NSW DEPARTMENT OF
PRIMARY INDUSTRIES

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SUNFLOWER PRODUCTION GUIDELINES FOR THE NORTHERN GRAINS REGION

Northern NSW and Southern QLD

INTRODUCTION

The Australian Oilseeds Federation, Australian Sunflower Association and the NSW Department of Primary Industries jointly funded a sunflower project from 2003 to 2006.

The project 'Sunflowers in Northern NSW and Southern Qld – Tools for Success' included benchmarking of 134 commercial crops across these regions supported by strategic replicated trials.

This publication contains the outcomes of the project and other key information for profitable sunflower production.

KEY MANAGEMENT ISSUES

- *Plant into 80–100 cm of wet soil to minimise the risk of crop failure.*
- *Sow monounsaturated sunflowers preferably in spring and polyunsaturated sunflowers in summer (late plant).*
- *Sunflowers are highly suited to no-tillage.*
- *Excess nitrogen causes a reduction in seed oil content whilst insufficient nitrogen will limit crop yields.*
- *The relationship between nitrogen nutrition, starting soil water and target yield is crucial.*
- *Weed control is critical in the first seven weeks after emergence.*
- *Monitor and manage insect pests, in particular Rutherglen bug.*
- *Aim to harvest and deliver grain at 9% moisture.*

SUNFLOWER MARKETING

The main end use for sunflower is oil, for which the receival standard is 40%. Oil production utilises two types of sunflower; monounsaturated and polyunsaturated.

In recent years, there has been a growing demand for monounsaturated sunflower oil although an intrinsic demand remains for polyunsaturated oil. Monounsaturated oil needs to contain more than 85% oleic acid. Mononsaturated oil is used for frying and margarines due to its long shelf life and high temperature cooking stability.

Polyunsaturated sunflower receival standards require linoleic acid contents of more than 62%. This oil is used for margarines, mayonnaise and cooking oils.

Difficulty in meeting domestic demand in recent years has led to attractive, but variable prices. Fixed tonnage and hectare contracts help reduce the risk of price fluctuations for growers.

Several alternative market options exist, including the confectionary/birdseed market and the stockfeed trade. Oil content is not a requirement for these markets. Several buyers for these markets are located in regional centres, which reduces freight costs.

Confectionary sunflowers are dehulled and the kernels used in a variety of products including breakfast foods, biscuits, snack bars and bread. Large seed is required with a minimum of 80% of seed passing over an 8/64 slotted screen. This end-use has specific hybrid preferences so advice should be sought prior to planting as contracts vary seasonally.

Human consumption in the form of whole seeds is an emerging overseas niche market which involves specialty large seeded hybrids.

OIL DEVELOPMENT

Monounsaturated sunflowers are preferably sown in spring, as higher average night temperatures during seed development will enhance oleic acid content.

AOF Australian Oilseeds Federation

Australian Sunflower Association

Polyunsaturated sunflowers are sown in summer as they require cool mean daily temperatures to produce high linoleic acid levels. Sowing in the late planting window ensures seed filling occurs in autumn. Sowing earlier than this, i.e. in spring, usually results in linoleic acid levels in the oil below the required 62%.

ROTATIONAL FIT AND TILLAGE PRACTICES

Sunflowers are highly suited to no-tillage with 68% of paddocks included in this study sown into no-tillage situations. Smaller proportions were minimum tillage (17%) and conventional tillage (15%).

Seeding equipment

The use of precision planters with presswheels aids in more even and uniform crop establishment which is why 72% of crops in the benchmarking study were established by this method. Press wheels aid in seed to soil contact.

Airseeders can be used to sow sunflowers, however seed placement is highly variable, resulting in uneven plant stands which are less efficient at utilising moisture, sunlight and nutrients. Gappy stands allow weeds to establish.

Disc or tyned seeders are suitable for crop establishment but have different applications depending on sowing conditions. Tynes enable moisture seeking (provided good quality seed is used) but cause more soil disturbance leaving a wider seed slot resulting in more rapid moisture loss in the seed furrow than a disc.

