dry sowing. In the early times of sowing at Merredin in 1993, dry matter and green area production were rapid in winter, and peak dry matter and peak green area indices were significantly greater than when sowing was delayed ($P<0.05$, Figs. 1 and 2). The duration from imbibition of the seed to first flower ranged from 68-90 days in 1993 and 63-80 days in 1994.

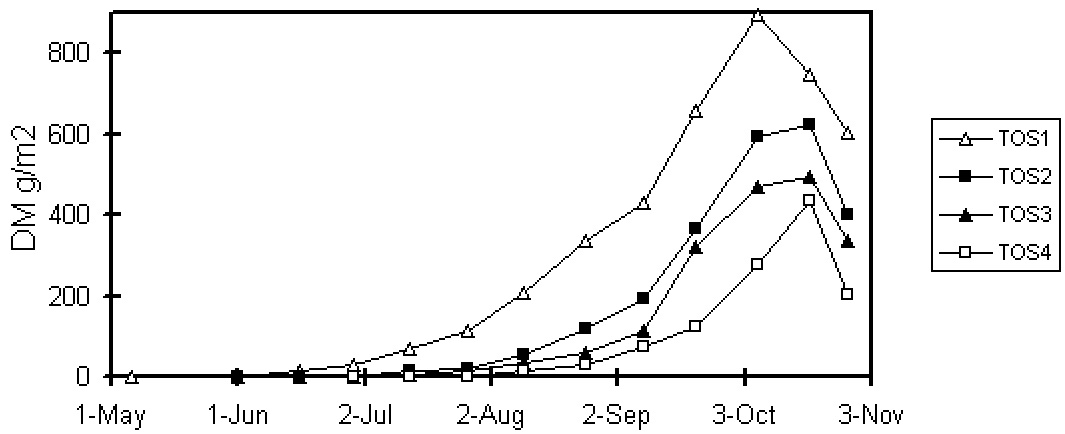

Figure 1. Dry matter production of 4 times of sowing (TOS) at Merredin in 1993.

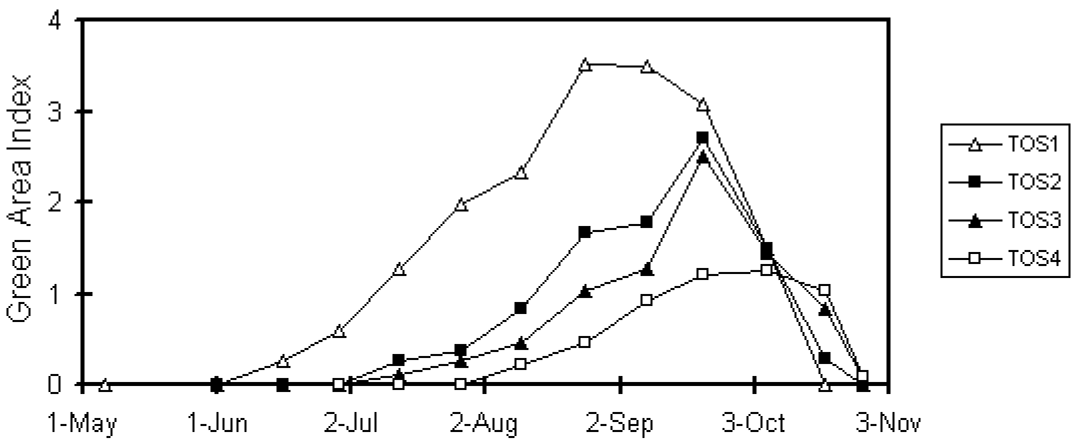

Figure 2. Green area index of 4 times of sowing (TOS) at Merredin in 1993.

