An evaluation of safflower, Linola™, sunflower, maize, buckwheat and sorghum as spring sown cropping options for south-eastern Australia

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Abstract

Safflower, Linola™, sunflower, maize, buckwheat and sorghum were compared as spring sown cropping options at two sites with contrasting amounts of soil water in western Victoria. At the rainfed site, safflower and one sunflower cultivar produced seed yields exceeding 0.86 t/ha, whilst sorghum, buckwheat and maize yielded less than 0.29 t/ha. At the pre-watered site, safflower and sunflower performed similarly with seed yields exceeding 3.45 t/ha, compared to 0.8 t/ha for sorghum and less than 0.4 t/ha for buckwheat. Sorghum established poorly at the pre-watered site and buckwheat seems very sensitive to frost. At the rainfed site, maize and sorghum appeared highly water stressed by flowering. Under the conditions of these experiments safflower, sunflower and Linola™ proved to be the highest yielding crops.

Key Words

Western Victoria, yield, biomass, harvest index

Introduction

Whether due to unfavourable autumn/winter conditions that prevent the planting (or failure *e.g.* waterlogging) of winter crops, management issues such as spreading risk and workloads, or simply to make the most of favourable spring rainfall, occasions may occur where farm enterprises can benefit by sowing some crops in late spring. In southern Australia, safflower has frequently been used for this purpose (1), but is safflower the only crop species capable of producing economic yields when sown in spring? Two experiments were sown in spring 2001, on sites with different amounts of stored soil water in the Victorian Wimmera, to compare the growth and yield of safflower, Linola™, sunflower, maize, buckwheat and sorghum.

Methods

Both sites were located near Horsham, at Longerenong (36.7?S, 142.3?E). The rainfed (RF) site had been fallowed with a combination of herbicide and cultivation for the previous two seasons, whilst the pre-watered (PW) site contained lucerne in the previous season and received 200 mm of irrigation water in June 2001. The soil type was a Wimmera, grey cracking clay (self-mulching grey vertosol) with a topsoil (0-10 cm) $pH_{(CaCl2)}$ of 7.5 (RF) and 6.3 (PW). Phosphorus at 19 kg/ha and nitrogen at 43 kg/ha were drilled before sowing. Each crop was sown at recommended seeding rates on the 11 October 2001. Row spacing was 375 mm. Each experiment was designed in randomised blocks with three replicates. Plot sizes were 20 ? 3.4 m (RF) and 12 ? 3.4 m (PW). The treatments at the RF site were safflower (*Carthamus tinctorius* cv. Sironaria and Saffola 517), Linola™ (*Linum usitatissimum* cv. Argyle), sunflower (*Helianthus annus* cv. Galah and Advantage), buckwheat (*Fagopyrum esculentum* cv. Hitachi), sorghum (*Sorghum bicolor* cv. Western Red and 86G87) and maize (*Zea mays* cv. 3394). The sunflower, maize and sorghum cultivars were hybrids. Due to limited space only Sironaria, Galah, Hitachi and Western Red were sown at the PW site. Total soil water at sowing (mm/2 m soil profile) was determined by taking 3 (PW) and 4 (RF) cores/replicate. Each crop was hand harvested at physiological maturity and seed yields are given at 8 % moisture.