Discs cause less disturbance in the seed row and result in the best establishment under ideal conditions, however their performance will be sub-optimal in extremely wet (smearing) or dry (depth limited) conditions.

Crop rotation

The optimum place for sunflower in the rotation is following a cereal to maximise the benefit from an integrated weed and disease management perspective.

Sunflowers are most commonly sown following a long fallow from either wheat or barley. This allows broadleaf weed control in the preceding crop and provides adequate stubble cover to minimise erosion. In the 2005/06 season 51% of paddocks in this survey were sown into this situation.

An alternative is to plant following a short fallow from sorghum, as was the case for 22% of paddocks in the 2005/06 season.

Double cropping is an option in seasons where the soil profile refills quickly, however it is not recommended where stored moisture is limited.

Sunflowers leave the soil softer and more friable than sorghum and also aid in restoring soil structure by breaking up compacted layers.

Stubble cover

Sunflowers leave very little residual ground cover following harvest and the remaining stalks are often difficult to manage due to their high stalk strength and slow breakdown. This results in the need to knock down and break up stubble manually. Stubble breakdown also aids in the release of nutrients such as potassium and nitrogen which are present at high levels in the stover.

PRE-PLANT PLANNING

Soil water

Sunflower yields are highly influenced by the amount of water available during the growing season. This can be supplied in three ways:

1. Starting soil water
2. In crop rainfall
3. Irrigation

The majority of sunflowers are dryland so starting with a full profile of moisture greatly increases the chance of an economic yield.

Planting into 80–100 cm of wet soil is recommended to minimise the risk of crop failure. If there is less than 80 cm of wet soil then it is recommended not to sow sunflowers.

Table 1. Soil water crop lower limits for sunflower in northern NSW.

Depth of soil	Pine Ridge	Tambar Springs	Breeza	Moree	Biniguy	Ashley
0–10 cm	0.25	0.30	0.27	0.27	0.18	0.22
10–30 cm	0.29	0.30	0.26	0.24	0.18	0.24
30–60 cm	0.35	0.35	0.34	0.33	0.20	0.25
60–90 cm	0.38	0.36	0.34	0.31	0.20	0.25
90–120 cm	0.41	0.27	0.30	0.26	0.24	0.30
120–150 cm	0.37	0.34	0.36	0.26	0.25	0.32
150–180 cm	–	–	–	0.26	0.25	0.32
Soil Type	Black Vertosol	Black Vertosol	Black Vertosol	Grey Vertosol	Red Chromosol	Grey Vertosol

Sowing time

Table 2. Suggested sowing times for sunflowers in northern NSW and southern Qld.

Region	Early Plant												Late Plant													
	Aug				Sept				Oct				Nov				Dec				Jan				Feb	
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Goondiwindi, Moree, Narrabri	◁	◁	✳	✳	✳	✳	✳	✳	▷	▷							◁	◁	✳	✳	✳	✳	✳	✳	▷	
Gunnedah, Quirindi					◁	◁	✳	✳	✳	✳	✳	▷	▷				◁	◁	✳	✳	✳	✳	✳	✳	▷	
Southern Queensland			◁	◁	✳	✳	✳	✳	✳	✳	✳	✳	▷				◁	✳	✳	✳	✳	✳	✳	▷		

◁ Earlier than ideal ✳ Optimum sowing time ▷ Later than ideal

Starting soil water should be assessed by either using a push probe or by soil coring and calculating starting plant available water (PAW). From this project, crop lower limits were established for a selection of soils in northern NSW(see Table 1). To calculate PAW refer to Soil Matters (Dalgliesh *et al*).

Sunflowers have a deep taproot which can extract moisture from up to 3 m deep in ideal soil conditions and have a higher soil water extraction ability than many other crops including sorghum and maize. This means that more water can be extracted by sunflowers from the same soil than other crops.