At all sites in 1993, machine harvested seed yields declined rapidly with late sowings and the average yield penalty varied from 27-56 kg/ha for every day that sowing was delayed after early May (Fig. 3). In contrast to the 1993 results, machine harvested seed yields were considerably less in 1994 (Fig. 4). Nevertheless, seed yields were above 0.8 t/ha with early sowings at all sites in 1994. Dry sowing resulted in significantly greater seed yields than sowing soon after the first autumn rains at Dongara, Northam and Newdegate ($P<0.05$). As in 1993, seed yields declined significantly with delayed sowing at all sites in 1994 except at Gnowangerup ($P<0.05$). At this site, rainfall in June and July was below average which adversely affected the first time of sowing, while there was effective rainfall in the months until November. In 1994, the average yield penalties with delayed sowing were 14-28 kg/ha/day at sites other than Gnowangerup.

Harvest indices varied from 37-62%, with means of 53% in 1993 and 46% in 1994 (data not presented). The number of pods/plant tended to decrease with delayed sowing, while the number of seeds/pod was relatively stable, with an average of 2.2 in both years. Mean seed weights varied from 31-56 g/100 seeds in 1993 and 22-41 g/100 seeds in the 1994. Mean seed weights decreased significantly with delayed sowing at Dumbleyung, Lake Grace and Merredin in 1993 and at Dongara, Northam and Merredin in

1994 ($P<0.05$). Seed yield was significantly ($P<0.05$) correlated with final dry matter at harvest ($r^2=0.80$ in 1993, 0.37 in 1994), the number of pods/m2 ($r^2=0.73$, 0.56), and the number of seeds/pod ($r^2=0.41$, 0.30).

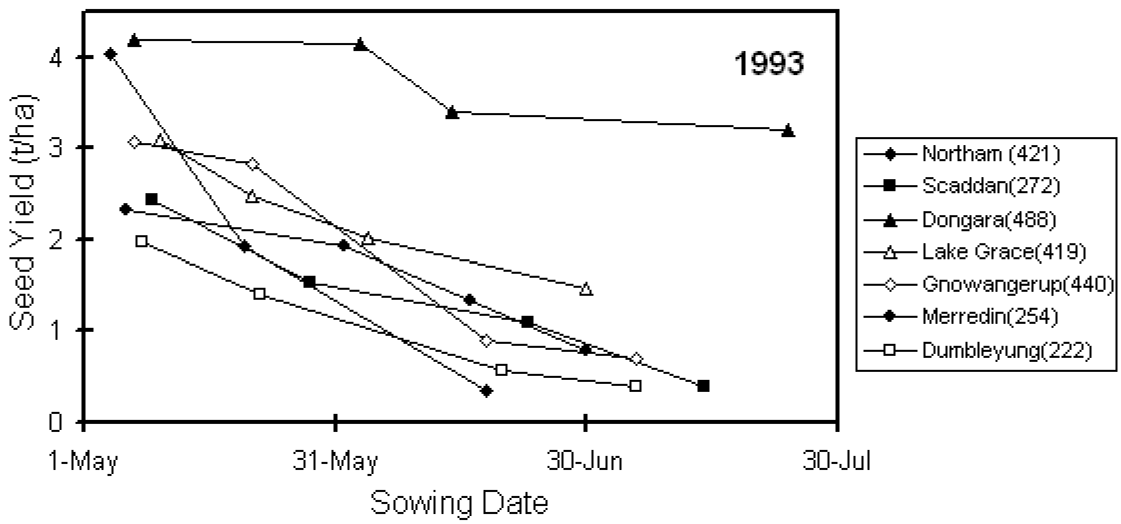

Figure 3. Machine harvested seed yields in 1993. L.s.d. (5%, kg/ha) are indicated in parentheses.

