Safflower : an oil crop for the Kimberleys

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EXPERIMENTS with irrigated safflower carried out at the Kimberley Research Station have shown that the crop is well adapted to the local conditions. In recent years yields of 2,000 to 3,000 lb. per acre have been generally obtained. Oil content of the main variety under trial varied between 33 and 35 per cent. Locally produced safflower oil could help to make the Australian paint industry largely independent of imports. Safflower meal is a protein-rich concentrate and could have considerable impact on the Kimberley cattle industry. Safflower is likely to play an important part in the early development of irrigation agriculture on the Ord plains.

Although a recent introduction to this country, safflower has been grown as an oil seed crop in the Middle East and India since ancient times. During the last decade the crop has attracted considerable attention from American farmers. In Australia experimental work on safflower has been carried out since the end of World War II, mainly by the C.S.I.R.O. at the Waite Agricultural Research Institute.

At the Kimberley Research Station the trials with safflower commenced in 1951, and during the last three years this work has been considerably intensified. The results are most promising and there is little doubt that safflower will play a leading part in the imminent development of irrigation agriculture on the Ord River plains.

Safflower (Carthamus tinctorius, L.) belongs to the Compositae family. It is an erect thistle-like plant growing from 2 to 5 ft. high. Some varieties are very spiny while others are almost spineless. The flowers are white, yellow or orange depending on the variety. The white oil-bearing seeds are similar in size to those of the sunflower. The plant develops a vigorous tap root often penetrating to the depth of 6 to 7 ft. and consequently is comparatively drought-resistant. While safflower is closely related to the thistles, it is very unlikely to become a weed since its seeds do not remain dormant in the soil.

* The author is an officer of the Division of Land Research and Regional Survey, C.S.I.R.O., working at the Kimberley Research Station operated jointly by the Western Australian Government and the C.S.I.R.O.
LAND PREPARATION AND PLANTING

The seedbed preparation is similar to that used in wheat farming. At Kimberley Research Station where safflower is grown under irrigation, a border-check irrigation system, which permits the use of an ordinary seed-drill, has been found preferable to furrow irrigation. With the latter system where the crop is planted in rows, weed control in inter-row spaces requires additional cultivation. Moreover, if the high seeding rates desirable for high yields are used, the crop grown in widely spaced rows is liable to lodge. Careful land levelling is however essential with the flood irrigation in order to prevent irregular watering. With proper equipment and sufficient experience it can be carried out fairly rapidly.

The experiments at Kimberley Research Station have shown that under local climatic conditions safflower must be grown as a dry winter season crop. It has been found that, in order to obtain best yields, safflower should be planted between early April and late May. Earlier planting is impracticable because the soil is too wet for cultivation after the rains. Later planting results in considerably reduced yields. The importance of timely planting is shown by the results of a time of planting experiment given in Table 1.

The rate of sowing and spacing are of considerable importance in the establishment, early growth and in determining the suitability of safflower for mechanical harvesting. It has been found that high sowing rates lead to better seedling emergence, especially where soil crusting occurs. High plant density is also desirable because it enables the crop to compete better with weeds, particularly since it reduces the duration of the rosette stage when weed competition is most serious.

With a low plant stand, the number of heads per plant is increased. This leads to delays in harvesting because the period of flowering and maturation is extended. A deeper cut with the header is necessary to gather all heads, thus slowing harvesting operations. To avoid the risk of rain, it is often necessary to harvest before the younger heads are completely mature and this results in reduced yields and lower oil contents. The oil content of seed from the later-maturing heads is invariably lower, consequently the oil yield of a crop containing a considerable proportion of such heads is obviously inferior. It is therefore desirable to keep the number of heads on individual plants down to four, while maintaining a high number of heads per acre. This can be achieved with a high plant density.

The experimental work at the Kimberley Research Station has shown that the most suitable plant population can be obtained with sowing rate of 60 lb. to 80 lb. per acre and row spacing of 7 in., a normal row width of grain drill.

Shallow seeding at about ½ in. depth appears to be desirable to obtain good stands.

![Blossom of safflower](image)

FERTILISER REQUIREMENTS

To date, comparatively little work has been done on fertiliser requirement of safflower grown on local heavy clay soils. The preliminary trials indicate that both phosphatic and nitrogenous fertilisers are necessary. On virgin land up to 3 cwt. per acre of superphosphate may be needed while on land previously "supered," 1 cwt. per acre may be sufficient. In all cases 1 cwt. per acre of sulphate of ammonia is
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required. In trials conducted to date application of higher rates of superphosphate and sulphate of ammonia had no significant effect on either grain or oil yield. Application of potassium fertiliser failed to produce any significant response in grain or oil yield of safflower.

Further work is still necessary to determine more precisely the fertiliser requirements of this crop and to find out whether fertiliser placement has any effect.

**IRRIGATION REQUIREMENTS**

Under Kimberley conditions, safflower is grown during the dry season entirely under irrigation.

In order to obtain a clean seed-bed with suitable tilth, pre-irrigation is generally necessary. After the crop is sown it receives its first irrigation as soon as possible and subsequently it is watered at approximately 10-day intervals until about four weeks after the commencement of flowering. Experience at the Station indicates that the maximum water requirements for crops planted in May occur during the flowering period in early September. Water stress at this time can have considerable effect on yield.