Herbicide plant back considerations

Sunflowers are sensitive to several common residual herbicides including sulfonylureas. Often there can be residues left in the soil from a previous application which may damage the next crop. The plant back period will be affected by the time since application, soil type, herbicide rate and rainfall.

Paddock selection

Sunflower paddocks should be selected to maximise crop performance. This includes identifying paddocks with low broadleaf weed populations. These weeds compete for water, light and nutrients and in-crop control options are limited.

Paddock selection also plays a role in minimising the risk of disease, primarily from Sclerotinia which is hosted by many other broadleaf crops such as chickpea and canola. Under favourable conditions Sclerotinia can build up and cause lodging and head rot in sunflower.

SOWING TIME

Table 2 contains suggested sowing times. Sunflowers have distinct advantages due to the opportunity to plant in two sowing windows. The early plant enables sowing of a percentage of the summer crop before the main sowing window opens. Conversely the late planting window allows double cropping in favourable seasons and the ability to plant after other summer crop sowing windows have closed.

Sowing time will always be a compromise. The early planting window risks frost and low soil temperatures during establishment and heat during flowering/seed fill. The late planting window often experiences extreme temperatures during establishment, whilst sowing after the end of January increases the risk of disease.

This applies to diseases such as Sclerotinia and powdery mildew which are favoured by rain, cool temperatures and/or high humidity. The risk of frost damage and slow crop drydown is also exacerbated for late plantings. Sowing time also influences water use with crops sown later in the spring using more water due to the summer heat.

SUNFLOWER PHENOLOGY

Days to critical growth stages for several commercial sunflower hybrids have been recorded. This information assists in matching hybrid maturity to sowing time. The exact number of days required to reach specific growth stages can vary depending on temperature and moisture. Table 3 should therefore be used as a guide only.

The critical time for heat stress is 12–15 days after flowering; hybrid maturity and planting date should be matched to avoid these high risk periods.

YIELD AND OIL EXPECTATIONS

Sunflower average yield and oil content varies between seasons, however generally higher yields are achieved in the Gunnedah district than in Moree and southern Queensland (Table 4).

As a result nitrogen and gross margin budgeting should be carried out using data for the relevant growing region and incorporate the starting soil water and anticipated in-crop rainfall.

PLANT POPULATION

Established plant population has a large effect on several factors including yield. Establishing more plants than those suggested in Table 5 risks lower yields, as head sizes are smaller and more competition for water occurs. Excessively low plant populations lead to thick stalks which are damaging to machinery and limit potential yield.

Table 3. Days to critical sunflower growth stages.

Hybrid	Region	Days to 4 cm bud	Days to mid flower	Days to petal drop
Hyoleic 41	Moree	74	86	101
	Gunnedah – Early	78	n.d.	n.d.
Ausigold 61	Moree	71	84	109
	Gunnedah – Early	75	90	n.d.
	Gunnedah – Late	n.d.	74	82
Ausigold 62	Moree	71	83	95
	Gunnedah – Early	73	90	n.d.
	Gunnedah – Late	n.d.	70	78
Sunoleic 06	Moree	71	84	97
	Gunnedah – Early	75	92	n.d.
	Gunnedah – Late	n.d.	67	78
Sunbird 7	Moree	65	83	109
	Gunnedah – Early	72	n.d.	n.d.
Hysun 39	Moree	70	82	100
	Gunnedah – Early	76	90	n.d.
	Gunnedah – Late	n.d.	70	n.d.
Advantage	Moree	72	87	97
	Gunnedah– Early	76	n.d.	n.d.
	Gunnedah – Late	n.d.	69	n.d.
Ausigold 4	Moree	72	84	109
	Gunnedah– Early	74	90	n.d.
	Gunnedah – Late	n.d.	67	n.d.

n.d. = No data.

Table 4. Average dryland yield and oil contents (2003–2006).

