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SAFFLOWER

SECTION 1

PLANNING / PADDOCK PREPARATION

PADDOCK SELECTION | PADDOCK ROTATION AND HISTORY | BENEFITS OF SAFFLOWER AS A ROTATION CROP | DISADVANTAGES OF SAFFLOWER AS A ROTATION CROP | FALLOW WEED CONTROL | SEEDBED REQUIREMENTS | SOIL MOISTURE | YIELD AND TARGETS | DISEASE STATUS OF PADDOCK

Planning/Paddock preparation

In Australia, safflower production commenced in northern NSW and Queensland, but has since shifted to include the higher rainfall (>450 mm), cereal-growing regions of southern NSW, Victoria and South Australia.

Safflower can be grown over a wide range of regions if severe frosts (<–4°C) are avoided during stem elongation and if harvest can be completed before heavy summer rainfall events that occur after the crop matures.

Safflower has a relatively high water requirement and is more reliable where stored soil water and rainfall allow total crop water use to exceed 300 mm between sowing and maturity.

Traditional production areas include the deep cracking clay soils near Moree, Warren and Griffith in NSW, the Wimmera region of Victoria, and the area from Bordertown southwards in South Australia. Safflower can also be grown successfully as an irrigated crop in most river valleys and irrigation areas, such as the Hay Plain in NSW. [1]

1.1 Paddock selection

Checklist for paddock selection for safflower:

- high water-holding capacity, deep soil with no hardpans and not prone to waterlogging
- clean paddocks with low populations of broadleaf weeds, particularly thistles
- no history of hard-to-kill broadleaf weeds such as bindweed, thorn apple (false castor oil), peach vine
- neutral to alkaline soils, good fertility (may still require phosphorus and zinc).

Particularly in the Northern Region, both winter and summer broadleaf weeds must be taken into consideration because of the late window for safflower and the likelihood of early-emerging summer weeds. There is no current registration for in-crop broadleaf control.

Safflower is adapted to a wide range of soils (Figure 1). It is best suited to neutral and alkaline soils and less tolerant of acidic soils. It is a deep-rooted crop and it should be grown on soils of ≥1 m depth and with good water-holding capacity.

Clay loams and alluvial soils are satisfactory. Shallow sandy soils and heavy, structureless soils prone to surface crusting are not suitable. Safflower is only slightly less tolerant than barley to salinity. It can be grown under irrigation, but this needs to be carefully monitored because many varieties are susceptible to Phytophthora root rot. Pre-irrigation of a paddock is usually recommended to ensure that the soil profile is full and no additional water is applied.

1 N Wachsmann, T Potter, R Byrne, S Knights (2010) Raising the bar with better safflower agronomy. Agronomic information and safflower case studies. GRDC, http://www.grdc.com.au/BetterSafflowerAgronomy

Figure 1: *Safflower is adapted to a wide range of soils.*

Photo: GRDC

Safflower's extensive root system can break up hard-set soils and can dry soil profiles where required. In some seasons, safflower is grown as an opportunity crop on full profiles of soil water on floodplains or normally dry lakebeds after floodwater recedes. Safflower may also provide cropping options in paddocks where herbicide-resistant weeds are present, because of the potential to use either knockdown herbicides or mechanical means of weed control, and the later sowing date of safflower. [2]

1.2 Paddock rotation and history

Safflower is a good rotation crop with winter cereals and is best sown into a no-till long fallow to ensure good subsoil moisture. As a rotation crop, it can disrupt cereal-disease cycles such as crown rot and take-all.

To avoid potential disease problems, safflower crops should not be grown in succession in the same paddock. A rotation of one season in four for safflower is recommended. A safflower crop can be followed by a summer crop; however, growers should note the minimal soil water available to the following crop due to the high water use of safflower.

It is important to select paddocks with good pre-plant weed control because safflower is a poor competitor with weeds in its early growth stages and herbicide options are limited. Safflower is susceptible to damage from various residual herbicides, so growers should consider previous herbicide use in a paddock. [3]

Spores of *Alternaria carthami* (the causal agent of Alternaria blight) can remain on infected stubble for >2 years. Paddocks selected should not be adjacent to the previous crop's stubble, and volunteer crop plants should be controlled, as well as alternative hosts. Spores *Phytophthora cryptogea* (causing Phytophthora root rot) will remain on many host crops. Avoid low-lying paddocks, paddocks with previous Phytophthora problems and paddocks where medics have grown. Safflower should not be sown directly into stubble of alternative hosts such as chickpeas.

