The performance of imported safflower (*Carthamus tinctorius* L.) hybrids in south-eastern Australia

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Abstract

Four safflower hybrids (3 oleic and 1 linoleic oil type) were compared to three open pollinated (OP) cultivars (1 oleic and 2 linoleic oil types) at 2 sites in the Victorian Wimmera during 2001/02. In a season of below average rainfall, the highest yielding hybrids (GW9009 = 1.18 t/ha and GW9025 = 1.28 t/ha) produced significantly more seed than the most widely sown OP cultivar in Australia (Sironaria = 0.95 t/ha) at Site A. There were no significant differences in seed yield at Site B (mean = 1.15 t/ha). At Site A, all oleic hybrids achieved significantly higher seed and oil yields/ha than the OP, oleic comparator (Saffola 517). Under these growing conditions, the hybrids generally produced greater amounts of biomass, exhibited increased branching with more capitula per plant and had heavier seeds, compared to the OP cultivars. However, possibly due to dry conditions, the net effect on yield was somewhat offset by each hybrid capitula containing fewer seeds than the OP cultivars.

Key Words

Seed yield, yield components, oil content, biomass

Introduction

Safflower is a minor crop in Australia which has received little attention in terms of developing or introducing new cultivars since the CSIRO safflower breeding program ceased in the late 1980's. This program developed the cultivar Sironaria, which is currently the most widely grown cultivar in Australia. Safflower improvement programs have continued overseas and significant progress has occurred in the development of safflower hybrids in the United States and India during the past decade (1,2). Limited overseas data suggests that under some growing conditions, safflower hybrids can produce superior seed yields and oil contents, compared to open pollinated (OP) cultivars (2,3). Four hybrids produced using a cytoplasmic male sterility system were sourced from Safftec?, California, and compared to three OP cultivars at 2 sites in the Wimmera region of Victoria during 2001/02.

Methods

Two randomised block experiments with 3 replicates (plot size 8 ? 1.7 m), were sown at Longerenong (36.7**?**S, 142.3?E, near Horsham), on the 16 August 2001. The $pH_{(CaCl2)}$ of the cracking grey clay soil was 7.5 and 6.3 at Site A and B, respectively. Row spacing was 220 mm and sowing depth 20 mm. Sowing rates were adjusted for seed weight and germination to give 20 plants/m^2 (~ 10 kg/ha). Phosphorus (19 kg/ha) and nitrogen (43 kg/ha) were drilled before sowing. One linoleic hybrid (GW9009) and 3 oleic hybrids (GW9023, GW9024, GW9025) were compared to the OP cultivars Sironaria (linoleic), Saffola 517 (oleic) and 120045 (linoleic, early maturing, ex. CSIRO). Biomass, seed yield and yield components were determined from hand and header samples. Oil content was assessed using a single bulked sample for each treatment and therefore not statistically analysed. Yield data were statistically analysed using ANOVA and to make some generalisations about the hybrids, treatments were also grouped as OP or hybrid and subjected to unbalanced ANOVA.

Results

With 304 mm of rain falling between April 01 and January 02, the season was considerably drier than the long term average (372 mm) for this period. Plant establishment at Site A was parallel to target densities, but only 75 % of the target density was achieved at site B. The hybrids commenced flowering at a similar time to Sironaria, 128 (Site A) and 132 (Site B) days after sowing (DAS). All treatments reached physiological maturity between 161 and 169 DAS. The hybrids GW9009 and GW9025 produced significantly more seed and oil/ha than Sironaria at Site A, but there were no significant differences in seed or oil yield/ha at Site B (Table 1). All oleic hybrids produced significantly more seed and oil/ha than the oleic comparator (Saffola 517). The oleic component of GW9025 (Site A = 67 %; Site B = 65 %) was somewhat less than Saffola 517 (Site A = 74 %; Site B = 73 %). The oleic component of the other oleic hybrids was comparatively low (47 to 60 %).