Region	Average Yield (t/ha)	Yield Range (t/ha)	Average Oil %	Oil % Range
Moree	1.42	0.50–3.00	39.4	30.7–45.8
Gunnedah	1.78	0.58–2.96	39.0	34.5–45.0
Sthn Qld	1.29	0.30–3.33	41.2*	40.0–43.0

* Only includes data from 8 crops.

Table 5. Dryland plant population guide.

Region	Target plant population ('000/ha)
Moree	25–30
Gunnedah	25–35
Southern Qld	25–35

Measured plant populations varied greatly across the three regions as shown in Table 6. Also, plant populations were often much higher than the recommended or targeted population.

Table 6. Measured plant populations (2003–2006).

Region	Average Plant Population (/ha)	Plant Population Range (/ha)
Moree	32,672	16,000–59,000
Gunnedah	38,867	23,000–60,000
Southern Qld	34,415	20,000–54,667

Sowing rates should be calculated to target optimal populations for each region. Sunflower seed has the germination % and the number of seeds per kg marked on each bag. Check the testing date for currency. It is also advisable to plant treated seed to protect against seedling pests and diseases.

Calculating seed requirements

When calculating seed requirements, allow on average 25% for establishment losses. Depending on planting conditions and machinery, losses can range from 10–50%. However you may include your own figure for establishment losses based on experience.

Seed size can also affect established populations as very small seed may allow doubles or triples to be planted in each hole.

Calculating a planting rate (kg/ha):

$$\frac{\text{Target plant population/ha} \times 10{,}000}{\text{Seeds/kg} \times \text{germination \%} \times (100 - \text{establishment loss \%})}$$

Example calculation:

$$\frac{35{,}000 \times 10{,}000}{15{,}000 \times 93 \times (100{-}25)} = 3.35 \text{ kg/ha}$$

NUTRITION

The supply of adequate nutrition to a sunflower crop is of high importance, however in the Northern Grains Region the type and amount of nutrition supplied is highly variable (See Table 8). Table 7 shows nutrient removal in sunflower.

Table 7. Nutrient removal in sunflower.

Yield	1 tonne /ha			2.5 tonne /ha		
Element (kg/ha)	Seed	Stover	Total	Seed	Stover	Total
Nitrogen	26	14	40	60	35	95
Phosphorus	4	1	5	9	3	12
Potassium	8	22	30	18	55	73

Source: The New Big Black Sunflower Pack

Nitrogen

Nitrogen (N) is the major nutrient required by sunflowers and has the greatest impact on characteristics such as the size and number of leaves, seed size and weight, yield and oil content. There is a S and N interaction for many of these factors as well.

Excess nitrogen causes a reduction in oil contents whilst insufficient N will limit crop yield. The challenge is targeting the optimum level. A nitrogen budget helps target optimal yield and oil contents.

Nitrogen fertiliser rates were consistently low in the Moree district, averaging 23 kg N/ha over the three year project. These rates fell well short of those required to meet the district average of 1.4 t/ha. In contrast N rates in the Gunnedah district were consistently high. Southern Queensland crops received on average, enough N for yields of 1.1 t/ha, close to the average yield.

A simple nitrogen budget is calculated as follows:

N removed in seed (kg/ha):

target yield (t/ha) × N removed (kg/t)

N required for crop (kg/ha):

N removed in seed × 1.7

Example:

2 t/ha (target yield) × 26 (kg N removed/t in seed) × 1.7

= 88.4 kg N /ha

Starting soil N can be determined by using previous crop history or a soil test to a depth of at least 1.2 m as it is reasonable to expect sunflowers to extract N to at least this depth unless there are subsoil constraints.

Replicated trials

The effect of N on yield and oil content was evaluated over two seasons at sites in northern NSW. Trials conducted at Pine Ridge on a high starting soil N site demonstrated the effects of excessive N. (Figure 1)

The starting soil N level at this site was 143 kg N/ha, sufficient to achieve 3.3 t/ha. Most of this nitrogen had accumulated as a bulge between 60–120 cm soil depth.

