Growth analysis of faba bean and lupin under grassy weed competition in a northern environment

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Introduction

Grassy weed pressure can significantly decrease the productivity of faba bean (*Vicia faba* L.) and narrow leafed lupin (*Lupinus angustifolius* L.). In a previous study, faba bean and lupin seed yields were reduced by 42 and 67%, respectively, when these crops were grown in the presence of grassy weed interference (Strydhorst et al. 2007).

The objectives of this study were to assess the effects of grassy weed density on faba bean and lupin crop dry matter (DM) production by sequentially assessing crop leaf area (LA) development, photosynthetically active radiation (PAR) interception, and canopy heights over the growing season.


Emerging Faba Bean and Barley


Emerging Lupin and Barley

Materials and Methods

Field experiments were conducted in 2004, 2005, and 2006 in the Parkland region of central Alberta, Canada. The experimental design was a strip-strip plot. The horizontal factor was pulse species, 'Snowbird' faba bean or 'Arabella' lupin, and the vertical factor was barley (*Hordeum vulgare* L.), planted as a model weed, at 3 densities (0, 25, and 50 plants m^{-2}). Leaf area development†, PAR interception‡, canopy height, and DM accumulation of faba bean and lupin were measured at approximately 21-d intervals between 37 and 120 d after planting (DAP).

All data were tested for normality using PROC UNIVARIATE (SAS Institute, 2003) and transformed as necessary. A preliminary repeated measures ANOVA was conducted to determine differences between years. A repeated measures ANOVA was performed on all data using the MIXED procedure of SAS (Littell et al. 2006). Year and block were considered random effects when years were not significantly different. Pulse species, weed density, and sampling time were considered fixed. For each pulse species and weed density, sampling time effects (n=5) were separated with orthogonal polynomial contrasts, using coefficients derived in the IML procedure of SAS.

† measured using a LI-3100 Li-Cor leaf area meter (Li-Cor, Lincoln, NE, USA)
‡ measured with a 1-m-long line quantum sensor connected to a model LI-188B Li-Cor quantum meter (Li-Cor, Lincoln, NE, USA)

Results – Crop DM Accumulation

The repeated measures ANOVA of pulse crop DM accumulation indicated that pulse species, weed density, sampling time and their interactions were significant. A grassy weed density of 25 plants m^{-2} reduced lupin DM by 72% and faba bean DM by 45% (Figure 1).

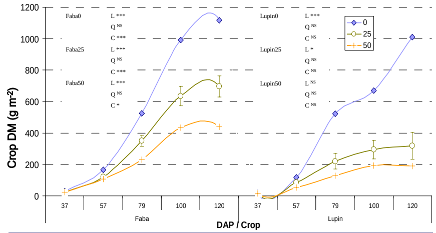

Figure 1. Crop dry matter (DM) accumulation for faba bean and lupin grown with barley weed densities of 0, 25, and 50 plants m^{-2} at Barrhead, AB averaged over 2004, 2005, and 2006. The graph indicates the significant pulse species by weed density by sampling time interaction ($P < 0.0001$). Abbreviations: DAP, days after planting; L, linear trend; Q, quadratic trend; C, cubic trend. *, **, *** Significant at $P < 0.05$, 0.01, 0.001, respectively. Bars indicate standard error of difference between weed densities, at each sampling time (n=36).

Results – Crop LAI

The repeated measures ANOVA of pulse crop LAI indicated that pulse species, weed density, sampling time and their interactions were significant. At 79 DAP, 25 barley plants m^{-2} reduced faba bean LAI by 41% and lupin LAI by 64% compared to weed free treatments(Figure 2).