The total quantity of irrigation water required for the crop is about 2½ acre feet.

**PLANT GROWTH AND DEVELOPMENT**

With Variety 4 (1), at present regarded as a standard variety for the region, three to five days elapse between the first irrigation and seedling emergence depending upon temperatures and depth of seeding. The rosette stage, which follows, lasts approximately three weeks. During this stage growth is slow but the plant forms its vegetative structure. Approximately four weeks after emergence the plant has its full complement of leaves, including the embryonic ones, and the first four to five rudimentary inflorescences. At the end of the third week rapid elongation commences and continues until the appearance of the first flower approximately six weeks later.

Oil formation begins almost immediately after fertilisation, and four weeks after commencement of flowering the oil content reaches its maximum. The iodine value of oil—a measure of oil quality—also changes rapidly, increasing to a maximum about five weeks after commencement of flowering. The increase in seed weight is a gradual process, showing a steady rise up to six weeks after commencement of flowering.

**HARVESTING**

The mature safflower crop can be easily harvested mechanically using an ordinary grain header. While it is necessary to reduce the speed of the threshing drum and adjust the clearance between drum and concave, the settings of the other parts are the same as those generally used for cereals. Because of thickness of the safflower stems it is necessary to remove some of the fingers of the comb, thus increasing their spacing.

The crop is ready to harvest when the bracts, that is the leaf-like structures enclosing the seed, are dry. It is desirable to harvest the crop while stems are still partially green. This gives a cleaner sample than with crop harvested later. Depending on time of planting and variety, the period from sowing to harvest is approximately 140 days.

**YIELDS AND OIL CONTENT**

The yields at Kimberley Research Station varied from 500 lb. to over 3,000 lb. per acre. In recent years with increased farming experience of this crop, and particularly the proper appreciation of the importance of time of planting and heavier sowing rates, the yields were generally between 2,000 lb. and 3,000 lb. per acre.

The oil content varies between 25 per cent, and 40 per cent, depending on variety and time of planting. With Variety 4 (1) planted in May the oil content is usually between 33 per cent. and 35 per cent.

**VARIETIES**

Some 30 varieties of safflower have been tried at Kimberley Research Station. With one exception, all varieties currently under trial at the Station have been developed at the Waite Agricultural Research Institute from the material originally imported from the Middle East and India. The varieties which have proved most suitable under Kimberley conditions are mainly derived from the Egyptian material.

As a result of variety trials, Variety 4 (1) was chosen for more intensive agronomic
investigations, and would at present be recommended for commercial cultivation. However, some other varieties are being maintained as a possible source of useful characteristics for future characteristics for future breeding programmes. For example, Variety 55 (1) has a very short rosette stage, which enables the plant to compete better with weeds in the early growth stages. Several other varieties have a higher oil content, while others may be useful because of their low iodine number. Variety 803 (20) is entirely spineless and possesses particularly large seed, which may be easier to decorticate.

Currently the seed stocks of 18 varieties are maintained at the Station.

PESTS AND DISEASES
The damage caused by insect pests under Kimberley conditions can be considerable if protective spraying is not employed. For example, in 1959, an unsprayed plot yielded 600 lb. per acre less than a sprayed plot. Larvae of *Prodenia litura* and *Heliothis armigera* are mainly responsible. The first species feeds on foliage while *Heliothis* damages the fruiting points of the plants. Endrin and DDT sprayed at regular intervals have been effective in controlling insects but further work has to be done to reduce control measures to a minimum.

No diseases of importance were noted at the Station.

CONCLUSIONS
Safflower oil properties fall between those of linseed and soyabean oils. The oil is mainly used in paint manufacture, and to a lesser extent as a linseed oil substitute by the floor covering industry. Because of its low linolenic glyceride content, paints and enamels made from safflower oil show outstanding non-yellowing properties. The oil is particularly suitable for manufacture of alkyd resins which are replacing oil and other resins in enamels.

At present only a small proportion of safflower oil is used for human consumption. However, it has been claimed that because of its high content of unsaturated glycerides, the inclusion of safflower oil in the diet may be of value in maintaining low cholesterol levels in the blood, and consequently reducing the danger of coronary and arterial diseases. If this claim is substantiated a considerable increase in demand for the oil could be anticipated.

The safflower meal or cake left over after the oil is extracted is a valuable livestock feed. The meal made from undecorticated (unhusked) seed contains about 18 per cent. protein. The protein content of decorticated meal is of the order of 35-40 per cent. If safflower cultivation develops in the Kimberleys the impact of locally produced protein-rich concentrate on the local cattle industry may be very considerable.

During the last decade the production of safflower has been rapidly increasing in the U.S.A., mainly in California. Estimated production in 1958 amounted to nearly 150 million lb. In Australia safflower has been tried at several centres, with promising results. However the crop is still only in an experimental stage commercially. Growing safflower in this
country would help to make its paint industry independent of overseas supplies. Conditions of the Kimberley region have been shown to be well suited to production of the crop under irrigation and safflower is likely to be one of the main crops in the early development of the Ord scheme.

ACKNOWLEDGMENTS

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<th>Seed Yield</th>
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