# Grain sorghum as a dryland cropping option in the Wimmera region, Victoria

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## ABSTRACT

Grain sorghum grown through the summer months in southern Australia may provide wider options for weed management and a means for reducing soil water within the 0-2m soil profile. Growing sorghum therefore could be a useful component for enhancing the sustainability of continuous cropping. In a time of sowing experiment in the Wimmera region in Victoria, we established that sorghum could be grown successfully, mostly using only the soil available water. The timing of sowing is critical, with yields of about 1.5 t/ha obtained from mid-October and mid-November sowing.

## KEY WORDS

Grain sorghum, time of sowing, sustainability.

## INTRODUCTION

Conservation farming with zero tillage, stubble retention and a continuous cropping regime, has, compared with fallow-based or ley-based systems, not only the potential for higher productivity, but also higher profitability as potentially high income crops are grown every year. However, new options to reduce weed populations and to manage herbicide resistant weeds are required to sustain continuous cropping. Winter chemical-fallow provides the opportunity to control winter weeds, including herbicide resistant populations, by the use of non-selective herbicides. The use of summer crops, such as grain sorghum (*Sorghum bicolor*), can provide a financial return in the year of the winter fallow, as well as utilising stored winter rainfall and maintaining surface vegetative cover over summer. Here we report an experiment designed to evaluate the suitability of sorghum as a dryland summer crop, growing in rotation with winter crops, in the Wimmera region, Victoria.

## MATERIALS AND METHODS

The experiment was conducted at Gooroc, 24 km northwest of St. Arnaud, Victoria. The average annual rainfall at St. Arnaud is 499 mm with reliable rainfall during the growing season, April -October (275mm). The field used for the experiment had been cropped continuously since 1985; during the winter of 1996, the experiment site was kept weed free with a chemical fallow (glyphosate plus oxyfluorfen) prior to sowing sorghum. The soil at the site is typical of much of the Wimmera area, being a light medium clay, slightly self mulching with pH 8.2 (1:5,soil:water) to 15 cm depth. Four times of sowing of sorghum were randomly arranged in blocks and replicated 4 times. The sowing times were 9 September, 14 October, 1 November (1996) and 24 January 1997. A quick maturing sorghum hybrid (cv. S34) was sown with a rate of 5 kg ha$^{-1}$ at 20mm depth, with 5.5 kg P ha$^{-1}$applied with the seed, into a standing wheat stubble (from the 1995 wheat crop). The soil was at field capacity at the 4 sowing times. There was a problem with seedling emergence due to N fertiliser toxicity with the September sowing, hence the data reported here are from nil N-fertiliser plots. Plot size was 2.8 x 20 m with 4 seeding rows per plot, at 710-mm spacing. Soil temperature sensors were inserted at seeding depth, and temperature was recorded throughout the plant growth cycle. Thermal day degrees (TDD) for sorghum was calculated as:

$$TDD = \sum [(T_{Max} + T_{Min}) / 2 - T_{Base}];$$

where, $T_{Max}$ is the maximum daily soil temperature, $T_{Min}$ is the minimum daily soil temperature and $T_{Base}$ is 10 ?C (P. Carberry, pers. comm). The dates at which plants reached emergence, floral initiation, booting, anthesis and physiological maturity were noted. Plant numbers were counted after emergence and floral initiation, and grain yield was determined by machine harvest.

## RESULTS

Growth stages in this experiment occurred at similar thermal day degrees, irrespective of sowing dates (Table 1). The January sown crop had just reached the booting stage at the time of frosts in April and this crop senesced thereafter. The frosts determined the end of growth, and subsequent harvest (17 April) of plants from the other 3 sowing times. The plant population was much lower with the early sowing, with differences also between the later sowing times. Grain yield was much lower with the early sowing (Table 1). The addition of N fertiliser (65 kg $ha^{-1}$) did not increase grain yield (October and November sowing times), although the N input did increase grain protein (data not shown).

**Table 1. Cumulative thermal day degrees of soil at seeding depth in relation to sorghum growth stages, plant density and grain yield.**

| | Days after sowing to phenological event/ thermal day degrees | | | | | | |
|---|---|---|---|---|---|---|---|
| Sowing date | Emergence | Floral initiation | Booting | Anthesis | Milky dough | Plant No. $m^{-2}$ | Yield t $ha^{-1}$ |
| 9 September | 29 / 64 | 105 /459 | 130 / 724 | 146 / 946 | 153 /1072 | 1.3 | 1.20 |
| 14 October | 12 / 65 | 80 /445 | 104 / 748 | 116 / 942 | 125 / 1067 | 5.3 | 1.37 |
| 1 November | 11 / 64 | 68 / 445 | 92 / 747 | 105 / 945 | 112 / 1071 | 6.7 | 1.54 |
| 24 January | 5 / 71 | 36 / 462 | 76 / 727 | - | - | 8.3 | - |
| | | | | | *P<0.05* | 1.2 | 0.35 |

## DISCUSSION

Temperature (thermal time) and photoperiod are known to determine the timing of emergence, floral initiation, anthesis and physiological maturity for sorghum. Soil temperature has a major effect on germination and emergence of sorghum plants. Dart *et al.* (1) found that sorghum required soil temperatures between 15-43?C for emergence and optimum plant growth. Below and above these temperatures plant germination and emergence are reduced. Soil temperatures at which seeds were sown on September 9 were considerably below this optimum. Soil temperature averaged 8?C for the 31 days between sowing and emergence with September sowing (data not shown). The soil temperature increased to a mean 7-day average of $15^{O}$C immediately prior to emergence. However, the seedling number at emergence had been affected by this delayed opportunity for germination. The other 3 sowing dates were within the optimum temperature range for seed germination and emergence, and the plant density of 6- 7 plant $m^{-2}$ obtained here was consistent with the highest grain yield. To compensate for a high seed mortality rate, associated with low soil temperature, the sorghum was sown at 5 kg $ha^{-1}$ that was higher than the recommended rate of 3 to 4 kg $ha^{-1}$ (2). With January sowing, there was almost full seed germination and emergence, and with this situation the 5 kg $ha^{-1}$ may be too high. Temperature also influenced the plant development rate, which increased linearly with later sowings and increase in temperature. These results were consistent with those of Ritchie and Alagarswamy (3), who stated that daily progression of plant development could be precisely described by the thermal day degree approach.

Alternatively, the results differ to those given by Wade *et al.* (4), in Queensland, who found that flowering occurred 60 days after sowing or at 1200 TDD. Although the January sowing had rapid phenological development, this sowing time was too late in this environment to realise any grain yield. Sorghum from the October and November sowing times extracted water from the soil to a depth of 1150 mm, and utilised 160-170 mm of water from this depth (unpublished data), as well as receiving about 50 mm summer rainfall.

## CONCLUSION

The experiment demonstrated that grain sorghum can be grown in the cracking clay soils in the Wimmera and, with the yields obtained, the opportunity exists for a profitable alternative management option within a conservation farming system.

## REFERENCES


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