In wet years, safflower can be planted following a sorghum crop provided there has been sufficient rainfall for a moist soil profile to at least 1 m depth. In drier or average seasons, safflower should be planted following a summer fallow from the previous

2 R Byrne (2009) Safflower. In Summer crop production guide 2009. NSW Department of Primary Industries. (Eds L Serafin, L Jenkins, R Byrne)

3 R Byrne (2009) Safflower. In Summer crop production guide 2009. NSW Department of Primary Industries. (Eds L Serafin, L Jenkins, R Byrne)

winter cereal crop. This allows sufficient moisture to be accumulated, and the safflower is then able to provide a break from cereal crown and root diseases.

Generally, it is not advised to follow a broadleaf crop with safflower, because the broadleaf weed population is likely to have increased. However, safflower following a cereal crop allows for good control of broadleaf weeds from previous seasons, running down the seedbank, and careful fallow control can reduce populations of summer weeds.

FAQ

1.3 Benefits of safflower as a rotation crop

Safflower can be a valuable addition to cropping systems, providing a number of strategic, agronomic and financial benefits as well as cash return.

Rotation benefits include:

- late winter crop option if there is a late break or failed establishment of the winter crop
- potential to double crop out of sorghum
- heat and drought tolerant oilseed crop suited to lower rainfall areas where canola and sunflower are not adapted
- broadleaf crop option—break crop for cereal diseases including Crown rot (*Fusarium pseudograminearum*), Common root rot (*Bipolaris sorokiniana*), Yellow leaf spot (*Pyrenophora tritici-repentis*) and Spot form of net blotch (*Pyrenophora teres* f. *maculata*)
- resistant to both *P. thornei* and *P. neglectus* root lesion nematodes
- good host to arbuscular mycorrhizae fungi (AMF), promoting the increase of AMF in the soil
- different weed spectrum to most other crops—it offers the opportunity to control late germinating weeds and/or herbicide resistant winter weeds and to incorporate additional IWM strategies
- greater crop enterprise diversity to spread economic and production risk
- used in a soil ameliorant role to improve soil structure; strategically as a first crop in the rotation after cotton to break up subsoil to remove compacted layers, improve aeration and water infiltration; and root development to subsequent crops (anecdotal reports of rooting depths of 2.2 m). [4]

Other advantages include:

- alternative crop suited to both dryland and irrigation
- low input, low maintenance and easy to grow
- crop inputs and machinery requirements similar to wheat production
- sowing and harvest windows effectively spread peak workloads and machinery use over a longer period, increasing efficiencies and harvest timeliness of different crops
- widely adapted to various soil types, but best suited soils with high water holding capacities
- competitive crop against weeds after the mid to late spring period
- tolerant of hot summer conditions during crop maturation due to deep roots, providing sufficient water is available
- utilises soil water deep in the soil profile. Lowers the water table with dissolved salts, reduces water logging in following crops and improves N efficiency by utilising leached N at depth

4 K Hertel (2016) Tactical agronomy of safflower and linseed: place in the rotation, yield potential, time of sowing, plant growth and marketing. GRDC Update Papers 1 March 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/03/Tactical-agronomy-of-safflower-and-linseed

- increasing climate variability presents opportunities for safflower as an oilseed as it can grow on less rainfall than other major oilseed crops such as canola, sunflower and soybeans. Potential to be grown across a wide geographic area. [5]

MORE INFORMATION

Root and crown diseases of wheat and barley

Crown rot—Queensland

1.3.1 Break crop

Safflower is not a host for the major root and crown diseases of cereals. Diseases such as crown rot that infect cereals such as wheat and barley are carried over from one cereal crop to the next on stubble, volunteer crop plants and certain grass weeds. Because these diseases are not hosted by safflower, with good grass-weed control, the populations of these organisms are significantly reduced in safflower crops, resulting in higher cereal yields in the following season. Safflower does not suffer from blackleg, making it a suitable break crop for canola, and it is one of a few crops resistant to both species of root-lesion nematodes, meaning that it will not allow build-up of either *Pratylenchus thornei* or *P. neglectus*.