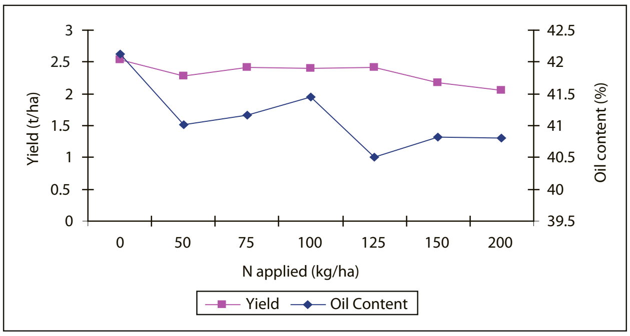


Figure 1. The relationship between N, oil and yield, Pine Ridge Gunnedah 2005/06

This amount of N was in excess of that required for dryland yields. Hence a decline in yield and oil content resulted from all additional N applied.

The relationship between N, starting soil water and target yield is crucial to yield and oil content.

The relationship between optimum yield and oil content was also demonstrated at the Gurley trial site (Figure 2). Starting soil N levels were measured as 52 kg N/ha, sufficient to achieve a yield of 1.2 t/ha.

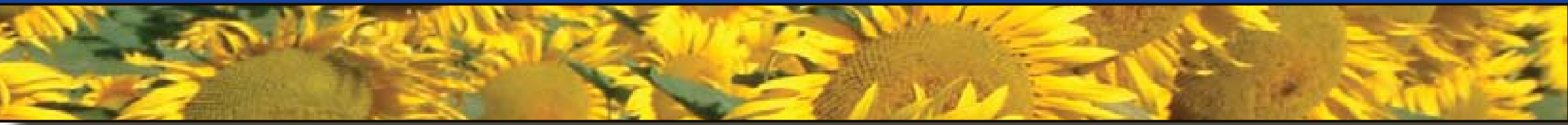
The maximum yield achieved at this site was with the addition of 125 kg N/ha (1.7 t/ha) while the maximum oil content was achieved with no additional nitrogen. Nitrogen application needs to be balanced; at this site 60 kg/ha of additional N would have optimised yield and oil content.

Benchmarking paddocks

Thirty two paddocks were sampled to determine starting soil nitrate levels in 2004/5 and 2005/06. One fifth of paddocks sampled had starting nitrate levels over 200 kg/ha, enough nitrogen to produce 4.6 t/ha, an unattainable yield under dryland conditions.

Table 8. Sunflower nutrition and average fertiliser application in the Northern Grains Region.

Benchmarking year	Average Yield (t/ha)	N (kg/ha)	P (kg/ha)	S (kg/ha)	Zn (kg/ha)	% of paddocks not fertilised
Moree						
2003/04	1.18	7.0	3.2	0.4	0.40	50
2004/05	1.57	15.2	3.6	0.6	0.42	15
2005/06	1.41	31.6	2.2	0.3	0.35	17
Gunnedah						
2003/04	1.66	68.1	2.7	2.7	0.30	10
2004/05	2.22	69.3	7.4	2.8	0.68	5
2005/06	1.47	71.0	4.6	15.3	0.51	6
Southern Queensland						
2003/04	1.58	60.0	6.5	0.7	0.83	0
2004/05	1.01	36.9	2.8	0.8	0.25	10
2005/06	1.25	43.6	3.2	0.9	0.43	20



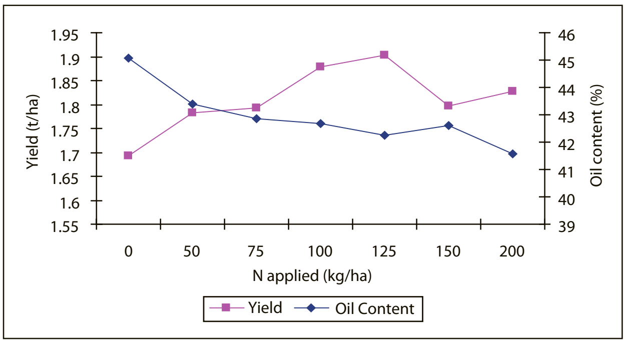


Figure 2. The relationship between N, oil and yield, Gurley Moree 2005/06

As N costs rise, awareness of N quantity and distribution through the soil profile and crop requirements become increasingly important. Not only does too much N negatively impact on oil contents and yields, the gross margin declines.