Table 1: Mean seed and oil yields (8 % moisture)

	Seed yield (t/ha)		**Oil %**		**Oil yield (t/ha)**	
Cultivar	**Site A**	**Site B**	**Site A**	**Site B**	**Site A**	**Site B**
Saffola 517	0.73 [a]	1.14	34.1	34.0	0.25 [a]	0.39
120045	0.88 [ab]	0.89	30.6	32.1	0.27 [ab]	0.29
Sironaria	0.95 [abc]	1.12	31.4	33.2	0.30 [ab]	0.37
GW9024	1.07 [bcd]	1.05	30.2	31.0	0.32 [bcd]	0.33
GW9023	1.15 [cd]	1.15	27.4	28.6	0.31 [abc]	0.33
GW9009	1.18 [d]	1.50	31.6	32.3	0.37 [cd]	0.48
GW9025	1.28 [d]	1.17	30.1	29.6	0.39 [d]	0.35
LSD (5 %)	*0.230* [**]	*n.s.*	*Bulked samples therefore no statistics*		*0.071* [**]	*n.s.*
CV %	*12.5*	*29.5*			*12.5*	*30.6*

[a,b,c] means with same superscript are not significantly different at $P = 0.05$, [**] $P < 0.01$, *n.s.* denotes not significant at $P = .0.05$

When treatments were grouped according to plant type (Table 2), the hybrids exhibited a significant yield advantage over the OP cultivars at Site A, but not at Site B. At both sites, the hybrids produced more biomass than the OP cultivars. The hybrids and the OP cultivars had similar harvest indices within a site, but there was a considerable difference between sites (also for yield components). Overall, the hybrids had more capitula per plant and heavier seeds, but fewer seeds/capitulum, compared to OP cultivars. The hybrids produced more secondary capitula, which at Site A comprised 19 % of total seed yield ($P < 0.001$), compared to 1 % for the OP cultivars. The lower density at site B resulted in increased secondary branching across all treatments and secondary capitula comprised 26 % of the hybrid yield which was significantly ($P = 0.007$) higher than the OP cultivars (15 %).

Table 2: Mean seed yields and components (8% moisture), biomass and harvest index (0% moisture)

Cultivar	Seed yield (t/ha)	Biomass (t/ha)	Harvest index	Capitula/plant	Capitula/m^2	Seeds/ capitulum	g/1000 seeds	g seed/ capitulum
Site A								
OP	0.85 ^{a}	4.77 ^{a}	0.17	7.7 ^{a}	135 ^{a}	19.9 ^{b}	32.0 ^{a}	0.64 ^{b}
Hybrid	1.17 ^{b}	7.15 ^{b}	0.15	12.3 ^{b}	261 ^{b}	12.6 ^{a}	35.9 ^{b}	0.46 ^{a}
CV % & sig.	*13.8* ***	*19.8* ***	*21.1* $^{n.s.}$	*17.6* ***	*19.3* ***	*15.9* ***	*8.2* **	*18.7* ***
Site B								
OP	1.05	3.26 ^{a}	0.30	16.5	105 ^{a}	27.1 ^{b}	36.5 ^{a}	0.99 ^{b}
Hybrid	1.22	4.14 ^{b}	0.27	17.8	155 ^{b}	20.3 ^{a}	39.8 ^{b}	0.81 ^{a}
CV % & sig.	*28.6* $^{n.s.}$	*24.5* *	*10.9* $^{n.s}$	*33.1* $^{n.s.}$	*21.9* ***	*16.6* ***	*7.6* *	*20.2* **

^{a,b} means with same superscript are not significantly different at P=0.05, $^{*}P$<0.05, $^{**}P$<0.01, $^{***}P$<0.01, *n.s.* denotes not significant at P=0.05

Conclusion

Although some of the hybrids did produce higher yields than the OP cultivars at one site, their overall performance was less than anticipated. Given the additional capitula and larger seeds of the hybrids, it could be expected that their yield potential may also be higher. In these experiments, this was at least partly negated because of fewer seeds per capitula. Whether this was a response to dry conditions or due to genetics is unclear. Further experiments are required to fully evaluate the potential of these, and hybrids from other sources, in a range of Australian environments.

References

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