The number of successive break crops required to reduce crown rot levels sufficiently will vary depending on rainfall in the break year(s). In dry years, when residue breakdown is slower, a 2-year break crop may be required to reduce crown rot to acceptable levels. With wetter seasons, a 1-year break may be sufficient.

1.3.2 Enterprise diversification

In a cereal-based enterprise, safflower can provide a hedge against unpredictable weather. Because safflower can be planted later than cereals, it can be substituted for part of the cereal crop if planting rains begin too late for cereals, or if too much rain prevents their establishment. A large amount of rain during cereal sowing and harvest can be detrimental to these crops, but may benefit safflower because its growing season is much later.

This allows for a more diversified cropping program, which has several advantages. For example, the later sowing and harvest of safflower spreads seasonal workloads and may reduce the exposure of crops to frost, and the incorporation of another crop species increases the opportunity to rotate herbicide groups. Safflower's late growing season can help to mitigate effects on the whole-farm budget of spring frost damage to cereals, thereby reducing risk.

1.3.3 Drought tolerance

Provided the soil profile is moderately wet at sowing, safflower can yield reasonably well with little follow-up rain, because of its deep taproot. Safflower tolerates heat and drought better than most other crops and can survive for extended periods without rain. Safflower will utilise deep soil moisture; therefore, the period of return to crop needs to be taken into account as part of the longer term rotation.

1.3.4 Tool for managing problem weeds

Safflower is often sown later than other winter crops, which allows more time for winter weeds to germinate before sowing. Such weeds can then be controlled using knockdown herbicides or cultivation, minimising resistance to selective herbicides. Furthermore, pre-emergent herbicides such as pendimethalin and trifluralin can be used at higher rates in safflower than in wheat, giving greater control of weeds such as annual ryegrass and wild oats. One drawback with safflower is the lack of broadleaf control options in-crop.

5 K Hertel (2016) Tactical agronomy of safflower and linseed: place in the rotation, yield potential, time of sowing, plant growth and marketing. GRDC Update Papers 1 March 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/03/Tactical-agronomy-of-safflower-and-linseed

1.3.5 Entry crop and soil ameliorant

Safflower's aggressive root system penetrates further into soil than many other crops. The roots create channels in the subsoil, improving water and air movement as well as root development in subsequent crops. Safflower can be used to dry wet soil profiles, such as after irrigated cotton. This facilitates the natural shrinking and cracking of compacted layers, which can be further shattered by deep ripping.

1.3.6 Tool for managing salinity and waterlogging

Safflower is a long-season crop with a deep taproot, so it has the ability to use surplus water from deep in the soil profile, lowering water tables with dissolved salts and reducing the expansion of saline seeps. Similarly, some growers use safflower to dry soil profiles to reduce waterlogging in subsequent crops.

1.3.7 Pest deterrence

The prickly nature of safflower later in its growing season means that it is occasionally grown in situations where other crops may fail under high kangaroo, bird or feral pig pressure. Safflower is relatively unpalatable to these animals and growers can achieve an economic return with minimal maintenance of the crop. [6] Safflower can also be grown as a barrier crop around other cereals and pulses to decrease the pest burden in those crops.

1.4 Disadvantages of safflower as a rotation crop

Despite the benefits of safflower in a range of farming systems, several factors tend to result in lower yields, making it a less popular crop. These include:

- Late maturity, which exposes safflower to heat and moisture stress at the end of the season (Figure 2). Sowing significantly earlier brings maturity forward by only a small amount and increases the risk of frost damage during stem elongation.
- The upright seed heads are like a cup and easily saturated by rain. Summer rain can therefore cause staining of seed, reducing its value, and/or sprouting, where ripe seeds germinate in the head.
- In-crop herbicide options are limited, especially for the control of broadleaf weeds.
- The depletion of water from the soil profile by safflower can result in less water being available for the subsequent crop(s).
- Because most cultivars develop spines, care is needed to prevent blockages and header fires during harvest. [7]

6 N Wachsmann, T Potter, R Byrne, S Knights (2010) Raising the bar with better safflower agronomy. Agronomic information and safflower case studies. GRDC, http://www.grdc.com.au/BetterSafflowerAgronomy

7 N Wachsmann, T Potter, R Byrne, S Knights (2010) Raising the bar with better safflower agronomy. Agronomic information and safflower case studies. GRDC, http://www.grdc.com.au/BetterSafflowerAgronomy

