The potential role of safflower (*Carthamus tinctorius* L.) in Australia's southern farming systems

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ABSTRACT

In Southern Australia, increased cropping intensity imposes a need for diversity in crop rotations to manage biological threats and economic risk. Safflower (*Carthamus tinctorius* L.) has been a minor crop in Australia for many years. A survey was undertaken to identify the current roles of safflower in southern farming systems and define limitations to further adoption. Suggestions for environmental, agronomic and research data were also requested. Participants cited the cost/price squeeze, herbicide resistant weeds and soil degradation as major threats to sustainability. The most frequent reasons for including safflower in rotations were: weed control, spread of physical workload, water use, disease break, economics, soil amelioration and a need to spring sow. Research priorities identified by safflower growers included increasing yield, price/markets, seed/oil quality, early vigour/weed competition and new varieties. Other issues included pests/diseases, time of sowing, fertiliser requirements and herbicides.

KEY WORDS: safflower, rotation, tactical role, sustainability, agronomy

INTRODUCTION

The decline of Australia's wool industry has led to increased cropping intensity in the southern regions of Australia's traditional wheat/sheep belt. Cereals, canola and a few pulse crops dominate rotations. Limited crop diversity increases disease risk, economic vulnerability and promotes the evolution of herbicide resistant weeds (HRWs). Further crop options for southern Australia are therefore required. Safflower (*Carthamus tinctorius* L.) has been a minor crop in Australia for many years, often being sown in spring as an opportunity crop where heavy winter rainfall prevents the sowing of cereals or canola (2). Recent interest in safflower has been inspired by several proposed tactical roles that the crop may fulfill in southern farming systems. For example, the suitability of safflower for spring sowing allows cultivation and broad-spectrum herbicides to be utilised to control weeds that germinated in the previous autumn, thus providing a means to control HRWs. Safflower's deep tap root and high water use may be beneficial in drying soil profiles (1), allowing other crops to be grown in environments prone to waterlogging. Further potential benefits of incorporating safflower into rotations include; production on sodic or saline soils (7), improvements to soil structure (5), a break crop for cereal diseases (2), increased biodiversity, management flexibility and spread of economic risk. These attributes, and the fact safflower can be grown and harvested with conventional machinery, suggest that safflower may offer significant benefits to cropping rotations in southern Australia. A survey of safflower growers (SGs) and non-growers (NGs) in southern Australia was undertaken in 2000 to substantiate anecdotal evidence on the current role of safflower in southern farming systems and identify limitations to further adoption. Suggestions for environmental, agronomic and research data were also requested.

MATERIALS AND METHODS

Two surveys (SG and NG) were prepared according to preferred survey guidelines (6). The questionnaires covered the following broad topics; description of site/farming system, safflower's place in the rotation, agronomy, strengths/weaknesses, research priorities and marketing/economics. The questions were largely open-ended to minimise influencing participants, however in a few instances example answers were provided to maintain focus. Draft surveys were tested and revised before being distributed to participants across a range of regions in southern Australia. A total of 150 SG surveys and 100 NG surveys were distributed largely by mail to potential participants identified through company grower lists, group facilitators/extension officers and personal contacts. About 30 farmers were contacted by phone before the survey was mailed and a small number of surveys were completed during personal interviews. Qualitative data were analysed as the frequency of responses (4,6) and quantitative data were subjected to basic statistical analysis using the software package SPSS 7.5. Some respondents provided several answers to some questions, so the sum of qualitative responses exceeded one hundred percent in some instances.

RESULTS and DISCUSSION

A total of 65 useable survey forms (41 SG and 24 NG) were returned from Victoria (48), South Australia (13), southern New South Wales (3) and Tasmania (1). Average annual rainfall ranged from 270 to 750 mm (SG mean: 469 mm; NG: 422 mm). Soil types included clay loams (38%), black clays (23%), sandy loams (9%) and red soils (6%). Soil pH ranged from 4.5 - 9.0 (mean = 6.9). Rotations typically included cereals, oilseeds and pulses, with and without pasture or fallow.

