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Profitable canola production in the northern grainbelt of Western Australia 2001

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PROFITABLE CANOLA PRODUCTION IN THE NORTHERN GRAINBELT OF WESTERN AUSTRALIA 2001

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Profitable canola production in the northern grainbelt of Western Australia 2001

CONTENTS

The adaptable Brassica for the north

Canola is a member of the Brassicaceae family that also includes mustard, turnip, wild radish, cauliflower, cabbage and broccoli.

It is a winter growing oilseed that can be produced in most arable areas of Australia where winter crops are currently grown. Originally known as rapeseed using the varieties *B. campestris*, the varieties of *B. napus* have almost completely replaced this earlier variety in all the areas where the crop is grown.

The swing to *B. napus* varieties was due to their superior yields, resistance to blackleg and better quality oil and meal. Canola can be grown on a wide variety of soil types, and is best in areas where spring rains are reliable and high in order to allow it to reach maximum potential yield. It is not as drought tolerant as wheat, thus requiring good conserved moisture or good finishing rains. Canola requires an average annual rainfall of at least 450 mm, however experience has shown that the crop can be viable in areas with an annual rainfall down to less than 325 mm.

Canola production in the northern grainbelt

Canola in the Northern Agricultural Region is relatively easy to grow provided a few simple rules are adhered to. Canola is an excellent break crop for cereals from the wheat/lupin rotation. The net effect of this is that the average profit of the cropping enterprise can be increased and the area of low returning lupins when canola is included in the rotation. Phase pasture management will also play an important role in maintaining the fertility of soils for sustain canola-wheat rotations in the north. The introduction of higher yielding triazine tolerant varieties and IT varieties has strengthened this advantage.

Canola production throughout the State has increased rapidly grown over the last 3 years with production in the Northern shires being the one region which can experience big fluctuations in production. In 1997 going from modest 46,000 tonnes for over 250,000 tonnes in 1999. The northern grainbelt produced 20 per cent of the State's crop in 1999.

The driving force behind this increase in area can be attributed to early breaks to the season and the successful adoption of Triazine Tolerant Canola variety Karoo and more recently Surpass501TT. For the northern grainbelt canola is seen as an opportunistic crop and can be sown on a large scale if opening rains permit, especially in eastern parts.

The most limiting factor for canola in the northern grainbelt is timing of opening rainfall and high temperature during pod fill. How we manage this main limiting factor in the north is the key to growing profitable canola in this region. Other limiting factors such as radish, soil acidity, fertiliser timing, blackleg disease, insect pests and harvest management all play a critical role in this profitability.

To produce canola and realise its full yield potential in this difficult environment, means all factors with in our control need to be optimised, otherwise yields will be decreased by the lowest factor.

These production factors are interdependent. If one factor is changed, the other factors will be affected. For example, when introducing early sowing of TT canola, we found that it triggered many changes in our growing practice.

For the purpose of this package the northern grainbelt includes the shires of Northampton, Greenough, Mingenew, Mullewa, Morawa, Coorow, Carnamah, Perenjori, Kalannie, Wongan Hills, Moora, Victoria Plains and Dalwallinu.

The purpose of the Regional Canola Package is to provide growers at a district level with an easy to follow overview of the best management practices for canola in the northern grainbelt.

It also is complements the Growing Golden Canola Manual which as a more detail reference guide on all aspects of canola research and development in Western Australia.

Order forms for this manual are available from you AGWEST office or contact AGWEST Information Resource 08 9368 3729.

Canola profitability in the Northern Agricultural Region

Profitability depends on many factors, such as the cost of total inputs, date of emergence, plant population, rainfall, soil type, occurrence of frost or hail, cost of transport, presence of insects or disease and net price received.

Tables 1 provide an indication of potential gross margins for canola at different yields and canola prices. Tables 2 shows the break even yields of canola at varying costs and canola prices.

Gross Margins of canola grown in the High (450 > mm) Medium (325-450 mm) and Low Rainfall Zone (< 325 mm), (42% oil and nil admixture).