Figure 2: *Wheat and safflower in the Victorian Wimmera. Safflower matures 4–6 weeks after wheat (photo taken 31 December). In this example, both crops were sown on 24 July.*

Photo: Nick Wachsmann

1.5 Fallow weed control

MORE INFORMATION

Weed control in winter crops 2016

Australian Pesticides and Veterinary Medicines Authority

Many herbicides have restrictive safe re-cropping intervals prior to planting safflower. When considering knockdown herbicides prior to planting, the rate and re-cropping interval should be checked for all Group I phenoxy herbicides (i.e. 2,4-D) and planned accordingly. For instance, in Queensland, application of Amicide® Advance 700 restricts plant-back for at least 14 days following at least 15 mm of rain.

Herbicide applications undertaken in the previous 12 months need to be considered. Particularly restrictive plant-backs apply to most residual broadleaf herbicides, such as picloram, a component of Tordon®, as well as commonly applied herbicides such as the Group B herbicide metsulfuron-methyl (e.g. Metsulfuron 600 WG). These herbicides can have restrictions of >9 months in some pH ranges, so planning for safflower paddocks and their management must begin early. Talk to your agronomist regarding likely herbicide restrictions and check current labels.

1.6 Seedbed requirements

MORE INFORMATION

Estimating plant available water capacity

Paddock preparation for safflower is similar to that for other oilseeds, with emphasis on weed control and good moisture profile. Safflower can be sown into cultivated seedbeds or direct-drilled into stubble from previous crops. If cultivating, avoid overworking, which may damage soil structure and consequently reduce establishment, especially where soils are prone to crusting.

Safflower can also be grown on raised beds, which will improve drainage, thereby reducing the risk of waterlogging and root diseases. Ideally, the topsoil should be moist enough for seeds to germinate, and crop reliability is improved where the profile contains water to a depth of at least 1 m at sowing. This can be checked by taking cores, pushing a steel probe into the soil, using capacitance probes or utilising tools such as 'HowWet?' (a program that uses farm rainfall records to estimate plant-available water and nitrate in the soil at planting and throughout the fallow season).

To prevent injury, ensure that plant-back periods for safflower are observed for herbicides used in the previous crop, summer or pre-sowing knockdown sprays (e.g. 7–21 days for some 2,4-D products, >9 months for some residual herbicides).

Several pre-emergent herbicides containing trifluralin, pendimethalin, triallate and EPTC are registered to control a range of grass and broadleaf weeds in safflower. At present, no seed-applied fungicides are registered for use in safflower in Australia.

1.7 Soil moisture

Although safflower can be grown on a range of soil types, it prefers deep neutral to alkaline soils that are well drained, but still have a high water-holding capacity (e.g. deep clay loams).

Fertile, deep black or grey, self-mulching or cracking clays that allow full development of the root system are ideal. Loams and alluvial soils are also satisfactory but should be deep and free from hardpans, compacted layers, and hostile chemicals or elements so that the root system can reach as deep into the profile as possible to extract water.

No-till farming systems with full stubble retention can increase the amount of water stored in soil profiles and therefore the reliability of safflower, provided weeds can be controlled.

Soils that are prone to extended periods of waterlogging are generally not suitable because they predispose crops to Phytophthora root rot, which is often fatal in safflower. Soils that are prone to crusting will reduce plant establishment, and unless in high-rainfall areas, sandy soils may limit safflower production by having water-holding capacity that is too low.

Paddocks with subsoil constraints such as boron that will impair root development should be avoided.

The salinity tolerance of safflower is moderate to high, similar to barley or cotton. It is more tolerant of sodium than calcium or magnesium salts and less tolerant as a seedling than at later growth stages, where yield is affected by salinity levels >14 dS/m. Tolerance to salinity does differ between varieties, but little information is available on the cultivars grown in Australia.

With its deep taproot, safflower is often used in a tactical role on problem soils to break up hardpans and to improve water and air infiltration into the subsoil through the creation of pores. [8]

Safflower is usually sown in late winter or spring in southern Australia. Because of its deep taproot and extended growing season, enabling it to use water longer into the season compared with other winter crops, safflower has been proposed as a crop that can be used to 'dewater' wet soils and utilise subsoil moisture that may be beyond the reach of other winter crops. This may have positive implications for the whole farming system where waterlogging or rising saline water tables threaten production. However, the same features can lead to poor or variable yields in dry environments.