Sulfur

Sulfur (S) forms important partnerships with N in sunflower production. Together they determine leaf area which provides photosynthates to developing florets and seeds, following through to yield and seed size. Deficiency when combined with N reduces yield as seed weight and the number of seeds per plant declines.

The amount of S removed in the seed of a one tonne crop is 5 kg/ha, with uptake highest between budding and anthesis; a large proportion is also taken up post-anthesis.

Table 9. Sulfur uptake by sunflower.

Growth Stage	% Uptake
Emergence – budding	20
Budding – anthesis	45
Post-anthesis	35

Potassium

Potassium (K) is required for stalk and tissue strength. Sunflowers are a high user of K, with every 1 t/ha yield, removing 30 kg K/ha.

Anecdotal evidence suggests that sunflower stalks release potassium slowly during breakdown having a beneficial effect on following crops such as cotton.

WEED CONTROL AND HERBICIDE USE

Registered herbicide options for use in-crop are limited. So it is important to select paddocks with low weed populations, particularly broadleaf weeds.

Grass weed control options are available but are all Group A herbicides. Due to increasing Group A herbicide resistance, post-emergence options are further reduced.

Avoid paddocks with the following weeds which were noted in the study to be particularly common.

The high incidence of barnyard grass is particularly important due to the recent identification of glyphosate resistance. Volunteer sorghum levels were concerning from a rotational point of view, illustrating the importance of effectively desiccating sorghum crops and fallow grass weed control.

Table 10. Most common weeds in sunflower.

Broadleaf Weeds	Grass Weeds
1. Bladder ketmia	1. Barnyard grass
2. Fleabane	2. Volunteer sorghum
3. Bindweed	
4. Milk thistle	

Only 20% of paddocks in 2004/05 and 13% in the 2003/04 and 2005/06 had nil weeds detected. This indicates the need for better weed control in sunflower.

The large number of weed species detected by the project and the prominence of broadleaf weeds is a reflection of the lack of herbicides available for post-emergence control of weeds and limitations with paddock selection.

Weed competition studies have shown weed control is critical in the first seven weeks following sunflower emergence. High levels of weed competition can reduce early crop biomass by 39% and final yield by 16%.

INSECTS AND INSECTICIDE USE

Seedling pests

The main seedling pests are brown cutworms, wireworms, false wireworms and brown field crickets. Check before planting and during establishment regularly and thoroughly for insect pests. Use insecticide seed dressings where possible and spray when insect populations exceed the economic threshold.

Reproductive stage pests

The two major pests of sunflower are Rutherglen bug (*Nysius vinitor* and *Nysius clevelandensis*) and *Helicoverpa* spp. Green vegetable bugs (*Nezara viridula*) are a secondary pest.

Rutherglen bug (Nysius vinitor)

Monitor and manage insect pests, in particular Rutherglen bug.

Rutherglen bugs reduce sunflower yield and oil content by sucking the developing seed, reducing seed weight and changing oil composition. The critical times to monitor Rutherglen bug populations are at budding and seed fill. Rutherglen bug damage is exacerbated in moisture stressed crops.

Table 11. Thresholds for Rutherglen bug.

Growth Stage	Threshold (adult bugs per plant)	
	Early plant	Late plant
Budding	10–15	30
Seed fill	20–25	30
Confectionary*	5	5

*The threshold is lower for confectionary sunflower due to the need to meet human consumption specifications.