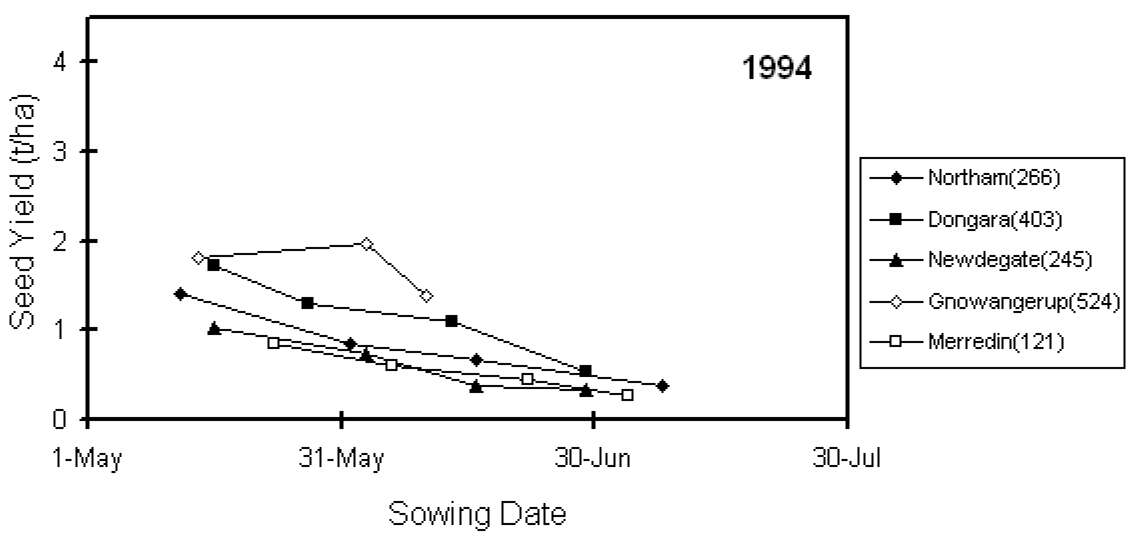

Figure 4. Machine harvested seed yields in 1994. L.s.d. (5%, kg/ha) are indicated in parentheses.

DISCUSSION

This study demonstrates how faba bean can produce considerable biomass and seed yield in a wide range of mediterranean environments in WA. Faba bean has vigorous early growth during winter when rainfall is reliable and temperatures are low. The cultivar Fiord reached anthesis 63-90 days after sowing, set some pods from these flowers and pod filling was largely completed before the onset of high temperatures and moisture stress in spring. In this way, faba bean escaped drought in these experiments despite being sensitive to high temperatures and moisture stress. Our results contrast the perception of faba bean as an unpredictable and variable crop in favourable environments. In the low rainfall region of our study where yield potentials are relatively low, dry matter production, green area and harvest indices of faba bean were large when compared to narrow-leafed lupin and field pea, and were similar to cereals.

As has been shown previously, faba bean seed yields declined rapidly with delayed sowing (1, 2, 7). Faba bean is able to exploit early sowing opportunities partly because of its tolerance of mild frosts, as observed in this study when nearby chickpea and wheat crops were damaged. Faba bean could also benefit from sowing even earlier than was tested in this study. Several experiments (8) and recent farmer experience show that given the first autumn rains commence in April, as is the case at Merredin every 5 years (on average), faba bean can be sown with little risk of frost damage and these crops produce a high seed yield. On the other hand, the first autumn rains do not commence until June every 4 years at Merredin (on average) and faba bean sown at this time is likely to produce low yields. In this case, farmers could select a more drought tolerant crop to sow, such as chickpea or lentil (*Lens culinaris*, 9). This study also demonstrates the potential of dry sowing faba bean to ensure the earliest possible imbibition and emergence.

In South Australia and Victoria, farmers sometimes delay sowing faba bean because early sown crops tend to be more prone to fungal infection those sown later. Fungal diseases did not affect yields in our study, but as the area of faba bean production and disease pressure increases, disease management may become important on a commercial scale. The release of the disease resistant faba bean cultivars will have a major impact on faba bean production in southern Australia, not only because of reduced disease and costs of chemical control, but also indirectly through giving confidence in early sowing. Disease control may not be critical for faba bean production in low rainfall environments where diseases are only likely to reduce yields in favourable seasons when humidity is high.

Faba bean production in WA is estimated at 25,000 ha in 1995 and is increasing rapidly. A recent analysis of soil types, likely gross margins and farming systems indicates that the area under faba bean could reach 200,000 ha within a decade. Details of seed yield and yield components (4), phenology, canopy development and biomass partitioning (5), and water-use efficiency (6) are discussed in subsequent papers.

ACKNOWLEDGEMENTS

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