1.7.1 Soil moisture use

Safflower uses more water than other winter crops, attributed to its deeper rooting depth and longer growing season. The deep rooting habit dries the soil profile. This has implications for subsequent crops, limiting crop potential where soil water reserves are not replenished by sufficient rainfall in dryland situations. When conditions remain dry, planned crop sequences may be disrupted.

Adequate stored soil moisture at sowing is crucial. Safflower production is a greater risk crop in low rainfall areas when there is low stored soil water at sowing. Limited starting soil moisture and lack of timely in-crop rainfall will produce poor or variable safflower yields.

MORE INFORMATION

SoilWaterApp – a new tool to measure and monitor soil water

MORE INFORMATION

Comparative growth, yield and water use of safflower, Linola™, mustard, canola and wheat in southern Australia

Comparative growth, water use and yield of chickpea, safflower and wheat in south-eastern Queensland

Estimating plant available water capacity

A 'how to' for getting soil water from your EM38 field measurements

Broadacre field crops. Managing water resources

8 N Wachsmann, T Potter, R Byrne, S Knights (2010) Raising the bar with better safflower agronomy. Agronomic information and safflower case studies. GRDC, http://www.grdc.com.au/BetterSafflowerAgronomy

CSIRO research conducted in the late 1980s at Dalby, Queensland, compared soil water use in safflower, wheat and chickpeas. Sown 2 June, safflower extracted 375 mm, compared with wheat 212 mm and chickpea 195 mm (Beech & Leach 1989). This equated to Water Use Efficiency (WUE) of safflower 2.6 kg /ha/mm, wheat 6.8 kg/ha/mm and chickpea 4.9 kg/ha/mm.

More recently, GRDC funded research conducted in western Victoria in 2000 and 2001 (Waschmann et al 2003) reported safflower used 100 mm of additional water compared to wheat in wetter seasons. Whilst all crop species measured similar daily water use, safflower's longer growing season (34–40 days more than wheat) meant it used additional soil water. To achieve similar yields to canola, safflower used an additional 120 mm. Safflower yielded 3.71 t/ha and canola 3.44 t/ha. [9]

1.7.2 Dryland

Safflower is a very adaptable crop that can be winter- or spring-sown in dryland conditions. It has good drought and heat tolerance and its deep taproot enables it to use nutrients below the root-zone of cereal crops. Given safflower's high water use, it is important to ensure sufficient water in the profile to achieve an economic yield. Safflower has a role as a niche crop on drying flood plains and lakebeds, particularly around far-western NSW.

Safflower is suitable for dryland production in deep soils with high water-holding capacity, where a good soil moisture status below 1 m depth is recorded. Climatic forecasts should be used to ascertain spring conditions and the likelihood of rainfall when estimating yield.

1.7.3 Irrigation

Safflower can be grown successfully on well-drained soils under irrigation, with yields >4 t/ha possible. Both overhead and flood irrigation can be used, but care is needed to prevent extended periods of waterlogging. The submersion of roots in water for >48 hours may kill crops by starving roots of oxygen and creating conditions suitable for root diseases like Phytophthora root rot.

The effect of waterlogging on safflower crops appears to be worse during warming temperatures later in the season. Experience suggests that irrigation should stop after flowering to allow water demands during seedfill to be met from soil reserves. Care is also needed with overhead irrigation to minimise the duration of humid conditions in the canopy, which favour the development of leaf and head diseases. Irrigated safflower does best on raised beds with good drainage.

For best results, the soil profile should be filled to at least 1.5 m depth prior to sowing, with small subsequent irrigations between stem elongation and flowering. Fully irrigated crops require ~500–750 mm of water, and Californian experience suggests that it is best to apply at least 60% of this prior to sowing. Sowing dry and watering up is not generally recommended because rain after irrigation on cold soils may reduce crop establishment. [10]

The economics of irrigating safflower should be compared with other crop choices in the rotations.

1.8 Yield and targets

The yield of oilseeds is generally lower than of cereals owing to the higher energy content of the seed. When sown as a winter crop, safflower can produce similar yields to canola but it requires additional water.