The main reasons for individual rotation strategies are presented in Table 1. SGs mentioned weed control, minimising risk and crop adaptation to soil, environment and/or farming system more frequently than NGs. NGs may place more emphasis on using pulses in the rotation to reduce ‘off farm' nitrogen inputs. Responses suggest that ‘making money' and using break crops to disrupt cereal disease cycles are important reasons behind rotation strategies for both SGs and NGs. Other minor responses included; efficient equipment utilisation, soil amelioration, rotation of chemical groups, ease of management, efficient water use and profile drainage. Table 2 describes the most frequent responses to a question regarding current threats to farming system sustainability. SGs were more concerned with HRWs, soil degradation, waterlogging, and the cost/price squeeze. A larger proportion of NGs believed that there were no threats to sustainability. Both SGs and NGs appear to be equally concerned about low rainfall in recent years. Other sustainability threats receiving minor mention included: salinity, disease, weeds, limited crop options, hard seeded crops, poor markets, cost of capital, physical workloads, decline of rural community and family succession.

Table 1: Rotation strategy reasons.

Reason	*Mentions (%)*	
	SGs	*NGs*
Weed control	36	21
Adaptation	36	17
Disease break	32	38
Make money	20	25
Spread risk	15	4
Pulses for nitrogen	10	17

Table 2: Major sustainability threats.

Threat	*Mentions (%)*	
	SGs	*NGs*
Cost/price squeeze	63	38
HRWs	42	25
Soil degradation	32	17
Waterlogging	22	4
Low rainfall (recent years)	22	29
None	5	25

The 41 SGs provided a total of 380 years of safflower growing experience (range = 1 – 25 years). SGs incorporated safflower into cropping rotations to; control weeds (39%), spread sowing and harvesting work loads (22%), break cereal disease cycles (20%), water use (15%), make money (15%) and to open soil with roots (12%). Several SGs used safflower strategically in rotations specifically to control HRWs (10%) or to dry soil profiles for subsequent crops (10%). In drier environments, safflower was sometimes sown as the final rotation species before fallow or pasture, as high water use restricted the yield of subsequent crops. Thirty nine percent of respondents mainly sowed safflower if paddocks became untrafficable in autumn/winter, preventing the sowing of winter crops. Two SGs planted safflower for the first time in 1999 to replace pulse crops that failed due to disease during winter. A further two SGs planted safflower as a cover crop for lucerne establishment.

The majority of SGs (56%) reported planting only the cultivar, Sironaria. A further 31% sowed a combination of Sironaria, Saffola and/or Gila. More than one third reported that Sironaria was the best cultivar available and a further 29% strongly indicated that the newer cultivar (Saffola) performed poorly. Sironaria was released by the CSIRO in 1987 to replace the disease prone cultivar Gila (2). A number of cultivars promoted under the name Saffola, were developed in America and introduced to Australia in the mid 1990's. Forty two percent purchased seed from agricultural merchants, 37% retained their own seed and the remainder used a combination of methods, including purchasing seed from other growers.

Sowing time ranged from July until December with the majority sowing in August and September. The pre-emergence herbicide trifluralin was used by 47% (Treflan® 0.8 – 3 L/ha; mean = 1.4 L/ha). For sowing safflower, 41% used minimum tillage, 36% direct drilling and 28% conventional cultivation. Row spacing ranged from 127 to 400 mm (mean = 198 mm) and sowing depth from 15 to 75 mm (mean = 35 mm). Sowing rate ranged from 10 to 25 kg/ha (mean = 17 kg/ha). Thirty two percent had tried various sowing rates to improve establishment, competition with weeds and/or overcome pest problems. Half of these growers reported that high sowing rates resulted in many small seed heads and reduced overall yield. Three growers however increased yields with high sowing rates, especially in high rainfall seasons. The results suggested that, at higher sowing rates, excess water use during the vegetative stage can result in a moisture deficit during the reproductive phase, thus reduced grain yield. Similar results have been reported for many crops *e.g.* field peas (3). Phosphorous applications at sowing included 11 – 15 kg/ha (30 %), 16 – 20 kg/ha (19%) and 26 – 30 kg/ha (24%). Sixty eight percent of growers applied between 6 and 15 kg/ha of nitrogen and 70% applied less that 1.5 kg/ha sulphur. Mono-ammonium phosphate (39%) and di-ammonium phosphate (26%) were the most frequent fertiliser forms used. Fourteen percent applied no fertiliser at sowing. Post sowing treatments included rolling (27%), harrowing (22%) and prickle chaining (7%).