Table 1a. Gross margin of canola ($/ha) [input cost = $285/ha] grown in the high (450-750 mm) and medium (325-450 mm) rainfall zones (42% oil)

Canola price ($/t net on farm)					
Yield (t/ha)	**275**	**300**	**325**	**350**	**375**
0.8	-65	-45	-25	-5	15
1.0	-10	15	40	65	90
1.2	45	75	105	135	165
1.4	110	135	170	205	240
1.6	155	185	235	275	315

Sensitivity analysis allows for a quick overview into how price and yield affects the Gross Margin.

Table 1b. Breakeven yields of canola at varying variable costs and canola price

Breakeven yields Variable cost	**Canola price ($/t net on farm)**				
	275	**300**	**325**	**350**	**375**
180	0.65	0.60	0.55	0.50	0.48
200	0.73	0.66	0.62	0.57	0.53
220	0.8	0.73	0.67	0.63	0.59
280	1.02	0.93	0.86	0.80	0.75

Table 1c. Actual five year average yields of canola based deliveries to CBH

Canola area and average yield based on deliveries to CBH northern wheatbelt			
Shire	**Ha planted 2000**	**2000 average yield**	**5 year average yield**
Northampton	1,991	0.5	0.8
Chapman Valley	5,481	0.8	1.02
Mullewa	15,308	0.3	0.46
Greenough	3,567	1.0	0.77
Mingenew	6,672	0.5	0.59
Irwin	1,285	0.7	0.84
Morawa	9,311	0.3	0.41
Perenjori	7,619	0.44	0.5
Three Springs	4,265	0.6	0.9
Coorow	7,924	0.49	1.06
Dalwallinu	8,925	0.4	0.5
Geraldton Port zone average		0.66	0.75

With average variable costs of $240/ha, the breakeven yield of canola at a net cash price of $320/t is 0.75 t/ha. Canola is a highly profitable crop but must be used opportunistically to achieve long term profitability.

Regional practicalities for canola in northern grainbelt

Sow canola early to achieve a longer vegetative period. This gives higher yields and oil contents. Recent years have seen the most profitable crops sown mid-April to mid-May. Delayed sowing from mid-May onward, depending on variety, will see yields and oil decline dramatically. Short season varieties can be sown later in May and into June depending on variety and location.

- Canola is sensitive to insects at the seedling stage because of its exposed growing tip.
- Generally, on better soils apply nitrogen 70 per cent at seeding and 30 per cent as the crop develops to full ground cover. Change to 50/50 on light soils in the high rainfall zone.
- Choose variety according to sowing time and expected season length, i.e. quick maturing varieties in the far northern and eastern areas where the season cuts off very quickly, longer season varieties for the earlier sowing closer to the cost.
- Check the quality of any retained seed as seed vigour will be important for rapid crop emergence. Adjust seeding rates accordingly. The larger seed size results in a more vigorous seedling resulting in improved establishment.
- The continuous flowering of canola can compensate for aphid damage. In a quick dry finish plants will not be able to withstand the same insect pressure as a soft finish. For this reason economic damage may be encountered at a lower yield threshold where the end of season is very warm.
- Swathing canola at 60 to 70 per cent seed colour change (when seed moisture is 30 to 35 per cent) minimises the risk of shattering losses. Frequent strong winds and hot conditions during September and early October along the costal regions increase the risk of shattering.
- Direct harvest canola when it is unlikely that breakeven yield be achieved and the crop can be harvested within four to five days.

Canola essentials - northern area

Paddock selection

Paddock selection is critical for a successful canola crop. Avoid paddocks with prolonged waterlogging and wind erosion. TT canola can be sown in paddocks with high broadleaf weed burdens - particularly wild radish, turnip, mustard and doublegee, brome grass and silver grass. Ryegrass and radish populations exist that are resistant to triazines (Group C resistance).

Soil type

Canola grows well on most soil types, however, it prefers well-drained gravel soils, red loams, sandy loams and deeper duplex soils. Soil test paddock for pH, phosphorus, sulphur and potassium levels.

Yields have generally been very low on poor white to grey sands and non-wetting soil types. Non-wetting soils require consistent rainfall to keep the soil surface wet enough for the seed to germinate.

