Accumulation of oil and protein in seeds of canola (*Brassica napus* L.) varieties at different sowing dates

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Abstract

Canola (*Brassica napus* L.) is an important oilseed crop in Australian dryland farming system and high oil concentration of seed is demanded by growers and markets. This study reports experiments investigating the accumulations of oil, protein and structural material (dry matter excluding oil and protein) in the seeds of canola cultivars of Monty and Karoo at two sowing dates. The amount of oil and protein were measured in developing seeds ranging from 27 to 85 days after flowering. Post-anthesis environments have much greater impact than varieties on the patterns of accumulation, although oil concentration of Monty was higher than that of Karoo. The amount of oil, protein and structural material accumulated faster in the seeds at 2nd sowing than that at the 1st sowing. Second sowing of Monty plants also produced 47.7 mg oil whilst 1st sowing produced 41.2 mg oil. Oil accumulated faster than protein and structural material from 56 to 78 days after flowering, and slowed down afterwards.

Key words: canola, Brassica napus, oil, protein, structural material, sowing date, variety

Introduction

Canola (*Brassica napus* L.) is an important oilseed crop in Western Australian dryland farming system. Oil concentration of canola seed is reduced by the adverse environmental conditions, with characteristics of a combination of terminal drought and increasing heat during seed development and maturation (French and Schultz, 1984; Si and Walton, 2004). Quality of canola seed includes oil and protein concentrations. These two components are inversely affected by growing environments (Si *et al*, 2003). To increase oil and protein concentrations in the seed have been one of the major focuses, by means of management and breeding. The understanding of physiological basis of seed development between varieties at these environments would provide insight to the relative importance of either management or breeding to the improvement of quality. This study reports the investigation of accumulations of oil, protein and structural material (dry matter excluding oil and protein) in the seeds of canola cultivars of Monty and Karoo at two very different sowing dates.

Materials and Methods

Two canola varieties of Monty (conventional variety) and Karoo (tolerant to triazine) were used to track down the accumulation of oil, protein and structural material in developing seeds. They were sown on 15 May and 30 June 2000 with 4 replicates for each treatment at the Shenton Park Field Station. Plants were irrigated throughout growing season to ensure they were growing under water stress-free conditions. Weeds were controlled adequately by hand and fertilisers were applied regularly. Sampling of pods commenced about 30 days after flowering and continued at weekly interval until plants matured. The lowest five growing pods on the main stem were taken at each plant and each sample consisted of more than 100 pods. We measured pod length and width, fresh and dry weights of pod wall and seed of the developing pods. The amount of oil and protein were measured using NIR methods. The seed residuals after excluding oil and protein were regarded as structural material.

Results

The amount of oil and protein was measured in developing seeds aged from 36 to 85 days after flowering in cv Monty. The amount of oil, protein and structural material increased with time during the period for Monty at both sowing dates (Fig. 1). This is also the case for Karoo (Fig. 2). The rates of increase for the seed components were much faster in 2nd sowing and the patterns were linear-like for both varieties.

For cv Monty, the amount of oil, protein and structural material was 9.4, 5.9 and 8.7 mg for each of them respectively at the time of 36 days after flowering when the first pod sample was taken of 1st sowing plants (Fig. 1). Oil accumulated more rapidly from 56 to 78 days after flowering, and slowed down afterwards when sown in 15 May. Protein and structural material accumulated in a similar pattern and their proportions to each other remained constant in the seed during seed growth and development. Seeds of 2nd sowing accumulated oil and protein faster in a linear pattern. Seed of 2nd sowing had 47.7 mg oil and 26.4 mg protein whilst seeds of 1st sowing had 41.2 mg oil and 23.1 mg protein.

Karoo accumulated oil and protein in a linear pattern in developing seeds from both sowing dates, although the slope was greater in 2nd sowing (Fig. 2). The actual amount of oil and protein and structural material were slightly less in Karoo seeds than that of Monty seeds.

Plants of Monty flowered a week earlier than Karoo for both sowing dates. Pod length reached maximum and width near maximum at 30 days after flowering when sampling commenced.