Weeds were reported as a problem by 37% of SGs. Twenty two percent sprayed with a grass selective herbicide and 22% used Ally® (metsulfuron) during the growing season. The average Ally® rate was 6 g/ha (general range = 5 – 7 g/ha), but one grower reported trying rates between 2 and 10 g/ha without adverse crop effects. Metsulfuron use is not registered on safflower, because under some conditions there is a risk of crop damage (DuPont, pers. comm.). Rutherglen bugs (42%) and Red Legged Earth Mites (29%) were frequently mentioned pests, but problems that are easily controlled with pesticides. Although 8% applied manganese and/or zinc during the growing season, most SGs applied no additional fertiliser. Seventeen percent had tried topdressing nitrogen on safflower with unreliable or little benefit.

Safflower is mostly direct-headed between January and March with minimum yields ranging from 0 to 1.7 t/ha (mean = 0.7 t/ha) and maximum yields ranging from 0.3 to 3.0 t/ha (mean = 1.7 t/ha). High yields were generally associated with high rainfall and September sowing. Sixty percent of SGs sold grain solely to birdseed markets. Thirty seven percent sold into oil markets +/- birdseed, and only 12% of participants mentioned meal markets. Only 19% of SGs believed the economic viability of safflower to be currently good, with 48% mentioning variable/marginal and 29% stating that economics were good in previous years, but are currently poor. Eighty percent believed that markets were inadequate.

Fifty percent of NGs had either grown or considered growing safflower in the past. Reasons cited for not growing safflower include yield/market/price issues, unsuitable environmental factors and lack of information. Most NGs indicated they would consider safflower if gross margins improved through resolving yield/price/market issues (46%), if environmental conditions were more suited to the crop (25%), a need arose for a spring-sown crop (17%) or more adapted cultivars were developed (13%).

Perceptions of safflower strengths are listed in Table 3. A larger proportion of NGs mentioned; flexible time of sowing, disease break, deep tap root and low input requirements as major strengths. SGs tended to mention improvements to soil structure and spread of workload more frequently. Both SGs and NGs had similar views for safflower providing good weed control and the crops ability to use water and drain soil profiles. SGs mentioned poor/variable yields (41%), price/market issues (29%), pests (7%) and poor establishment (7%) as being major weaknesses of safflower. NGs cited similar weaknesses.

Table 3: Major strengths of safflower.

Strength	*Mentions (%)*	
	SGs	*NGs*
Improves soil structure	24	17
Good weed control tool	19	17
Water use/profile drainage	17	17
Flexible time of sowing	19	21
Low input/ cheap to grow	12	17
Easy to grow	12	4
Disease break	10	17
Spread workloads	7	4
Deep tap root	0	17
Non cereal/pulse option	2	4

Table 4: Safflower research priorities.

Research priority	*Mentions (%)*	
	SGs	*NGs*
Increasing markets/price	55	25
Increasing yield	55	21
New cultivars	29	21
Modifying seed/oil quality	10	13
Pest/disease resistance	10	8
Increasing seedling vigour	10	0
Fertiliser requirements	7	17
Time of sowing	12	13
Rotation benefits	0	13
Environmental adaptation	13	13

Table 4 lists the most frequently mentioned research priorities for safflower. Other research issues mentioned include; herbicide options, waterlogging tolerance, sowing rates, modification of growing season, improved crop establishment, quantification of soil benefits and pest thresholds. Increasing yield, markets and grain price, therefore gross margins, appear to be important issues. Participants suggested improving grain quality by reducing the proportion of husk, increasing oil content, changing the oil profile and finding new end use products for safflower, as possible means of resolving marketing issues. Many research priorities listed *e.g.* increasing yield, pest/disease resistance, early vigour, environmental adaptation and grain quality could be at least partially addressed through plant breeding and introducing new cultivars.

CONCLUSION

The survey suggests that safflower is being grown in southern Australia partly for economic reasons, but also as a tactical crop within rotations. These roles included; soil profile drainage, weed management (including HRWs), soil amelioration and spread of workload. Safflower is also frequently sown in spring as an opportunity crop when rainfall prevents the sowing of winter crops or where winter crops fail due to waterlogging or disease. Grain marketing appears to be a major problem requiring attention. Many NGs indicated that they would consider safflower if yield/price/market issues were improved. Safflower's potential role in controlling HRWs, drying soil profiles, soil amelioration and the addition of a non-cereal/pulse/brassica crop to rotations may benefit cropping enterprises in southern Australia. Many research priorities mentioned by survey participants could be improved by developing new cultivars with superior yield, grain quality, marketability, early vigour and adaptation to specific agro-ecological zones in southern Australia. The University of Melbourne has sourced a range of local and newer overseas cultivars and these are currently under evaluation at several sites in southern Australia.

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