Warm temperatures and frequent strong winds during April and early May dry out the soil surface very quickly, reducing moisture available for germination. Such winds often frustrate seed depth when erosion causes furrow fill, especially on sandplain. Canola emergence is very sensitive to poor depth control.

Canola yields will be poor on light soils with a pH less than 4.7 in $CaCl_2$. Yield responses have occurred from liming in the first season. Soils with pH below 4.7 should be limed at least one year prior to sowing canola.

Preferred soil types are deep yellow sand plain, red loams of Northampton, stronger Mingenew sand plain soils, Yuna sandplain and the gravel soils in the Western Midlands.

Rotation

The main rotational advantage of canola in NAR is the ability to rotate herbicide groups and grow a profitable break crop following pasture, legume or cereal crops, without severe pasture manipulation in the previous year. Growing canola following lupins should be avoided due to the risk of increased Group C herbicide resistance, and the opportunity cost of sacrificing returns from wheat after lupins. Wind erosion is more risky when sowing canola onto lupin stubbles on the lighter soils, and control of volunteer lupins is expensive.

Most canola in the Northern Agricultural region is sown onto wheat stubbles, which have been in a continuous wheat/lupin rotation. The most common rotation is L/W/C/W. Longer rotations containing a higher percentage of cereals are profitable, provided adequate weed control can be maintained. Inadequate grass weed control is the main reason for the failure of long rotations.

Avoid growing canola in the same paddock with less than three years between canola crops for the management of Blackleg.

Options for rotations include:

L/W/C/W	lupins/wheat/canola/wheat
L/C/W/W	lupins/canola/wheat/wheat
L/C/W/W	lupins/canola/wheat/wheat
P/C/W/B/P/C	pasture/canola/wheat/barley/pasture/canola (3 years break)
P/C/W/L/O or B/P/C	pasture/canola/wheat/lupins/oats or barley/pasture/canola (4 years break)
P/C/W/L/B/O/P/C	pasture/canola/wheat/lupins/barley/oats/pasture/canola (5 years break)

Profit depends on the yields of all crops in the rotation, the effects they have on the stock enterprise and the area planted to lupins.

The Rotational Gross Margins of some expected canola rotations compared with a typical wheat/lupin using average input costs and average yields from the northern grainbelt.

Paddock preparation

Reduce the stubble levels or summer weed residues before seeding canola as germination can be reduced by the leachate produced by residues. Cereal stubbles for dry seeding is preferred on light sandy surfaced soils where wind erosion is possible to minimise sand blasting of seedlings. Furrow sowing should be used on non-wetting sandy soils to conserve moisture and assist germination. Seed-soil contact can be problematic when sowing into very high levels of stubble with the incorrect machine. Press wheels and precision placement of seed such as the DBS will improve establishment if conditions are non-ideal. Furrow fill has the ability to drastically reduce the establishment percentage on light soils with little stubble cover if strong winds or heavy rainfall is received soon after sowing.

Time of sowing

Time of sowing should be as early as the season permits, but NOT before the beginning of April. Maximise the opportunity to use a knockdown herbicide wherever possible before seeding canola. Weeds can reduce yield potential dramatically.

March sown crops have been tried with varied success as the risk of long dry spells during April/May can be high in addition to the added risk of increased warm season insect activity. Very early sowing should only be considered if very good sub soil moisture is present. There has been very high insect

pressure on March sown canola crops including Cabbage Moth, Pasture Looper and Weed Web Moth).

Date of emergence correlates strongly with canola yield and oil content. Studies from 1997 through to 1999 have show that canola yield has a very significant response to time of sowing. As a general rule of thumb, canola typically will suffer a yield loss of five per cent for every week delay in seeding from the beginning of April. Beyond the end of May any delay in seeding will suffer an even greater yield penalties of up to 10 per cent per week.