Results

The RF and PW sites had 737 and 902 mm of total stored soil water at sowing (2 m depth) and 64 mm of rain fell to 100 days after sowing (DAS). A further 16 mm fell over 5 events (including 2 ? 5 mm) between 101 and 165 DAS. The growing season was unusually cool, with the mean daily maximum temperature for December and January being 26.2?C, compared to the long-term average of 28.7?C for these months. With the exception of sorghum at the PW site, crop establishment was satisfactory at both sites. At the PW site, only one third of the target density for sorghum (10 plants/m^2) was achieved and this is attributed to soil temperatures being too low for reasonable germination of this species. Furthermore, the early growth of sorghum was very slow at both sites. Linola™ and buckwheat were the first crops to flower (~ 55 DAS) followed by safflower and sunflower 92 to 96 DAS. Maize flowered 113 DAS and sorghum between 119 and 122 DAS. The crops reached physiological maturity in a similar sequence, with Linola™ being the earliest crop (99 DAS) and sorghum the latest (RF 161 DAS, PW 165 DAS). Sunflower and safflower matured about 131 DAS at the RF site and 139 DAS at the PW site. Buckwheat at both sites was affected by an unseasonal frost in November (0?C, 31 DAS), and never fully recovered. This frost did not appear to affect any other crop species. Maize experienced bird damage during the seedling phase and sunflower at maturity.

At the RF site (Table 1), Galah (sunflower) and Sironaria (safflower) achieved significantly higher seed yields than all other treatments. Although both safflower cultivars had similar yields, there was a considerable difference between the sunflower cultivars. Sunflower and safflower produced similar amounts of biomass, but the low seed yield for Advantage resulted in a low harvest index (HI). With comparatively little biomass and a seed yield of 0.71 t/ha, Linola™ had the highest HI. Buckwheat performed poorly. Although maize and sorghum produced > 3 t drymatter (DM)/ha at this site, seed yields were very low. With senescing leaves, both crops appeared highly water stressed at flowering.

Table 1: Seed yield, total biomass and HI for all treatments at the RF and PW sites.

	Rainfed (RF) site			**Pre-watered (PW) site**		
Crop Cultivar	Seed yield (t/ha)	Biomass (t DM/ha)	HI (0 % moisture)	Seed yield (t/ha)	Biomass (t DM/ha)	HI (0 % moisture)
Sorghum *Western Red*	0.08 [a]	3.36 [bc]	0.02 [a]	0.78 [a]	3.71 [b]	0.20 [a]
Maize *3394*	0.24 [ab]	3.07 [b]	0.07 [b]			
Buckwheat *Hitachi*	0.25 [b]	1.62 [a]	0.15 [c]	0.35 [a]	1.27 [a]	0.25 [a]
Sorghum *86G87*	0.29 [b]	3.63 [bc]	0.07 [b]			
Sunflower *Advantage*	0.68 [c]	4.22 [cd]	0.15 [c]			
Linola™ *Argyle*	0.71 [cd]	2.03 [a]	0.32 [e]			
Safflower *Saffola 517*	0.86 [de]	4.76 [d]	0.17 [cd]			
Safflower *Sironaria*	0.97 [ef]	4.61 [d]	0.19 [cd]	3.45 [b]	10.32 [c]	0.31 [b]

Sunflower *Galah*	1.03 [f]	4.83 [d]	0.20 [d]	3.79 [b]	10.28 [c]	0.34 [b]
LSD (5 %)	0.16 ***	0.90 ***	0.04 ***	0.82 ***	2.38 ***	0.08 **
CV %	16.5	14.5	14.6	19.6	22.9	16.2

[a,b,c] means with the same superscript are not significantly different at $P = 0.05$, *** $P < 0.001$, ** $P < 0.01$

Seed yields, biomass and HI were higher for all treatments at the PW site (Table 1) compared to the RF site. On this site, safflower and sunflower performed similarly, producing substantially higher biomass and seed yields than sorghum and buckwheat.

Conclusion

Sorghum appears to be a poor option in western Victoria, as high soil temperatures are often not concurrent with sufficient soil moisture for good germination and strong early growth. Buckwheat appears very sensitive to frost and water stress, which may limit its use in western Victoria. At the RF site, although the early growth of maize was reasonable, leaves began senescing prior to flowering due to water stress, resulting in low seed yields. This also occurred with sorghum at the RF site. Overall sunflower, safflower and possibly Linola™ were the most reliable crops in these experiments and the choice of cultivar can have a significant impact on seed yields.

References

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