EFFECTS OF EARLY WATER DEFICIT ON GROWTH AND DEVELOPMENT OF FABA BEAN

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Abstract

Faba beans survived up to 8 weeks of drought following crop establishment with no plant death. However crop growth was reduced by more than 75% during the drought period. Recovery after rewatering was rapid, and previously stressed plants were able to use subsequent rainfall as efficiently as control plants to produce grain yield.

Key words: Faba bean, water deficit, drought, early sowing.

Faba bean has become an important high yielding pulse crop in Western Australia since 1994 (7). Early sowing is necessary in low rainfall areas to avoid flowering and filling seeds during hot, dry conditions at the end of the growing season (5). Growers therefore try to plant beans in April if they can. In many seasons substantial rain falls in April, allowing beans to be sown, but this can be followed by up to 6 weeks of drought (4).

Despite the risk of severe water deficits developing in early sown crops, there is only limited research on their implications for crop production. French and Dracup (2) showed that they can reduce establishment of narrow-leaf lupins. They can also delay phenology in lupins and wheat, and reduce grain yield in wheat (3, 1). This study aimed to see if a seedling faba bean crop could survive water deficits likely to occur in the field, and to investigate how these deficits influenced grain yield.

Materials and methods

150 kg/ha Fiord faba bean were sown on 13 May 1997 on a sandy loam duplex soil with 100 kg/ha Agras No. 1 (17.5% N, 7.6% P) at Merredin Research Station (31°20’ S, 118°16’ E). There was about 15 mm soil water at sowing. Following crop establishment rainfall was excluded from part of the area using a PiGola rainshelter (20 mm rain fell from sowing to erection of the rainshelter). A range of water deficit treatments were imposed by relieving the developing stress after 2, 4, 6 and 8 weeks by applying 15 mm irrigation using trickle tape. There was also a non-stressed control irrigated weekly throughout the treatment period. Plots were irrigated weekly after stress relief until the treatment period was finished. Then the whole experiment received only natural rainfall. 76 mm rain fell in August, September and October after irrigations ceased.

Leaf water potential was monitored throughout the stress period using a pressure chamber; dry weight, leaf number and leaf area were measured on samples of 5 plants harvested weekly; seedling survival and flowering time were monitored on 10 tagged plants in each plot; grain yield was measured on 2 m² quadrats cut from each plot; and soil water was monitored with a neutron moisture meter in access tubes installed to 1.8 m.

Results and discussion

Droughted treatments were significantly more stressed than controls only 2 weeks into the treatment period (Fig. 1a). Leaf water potential continued to decline, reaching a minimum of -1.38 MPa after 8 weeks drought. This is not low compared to levels reached by faba bean during reproductive growth (8) but indicates quite severe stress in seedlings, as shown by the high proportion of wilted plants during July (Fig. 1b). Leaf water potential recovered to control levels rapidly following rewatering. There was no seedling death in even the most extreme treatment (Fig. 1b), even though 43% of plants were severely wilted 3 weeks prior to stress relief (Fig. 1b). However growth was severely retarded by drought (Fig. 2a),
with a four-fold difference in crop dry matter being generated by the end of the treatment period. Other measurements show that the differences in dry matter production can be explained by differences in radiation interception. The drought treatments also retarded crop phenology. By the end of the treatment period the 8 week drought treatment had 8.3 main stem leaves/plant, compared to 11.9 in the controls (SED 0.34). Drought also delayed flowering from 84 days after sowing in the controls to 95 in the 8 week drought treatment.

Delays in phenology and reduced growth induced by early water deficit cause irreversible reductions in yield potential in wheat (1). However faba bean is less determinate than wheat so may be able to compensate for early losses should conditions become favourable. Early water deficit had large effects on grain yield in this experiment (control 239 g/m$^2$, 8 week drought 149 g/m$^2$, SED 29.9). The absence of treatment differences in the relationship between grain yield and crop water use (Fig. 2b) is consistent with early water deficit not limiting the potential of the crop to compensate following stress relief. Fig. 2b includes data from plots that received rainfall as well as irrigation during the treatment period, and the combined regression line has a slope equivalent to 14.8 kg/ha/mm, compared to 15 found by Loss et al. (6) elsewhere in Western Australia.

Conclusions

A drought of more than 6 weeks following a sowing opportunity in mid-April is very unlikely in the low rainfall agricultural areas of Western Australia. As the faba beans in this experiment survived 10 weeks from sowing with only 20 mm rainfall (including 8 weeks with no rainfall) there is little risk of crop death from drought under these circumstances. While early water deficit may severely retards crop growth, this does not restrict the crop’s ability to respond to later rains. Farmers should therefore not delay sowing faba beans after mid-April for fear of crop death or impaired yield.

References