Table 2. Effect of sowing date on canola yield and oil content, Merredin 1997

	Yields (kg/ha)			Oil content (% @ 8.5% mc)		
Sowing date	**26 April**	**9 June**	**23 June**	**26 April**	**9 June**	**23 June**
Monty	1014	815	448	44	41	41
Karoo	856	606	259	39	37	36
Hyola 42	1015	888	437	43	40	39

Latest date to sow canola

Oil contents can be seriously affected by a delay in seeding. A strong correlation between average rainfall post anthesis (when 10 per cent of petals remain) and the oil content of canola has been found. By using the mean oilseed content achieved by the four main varieties sown in trials during 1997 and 1998 we are able calculate this relationship to develop a crude rule of thumb for the last date to sow. From the actual results of the 1997 trials, the empirical data suggests in the North and Central areas, 42 per cent oil would occur for Karoo sown about 15 May and achieve a yield of about 1.5 t/ha. If sown on 7 June, Karoo would have achieved a 39 per cent oil content with a yield of 1-1.25 t/ha. Looking at Pinnacle in the high rainfall environment of Mt Barker during the same year it would give 42 per cent oil content sown as late as the beginning of July.

The average daily mean temperatures during pod maturation stage has also a major influence upon oil content of canola. Earlier sown crops will mature in cooler conditions allowing high oil contents. Below is a summary of what are the last dates to sow the Karoo to achieve on average 42 per cent oil content or better. Karoo is a longer maturing variety compared with Hyola 42 and so must be sown earlier to have its flowering and seed formation in the cooler period.

Canola is sensitive to severe frost and frost prone areas should be avoided where possible when sowing early. However compared to cereals it is more tolerant because of its extended flowering period. Refer to the Pulse and Canola Frost Guide for more details.

Table 3. By using the relationship between yield, oil content per cent and post-anthesis rainfall for 1997 and 1998 we are able to crudely predict the following last dates to plant Karoo to achieve 40 per cent oil at 8.5 per cent moisture

Mingenew	Karoo	2 June
Wongan Hills	Karoo	30 May
Merredin	Karoo	1 May

To achieve 40 per cent oil requires at least 100 mm post-anthesis rain on a loamy sandy soil, naturally there will be significant varietal difference but for these calculations we have used Karoo. The effect of stored moisture has not been researched. Refer also to the Graphs on page 16 of this package.

Seeding rate

Canola is a very flexible crop, in that the variations in population over a relatively wide range normally have little effect on the final yield. Canola will branch to fill in spaces in the crop.

Local and Canadian studies demonstrate that populations ranging from 60 to 200 plants per square metre result in similar yields. Trials at Merredin have shown that optimal plant numbers for Karoo range between 50 and 90 plants per metre square using 5 kg/ha of seed with conventional seeding techniques.

The current canola varieties are large seeded with a range of about 250,000 to 320,000 seeds/kg. **Five kilogram per hectare** canola will give 140-160 seeds per square metre. Establishment efficiency for canola using a knife point and rotary harrow system is generally 40 to 60 per cent.

Using an average field germination of 60 per cent and a recommended seeding rate of 5 kg/ha with knife points and conventional harrowing systems you should be on the right track.

Rule of thumb:
A canola population in the northern grainbelt between 50-60 plants/m^2 (assessing 30 days after emergence) in an even distribution will result in a maximum yield.

Maximum emergence is important, as canola seedlings are small and prone to insect and wind damage. If the target density is not reached amend the seeding technology instead of increasing the seeding rate. If a portion of a crop fails due to poor establishment from seedling damage, reseeding is rarely profitable, as the delay in emergence of the new crop results in low yield and oil content. There is often a second germination of seed from the original seeding that will germinate with the reseeded crop causing excessive crop density.

Plant distribution/tine width

Even seed and plant distribution will help maximise yield and provide better weed competition. This is particularly true in the dry short growing season of the NAR. Row spacing is important for trash clearance and trash is important for improving moisture conservation and reducing wind and rain erosion.

Canola seed yields are affected by increased row spacing. For every inch wider than 7 inches yield can decline by 2 per cent. However this can be easily compensated by reduction in weed seed disturbance and increased moisture conservation that wider row spacing can generate. Precision seeding does pay off. Row spacings between 6 and 14 inches will in most situations generate a satisfactory spread of plants to maximise yield.