Lupin with 0 barley plants m^{-2}


Lupin with 25 barley plants m^{-2}


Faba bean with 0 barley plants m^{-2}


Faba bean with 25 barley plants m^{-2}

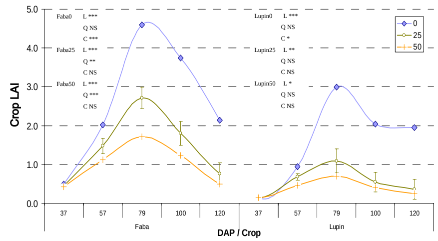

Figure 2. Crop leaf area index (LAI) for faba bean and lupin grown with barley weed densities of 0, 25, and 50 plants m^{-2} at Barrhead, AB averaged over 2004, 2005, and 2006. The graph indicates the significant pulse species by weed density by sampling time interaction ($P = 0.0092$).

Results – Crop Canopy Height

The repeated measures ANOVA of pulse canopy height indicated that pulse species, weed density, sampling time, pulse species x sampling time, and weed density x sampling time were significant. Grassy weeds tended to be shorter than the faba bean canopy but taller than the lupin canopy (Figure 3). Grassy weeds caused a 13–17% reduction in pulse canopy height.

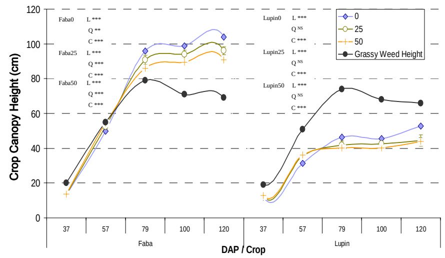

Figure 3. Canopy height for faba bean and lupin grown with barley weed densities of 0, 25, and 50 plants m^{-2} at Barrhead, AB averaged over 2004, 2005, and 2006. The graph indicates the significant pulse species by sampling time ($P < 0.0001$) and weed density by sampling time ($P < 0.0001$) interactions.

Results – Crop Light Availability

The repeated measures ANOVA of the proportion of light‡ available to the pulse canopy indicated that pulse species, weed density, sampling time, and their interactions were significant. Weed pressure significantly reduced the amount of light available to the lupin crop 57-120 DAP (Figure 4).

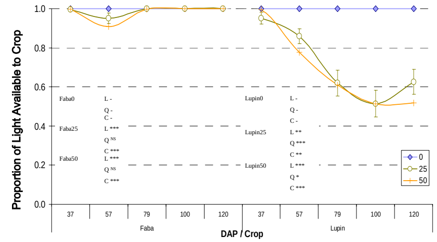

Figure 4. Proportion of light‡ available to faba bean and lupin grown with barley weed densities of 0, 25, and 50 plants m^{-2} at Barrhead, AB averaged over 2004, 2005, and 2006. The graph indicates the significant pulse species by weed density by sampling time interaction ($P < 0.0001$).

Discussion and Conclusion

Although both faba bean and lupin experienced DM yield reductions as the grassy weed density increased, lupin DM yield reductions were more severe. The improved competitive ability of faba bean may be attributed to its canopy height advantage over the grassy weeds, a high LAI, and access to 100% of the available light at the top of the faba bean canopy. In contrast, grassy weeds had a canopy height advantage over lupin which greatly reduced light availability to the lupin canopy. Lupin's competitive ability was further reduced by its low LAI.

From an agronomic perspective, enhanced lupin competitiveness may be achieved by narrowing row spacings or increasing crop seeding rates. This study clearly demonstrates the need for early and effective grassy weed control in lupin crops. For lupin to be a practical option for producers in a northern environment, lupin seed must have a higher market value than faba bean to compensate for lower yields and higher input costs for weed control. To improve the competitiveness of lupin, breeders should focus on increasing canopy height and LAI.


Height difference between lupin and barley plants

References

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Acknowledgements: The authors would like to thank: Jackie Tieulie, Susan Jess, Neil Clark, Boris Henriquez – AAFRD technical staff; APG-Zone 3 technical staff and AFFC Lacombe technical staff.
The essential funding support of ACIDF, APG, AAFRD, AAFC, NSERC, and Alberta Ingenuity for making this project possible!