Brown marks on the seed from piercing make confectionary seed visually unattractive. It can be difficult to maintain numbers below the threshold of five adult Rutherglen bugs per plant.

Rutherglen bugs breed up on a wide range of host plants including winter weeds. The life cycle of the Rutherglen bug begins with females laying up to 400 eggs which hatch approximately one week later. The nymphs are wingless, with a pear shaped body and reddish brown in colour. Nymphs develop over three weeks, before gaining wings, changing their shape and size and becoming adults. They have rapid breeding capabilities, which mean 40 adults per plant at flowering can breed up into 1200 nymphs by harvest.

Females use the developing sunflower seed as a protein source to initiate egg laying. Eggs are laid between the seeds and dead florets up to two weeks post flowering. This means a second generation could be mature enough to lay a third generation by the time the crop reaches physiological maturity. Damage can continue until harvest depending on seed hardness.

Understanding the lifecycle of the Rutherglen bug when making spray decisions is helpful. The target is not to allow adults to breed as population explosions will then occur. Adults will not start breeding until a protein source is available i.e. developing sunflower seed. Adults stop breeding in late February.

The most effective pesticides are synthetic pyrethroids which unfortunately have very little residual effect and severely disrupt natural predator populations. As adults are winged, re-infestation can occur rapidly after treatment. If crops require spraying, best results are achieved before the heads turn down towards the ground.

Helicoverpa spp.

There are two species of heliothis which occur in sunflower; *Helicoverpa armigera and Helicoverpa punctigera.* They usually occur from late budding until late seed fill. Heliothis damage sunflowers in three ways:

1. leaf feeding
2. eating florets and developing seeds
3. boring holes into the back of sunflower heads

Sunflower can tolerate large numbers of *Helicoverpa* caterpillars, especially from flowering onwards. There is no significant yield reduction from *Helicoverpa* feeding on leaves, seeds or florets in the absence of secondary head rots. At budding, more than four 5 mm long larvae per head is the threshold for spraying.

Natural mortality rates of 30% for larvae less than 5 mm are common and should be taken into account. Therefore by including expected mortality the threshold for larvae in the 1–5 mm size range is 6 larvae per head.

Select control options that are compatible with the insecticide resistance management strategy for your region. Larvae are difficult to control when they are feeding on the sunflower face and under bracts, especially once the heads turn to face the ground. Crops should therefore be sprayed before the heads turn down.

Green vegetable bug (Nezara viridula)

Green vegetable bugs (GVB) tend to feed on the upper stems and heads and when present in large numbers cause wilting, shrivelling and deformed heads. Occasionally they feed on developing seed. The current threshold is one mature bug or 5th instar nymph per plant.

Females lay 30–130 eggs in a raft on the leaf surface which hatch in 5–21 days and it takes 30 days to progress through the 5 nymphal instars. Adult life spans vary from several weeks to four months, with summer reducing their longevity.

Green vegetable bug have a wide host range and cause damage by sucking sap. If they gather around the peduncle, water and nutrient supply to the developing head will be reduced.

Insecticide use

The benchmarking study indicated a high degree of variability in insecticide application across the regions. Southern Queensland had a consistently lower proportion of insecticide applications, whilst Gunnedah consistently sprayed 50% or more of crops. In the Moree region application was seasonally dependent.

Insecticides are primarily targeted at controlling Rutherglen bugs. Other secondary pests targeted include *Helicoverpa* spp. Insecticde use was dominated by synthetic pyrethroids. Trials carried out by QDPI&F have shown pyrethroids to be the most effective chemical in controlling Rutherglen bugs in sunflowers.