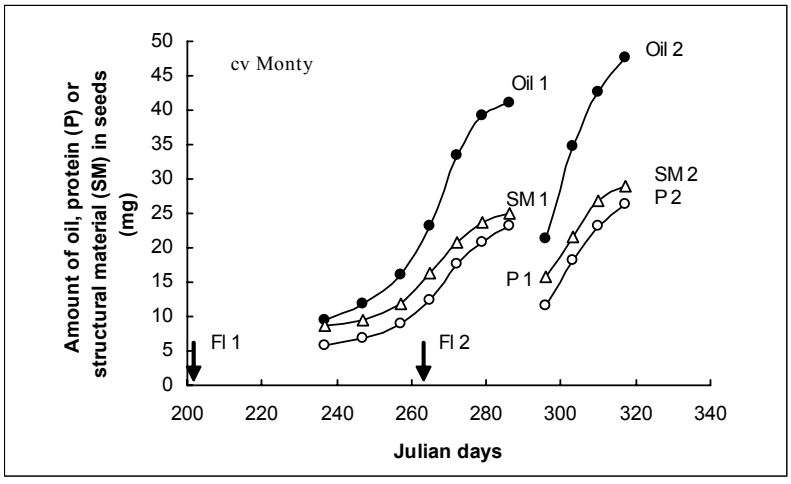

Fig. 1. The amount of oil (●), protein (○), and structure material (Δ) in the seed of cv. Monty grown at Shenton Park, WA, and sown on 15 May and 30 June 2000. Fl is the date of 50% anthesis and the numbers 1 and 2 represent the two sowing dates. Fl 1 was 20 July and Fl 2 was 20 September.

Discussion

Date of sowing has a much greater impact on amount and pattern of oil accumulation in developing seed than variety does under irrigated condition as shown in this study. There is a well established fact that delay in sowing reduces oil concentration of canola grown in the field across Australia (Si and Walton 2004; Hocking and Stapper 2001). This is caused by the combination of increasing temperature and decreased rainfall during post-anthesis (Si and Walton, 2004). Experiments reported in this study suggest that sightly warm temperature alone induced by later sowing did not reduce the amount of oil in seeds. In fact, 2nd sowing produces more oil at maturity. Warm temperature increases rate of accumulation. If plants do not suffer water stress, plants sown in 30 June have the benefit of warm temperature during post-anthesis for rapid and robust growth to produce higher oil concentration.

Pattern of oil accumulation measured in Monty of 1st sowing is of a typical sigmoid curve and it is consistent with the oil accumulation reported by Hocking and Mason (1993). Seeds of 2nd sowing have grown very fast and matured rapidly under warm temperature. The oil accumulation in the seeds is almost a linear line with a steep slope. When sampling commenced at 33 days after flowering, 21.2 mg oil are present in the seed of Monty. This is close to the amount of oil (23 mg) in Monty seed at 64 days after flowering of the 1st sowing.

Accumulation of protein and structural material is similar and remains relative proportion to each other throughout seed growth and maturation. Study of relationship between oil and protein concentrations reveals that when oil goes up under favourable environments protein concentration goes down (Si *et al*, 2003).

Monty has produced more oil, more protein and more structural material than Karoo under the same growing condition. Karoo is tolerant to triazine and the gene conferring triazine tolerance is associated reduced capacity of photosynthesis and thus results in 15% seed yield and oil penalty (Robertson *et al*, 2002).

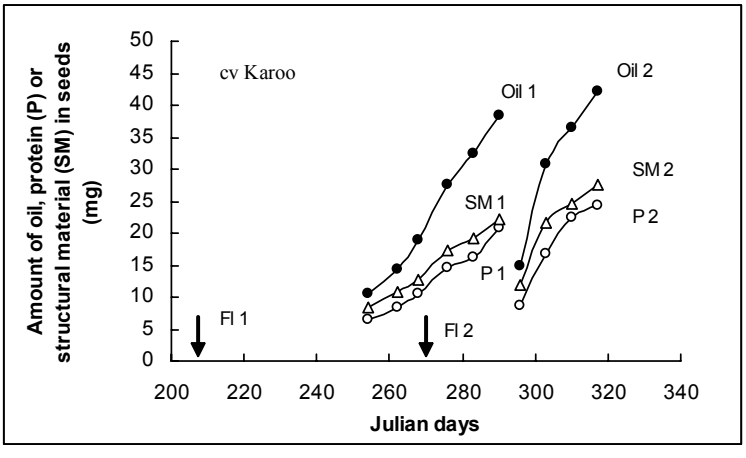

Fig 2. The amount of oil (●), protein (○), and structure material (Δ) in the seed of cv. Karoo grown at Shenton Park, WA, and sown on 15 May and 30 June 2000. Fl is the date of 50% anthesis and the numbers 1 and 2 represent the two sowing dates. Fl 1 was 27 July and Fl 2 was 26 September.

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