9 K Hertel (2016) Tactical agronomy of safflower and linseed: place in the rotation, yield potential, time of sowing, plant growth and marketing. GRDC Update Papers 1 March 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/03/Tactical-agronomy-of-safflower-and-linseed

10 N Wachsmann, T Potter, R Byrne, S Knights (2010) Raising the bar with better safflower agronomy. Agronomic information and safflower case studies. GRDC, http://www.grdc.com.au/BetterSafflowerAgronomy

For example, in an experiment in the Victorian Wimmera, canola used 387 mm of water to produce a yield of 3.4 t/ha, whereas safflower used 507 mm of water to produce 3.7 t/ha of seed. In other words, the Water Use Efficiency of safflower is often less than that of canola.

Where stored soil water and rainfall limit crop water use to <300 mm, canola, mustard or linseed are likely to be higher yielding winter oilseed options. However, in wetter situations, safflower can be competitive with these crops. Safflower generally requires fewer inputs and does not need to be windrowed. [11]

Safflower generally has lower input costs in terms of insecticide and fungicide treatments, although the fertiliser requirement is generally the same as comparable oilseeds. Harvest costs for safflower can be generally lower than for canola (when comparing with windrowing); however, they are generally higher than a standard cereal crop.

1.8.1 Seasonal outlook

Safflower provides flexibility for growers to adapt to seasonal conditions because it has a wide sowing window that can adapt to the availability of rainfall during the season. Growers need to consider the markets within each season; they can be quite volatile. Growers should secure contracts before sowing.

1.8.2 Fallow moisture

Soil moisture is one of the integral requirements for viable safflower production, and as such, water conservation prior to sowing is crucial. Stubble retention may improve water conservation, together with good control of fallow weeds.

1.8.3 Water Use Efficiency

Although safflower is often regarded as drought-tolerant, it does have a high water requirement. It survives dry conditions by developing an extensive taproot and scavenging for deep soil water rather than relying on growing season rainfall. This assumes that deep soil water is present and that adverse soil conditions do not restrict root growth. Safflower's high water requirement is often ascribed to its relatively long growing season, and some water must be available to crops during flowering and seedfill. Safflower performs best in regions that receive >450 mm of rainfall annually, but yields exceeding 1 t/ha can be expected on clay soils that are wet to 1 m depth at sowing, provided at least 50 mm of post-sowing rainfall is received.

The higher water use of safflower was demonstrated in trials mentioned above in the Victorian Wimmera and near the South Australian border when it was compared with wheat, canola, mustard and linseed. Safflower produced similar yields to canola in two wetter site-years, but used an additional ~120 mm.

Over the four site-years in which these trials were conducted, safflower yields varied 9-fold (0.4–3.7 t/ha), whereas the yields of canola (1.2–3.4 t/ha) and wheat (2.1–6.0 t/ha) varied only 3-fold. Where conditions limited the water use of safflower to <290 mm, canola, mustard and linseed were more productive winter oilseed options.

Water use data from these and other experiments over a range of sowing times indicate that safflower can produce yields of ~1 t/ha where conditions (stored soil water + rainfall) allow total water use to be 275 mm, but yield reliability increases where more water is available (Figure 3). Situations allowing safflower to use 500 mm of water have resulted in yields approaching 4 t/ha in trials, provided waterlogging is avoided. [12]

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11 N Wachsmann, T Potter, R Byrne, S Knights (2010) Raising the bar with better safflower agronomy. Agronomic information and safflower case studies. GRDC, http://www.grdc.com.au/BetterSafflowerAgronomy

12 N Wachsmann, T Potter, R Byrne, S Knights (2010) Raising the bar with better safflower agronomy. Agronomic information and safflower case studies. GRDC, http://www.grdc.com.au/BetterSafflowerAgronomy

MORE INFORMATION

[Growing safflower in Australia: agronomic research and suggestions to increase yields and production]

[The search for alternative safflower cultivars adapted to southeastern Australia with improved marketability]

[The performance of imported sunflower hybrids in south-eastern Australia]

MORE INFORMATION

[Nitrogen use efficiency of safflower as compared to sunflower]