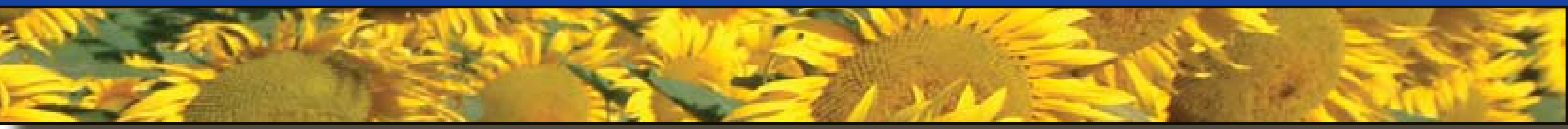
IRRIGATED SUNFLOWERS

Sunflowers are suited to a range of irrigation systems and have a lower water use than other summer crops such as maize, cotton and soybean.

Sunflowers have a relatively low water demand until 10 days after buds are visible. Demand then increases dramatically until approximately 26 days after 50% flowering, but water is required through until maturity.

During the vegetative stages water stress does not significantly affect sunflower yield potential and in most cases delaying irrigation will increase the harvest index. The top third of leaves contribute the most to yield.

Research conducted in the USA suggests that maximum yield and highest water use efficiency is obtained from three irrigations timed to coincide with pre-planting, budding and petal drop. In limited irrigation systems, irrigating preplant and at full bloom optimises yield potential and total water use (Table 10).



Irrigation scheduling depends on three factors:

1. Extractable soil water capacity (ESW) (mm/m of soil)
2. Daily evaporation rates (pan evaporation in mm/day)
3. Effective rainfall (in-crop)

The optimal irrigation interval is the time taken for the crop to use 50% of the ESW (may be 60–65% in limited irrigation situations). Daily root growth at a rate of 3.2 to 3.5 cm per day is also a consideration.

Irrigating prior to planting or starting with a full profile should provide sufficient moisture to avoid crop stress until after bud initiation.

Table 10. Irrigation scheduling for sunflower.

No of irrigations available	Growth stage for application
1	Pre-plant
2	Pre-plant and full bloom
3	Pre-plant, budding and petal drop

Crops should be monitored to ensure excessive moisture stress does not occur. Sunflowers may show signs of moisture stress (wilting) up until bud initiation during the heat of the day but should recover at night. Irrigation should commence if they do not recover in the evenings.

HARVEST

Identification of physiological maturity

Physiological maturity signifies when the maximum seed weight has been reached. The crop can then be harvested at any time, however sufficient drydown needs to occur to reach a moisture content suitable for storage or delivery.

Physiological maturity is identified when the bracts surrounding the sunflower head change to brown, preceding this they will change from green to yellow and eventually to brown. The seed moisture content at physiological maturity is usually between 30–40% and the crop is suitable for desiccation to aid in quicker drydown.

Harvest timing

The receival standard for moisture is 9%, however often crops are not harvested until the moisture content is much lower, around 5–6%. This is lost yield. *Aim to harvest and deliver as close as possible to 9% moisture.*

A survey of 48 sunflower crops grown during 2005/06 showed that the average moisture at delivery was 7% which is a loss of 2 tonne in 100 tonnes. The moisture ranged from 4.5–12 %.

Conversely harvesting above 9% moisture means storage of sunflowers is potentially dangerous due to the risk of fire in the silo and downgrading due to mould.

Harvesting at low moisture contents (< 6%) may cause an increase in admixture as the plant stalks and heads become dry and brittle, shattering easily into small pieces. This added trash is difficult to separate by grading and penalties apply for excess admixture.

Header set up

Conventional headers need alterations to harvest sunflowers effectively. The most common changes include:

Sunflower trays – are attached below the cutter bar to catch sunflower seeds falling out of the heads during the harvesting process.

Sullivan reel and headsnatcher – are designed to minimise the amount of plant material entering the front reducing potential contamination. Both remove the sunflower head just below the peduncle, causing minimal disturbance to the rest of the plant. These modifications allow the ability to harvest at higher moisture contents and whilst some green leaf remains.

Prior to commencing harvest, fan and concave settings should be adjusted to ensure sunflower heads are properly threshed, retaining the maximum amount of seed and the least amount of trash.

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