The early growth of Linola(/linseed (Linum usitatissimum L.) in Tasmania

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ABSTRACT

The potential of genotype, sowing rate and sowing arrangement to improve the early growth of Linola(/linseed (Linum usitatissimum L.) was investigated in Tasmania during 1999/2000. A glasshouse experiment compared Argyle (Linola(), Glenelg (linseed) and some Argyle (Linum angustifolium hybrids. Up to 52 days after sowing (DAS), the hybrids produced about half the biomass of commercial Linum varieties and less than 20 % of the biomass produced by canola. In a field experiment, an initial strong response to sowing rate (20 - 80 kg/ha) for biomass production (kg DM/ha) and leaf area index (LAI) had declined by early flowering. Grain yield was negatively correlated with sowing rate; the 20 kg/ha treatment produced 3.2 t/ha, compared to 1.7 t/ha from the 80 kg/ha treatment, possibly due to moisture stress at flowering. Compared with normal row sowing, bi-directional sowing had minimal effects on plant density, LAI, biomass and grain yield.

KEY WORDS

Linum, sowing rate, genotype, early growth, grain yield.

INTRODUCTION

For a range of economic and biological reasons, such as the management of herbicide resistant weeds, increased 'break crop' options and increased biodiversity, there is a need to increase the array of species used in the cropping regions of southern Australia. LinolaTM and linseed (Linum usitatissium L.) currently are minor oilseed crops in Australia. However, inputs into research and development of LinolaTM and linseed are warranted because they are suited to the Australian farming environment and Canadian and Australian germplasm is available. Agronomic problems reported for Linum include slow early crop development and limited branching (3), resulting in poor competition with weeds. In other species, strong early vigour is reported to increase the ability of crops to compete with weeds (2), improve winter growth (1) and increase water use efficiency (5). A project was conducted in Tasmania during 1999/2000 to investigate the potential of improving the early growth of Linum by manipulating sowing rate and sowing arrangement. Several genotypes, including some Argyle (Linum angustifolium hybrids were also evaluated for early growth. Sowing rate was the main factor influencing the early growth and biomass production of Linum.

MATERIALS AND METHODS

A preliminary glasshouse experiment was established in 1999 to compare the early growth of Argyle, Glenelg, 8 Argyle (Linum angustifolium hybrids and canola. The randomised block experiment with 4 replications was established in 300 (290 (200 mm pots containing potting mix. Biomass production and LAI were assessed 31 and 52 DAS. A second glasshouse experiment looked at Linum sowing rates (densities of 80, 160, 320, 640 and 1280 plants/m2). Canola was included at rates of 80 and 160 plants/m2. The experimental design was a randomised block experiment, also with 4 replicates. Pot size was 440 (355 (155 mm. Biomass was assessed by progressively sampling alternate rows at 25, 39 and 46 DAS.

A field experiment on an alluvial sand at Cressy, northern Tasmania, was established on the 12 May 1999. Average annual rainfall at the site is 665 mm and 372 mm was recorded during the 1999 growing season (April to November). The experimental design was a 4 (2 (2 factorial with 4 replicates (plot size was 4.5 (4.5 m). Treatments were sowing rate (20, 40, 60 and 80 kg/ha, adjusted for seed weight and germination), sowing pattern (normal single rows and bi-directional sowing) and genotype (Glenelg and Argyle). Plant density, biomass and LAI assessments were carried out 62, 97, 125 and 145 DAS (early flowering). Grain yield and yield components were assessed at maturity (January). In all experiments, crop nutrition and pest control procedures were undertaken in accordance with DPI recommendations.

RESULTS

In the preliminary glasshouse evaluation of Argyle, Glenelg and the Argyle (L. angustifolium hybrids, the hybrids produced about half the biomass (mean = 111 g DM/m2) of the commercial varieties (mean = 208 g/m2) to 52 DAS. Canola was included as a comparator and it produced about three times the biomass (mean = 675 g/m2) of the commercial Linum varieties over the same period. In the field trial, the linseed variety Glenelg produced significantly ($P < 0.05$) more biomass than the LinolaTM variety Argyle between 62 DAS (Argyle = 95 kg DM/ha; Glenelg = 142 kg DM/ha) and 145 DAS (start of flowering) (Argyle = 3153 kg DM/ha; Glenelg = 3904 kg DM/ha). However, this did not translate into a significant grain yield difference between the varieties (mean = 2469 kg/ha).

In sowing rate trials conducted in the glasshouse and the field, early biomass production was increased by higher sowing rates over the range (20 - 80 kg/ha) investigated. Higher sowing rates produced a higher LAI that was positively correlated with biomass production. For example, in the field trial, LAI at 125 DAS was 2.0 in the 20 kg/ha treatment and 4.8 in the 80 kg/ha treatment. By 145 DAS, the relative biomass difference between plots of different sowing rates had declined, presumably because high sowing rate plots had achieved a critical LAI (~5.5). At 145 DAS, stem diameter was inversely proportional to sowing rate. Glenelg was significantly taller and had a greater stem diameter than Argyle. However, a lodging rating in January showed Argyle to have significantly greater lodging resistance than Glenelg.

Grain yields were negatively correlated with sowing rate - the 20 kg/ha sowing rate treatment produced a yield of 3.2 t/ha, compared with 1.7 t/ha from the 80 kg/ha treatment. Yield component assessment showed that both the number of capsules per plant and the number of seeds per capsule were negatively correlated with sowing rate, possibly due to dry conditions during the reproductive phase. The hypothesis that bi-directional sowing (drilling plots in two opposite directions) might minimise competition between crop plants, increase early ground cover, increase competition with weeds and enhance grain yields was rejected.

DISCUSSION

In summary, the early biomass production of linseed and LinolaTM was less than that of canola and it was only slightly affected by genotype and by bi-directional sowing. Higher sowing rates improved early LAI and growth, but resulted in a decreased grain yield. The overall negative response to seeding rate, which may be attributed to limited soil moisture and low rainfall during the flowering period, did not occur in a previous investigation of the effect of seeding rate on the grain yield of flax in Tasmania (4). Further agronomic work is required to clarify sowing rate by environmental interactions. Overall, the crop was not difficult to grow but it proved to be difficult to harvest with conventional machinery under Tasmanian conditions. Assuming problems such as competition with weeds, lodging, harvesting difficulties and marketing can be overcome, the crop may be a viable alternative rotation crop to canola in southern Australia as it is in Canada. Some breeding or genetic engineering work may be useful in improving oil traits, lodging resistance, early vigour and harvesting characteristics.

ACKNOWLEDGMENTS

The authors would like to thank Charles Sturt University and the Tasmanian Department of Primary Industry for supporting the project. Our thanks are also extended to Dr A. Green and Mr R. Dent for providing advice and supplying seed, and to the other people who assisted with this research.

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