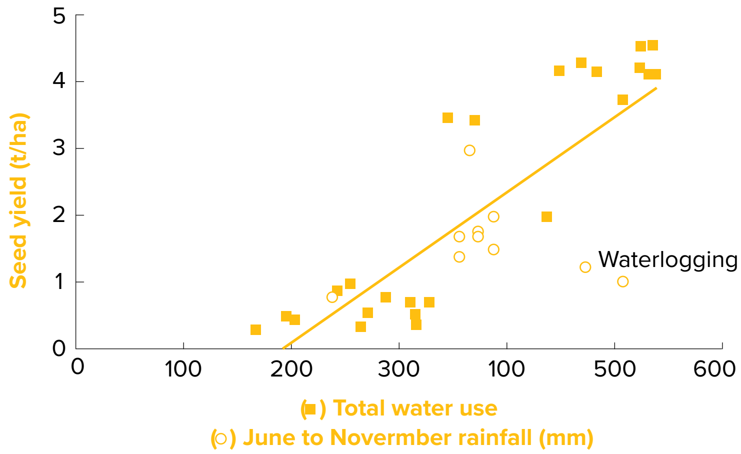

Figure 3: *Relationship between safflower yield and total water use (■) for June–November rainfall.*
(○) across a range of experiments in the Victorian Wimmera and the south east of South Australia.

In summary, winter-sown safflower has a higher water requirement than other crops grown in the cereal-growing regions of southern Australia. Nevertheless, yields in excess of 4 t/ha when sown in winter and 3 t/ha when sown in spring are possible with high soil-water availability.

For safflower to compete with canola as a cash crop in the 350–550 mm annual average rainfall, broadacre cropping zones, it will need to return a profitability similar to canola. [13]

1.8.4 Nitrogen-use efficiency

Safflower has nitrogen requirements similar to cereals. International research has found that, in terms of nitrogen utilisation, safflower is a low-input crop and outperforms sunflower with respect to seed yield on soils low in available nitrogen.

1.8.5 Double-crop options

Double-crop options may be limited when growing safflower, owing to its high water demand.

Safflower is often considered an opportunity crop. Because it requires a relatively full profile for planting, it may be suitable for double cropping out of a summer crop when autumn rainfall is particularly favourable. The comparatively late sowing window allows more time for moisture recharge then early-plant cereals, pulses and canola. In terms of double cropping following safflower, the late harvest period compared with cereals makes it unlikely that the summer planting window would still be open, and instead, fallowing to a winter cereal is more appropriate.

1.9 Disease status of paddock

Seasonal conditions largely determine the incidence and severity of disease in safflower. Management includes preventative strategies and variety resistance. The main issues of concern in the Northern region are Alternaria and Phytophthora.

13 N Wachsmann, D Jochinke, T Potter, R Norton (2008) Growing safflower in Australia: Part 2—Agronomic research and suggestions to increase yields and production. Australian Oilseeds Federation, http://www.australianoilseeds.com/__data/assets/pdf_file/0003/6744/Final_Wachsmann_paper.pdf

Alternaria leaf spot (*Alternaria carthami)* when present at high infection levels can result in significant yield loss of up to 50%. Oil (and protein) content can be reduced. Sironaria is resistant. [14]

Phytophthora root rot (*P. cryptogea*) (and Pythium root rot) is the most significant soilborne disease of safflower. This is often an unpredictable fungal disease and usually occurs in wet soils, especially when temperatures are high. it is present in all growing areas but is most prevalent in irrigated crops where yield can be significantly reduced depending on the timing and extent of the infection. Growers are recommended to avoid producing safflower in soils suspected of having Phytophthora infection, avoid poorly drained soils, and use sound irrigation practices to minimise the incidence of waterlogging. [15] Sironaria is resistant to phytophthora. [16]

Rust (*Puccinia carthami*) may cause significant yield loss where infection occurs early in the season. Inoculum survives in crop residues and alternative host Carthamus species like safflower. [17]

1.9.1 Cropping history effects

Phytophthora cryptogea is hosted on a wide range of crops and harboured in the soil and has the ability to survive for long periods in the absence of preferred hosts. It can infect the fine roots of many weeds without causing obvious symptoms. [18]

Safflower is a potential host to sclerotinia (*Sclerotinia sclerotiorum*). Other alternate host crops include sunflower, mustard, canola and chickpea. [19]

14 K Hertel (2016) Tactical agronomy of safflower and linseed: place in the rotation, yield potential, time of sowing, plant growth and marketing. GRDC Update Papers 1 March 2016, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/03/Tactical-agronomy-of-safflower-and-linseed

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