Dry sowing of canola

Dry sowing of canola has been a successful adoption to the farming system in the NAR. Although not advisable, the practice has allowed the early seeding (early April) of canola before lupins. Triazine Tolerant (TT) varieties should be sown deeper (3-4 cm) when sown dry, and a maximum of 10 units of nitrogenous fertiliser sown with the seed. This becomes more critical on dry lighter soils as toxicity problems increase. If possible separate seed and fertiliser. Increase the seeding rate to 6-10 kg/ha, for conventional machines or 4-6 kg/ha for No-till machines. Use the higher seed rate on light non wetting soils.

Apply a bare earth insecticide treatment PSPE immediately after opening rains. Early sowing of canola into partial moisture results in canola emerging as the first green growth for the season. The crop becomes a haven for any warm season insects, and this problem becomes worse when there has been summer. Early sown crops are high risk if left unchecked.

To leave options open canola can be dry sown with out applying pre-emergent Atrazine. If opening rain arrives too late for canola to be profitable an alternative crop such as barley can be sown. If it is decided that the rain has come early enough and the chances of an economical canola crop still exist then the Atrazine can be applied immediately after the first rain along with a bare earth insecticide.

Seed quality

The most expensive seed is seed that does not perform. Agriculture Western Australia advises growers to renew canola seed every year with quality assured seed, or at least every second year.

Purchasing canola seed from seed companies ensures that the seed meets the standard requirements, i.e. it comes from controlled and inspected paddocks and also been tested for germination, weeds and other foreign seeds. If you intend retaining your own seed, then it should be graded heavily to maximise seed size and tested for germination and weed seeds.

Canola is able to cross-pollinate with neighbouring plants. The longer that seed is retained on farm, the more outcrossing occurs and genetic segregation produces 'off' type plants. These off type plants can differ in grain quality and maturity from the main population of canola plants in a paddock. There is also an increased risk of weed seed contamination, poor germination and disease infection with retained seed. Many growers store their seed in bags or Bulka-Bags to minimise viability losses due to over heating and sterilisation. Seed that has been stored for more than one-year will suffer reduced germination percentage. Always conduct a germination test.

Ideal seedbed

Canola seed sown to a depth of 12-25 mm into a firm, moist seedbed germinates rapidly with a high percentage of emergence. On sandy soils or in environments where the topsoil dries quickly, planting can be slightly deeper, around 30 mm. Large seed will also help when sowing deeper.

Local and Canadian studies show increasing seeding depth to 50-75 mm results in poor emergence, reduced root, seedling and plant growth, seedling disease, and reduced yields. Canola seeds do not have sufficient stored energy to push their cotyledons to the surface from depth at which cereals are normally sown. If sufficient moisture is not available at the 50 mm depth, then the best practise is to shallow (dry) seed and wait for further rain.

Seeding technique

Knife points and triple disc seeders give excellent establishment where press wheels are used to control seeding depth and provide soil-seed contact. On sandy soils under marginal moisture conditions, use a light roller or press wheels to maximise seedling emergence. When broadcasting and harrowing in, or direct drilling on light sandy soils increase seeding rates by 10% for better establishment.

Seeding and planting equipment

Canola can be seeded satisfactorily with a range of equipment. The seeder must do the following:

- Open a furrow into sufficient moisture (except when dry seeding).
- Place the seed at a uniform depth on a firm seedbed.
- Accurately meter the seed in each run.
- Cover the seed with soil.
- Pack the soil around the seeds ensuring good seed soil contact.

The 'knife point press wheel' machine fulfils the above requirements whereas the 'full cut finger harrow' combine rarely does. The 'full cut' technique is an inadequate way to establish early sown crops in the northern grainbelt as it will cause the seed bed to dry out rapidly and result in variable establishment and emergence. Full cut cultivation on light soils dramatically increase the risk of wind erosion causing furrow fill or sand blasting.

Note: Canola favours deep drained soils. To make the hard pan soils penetrable for the root system it can be important to deep rip the paddocks after a long term pasture phase. Canola, like wheat is very responsive to deep ripped soils. A machine that provides minimal surface disturbance while ripping deep below the seed encourages fast deep root growth.

It is important to achieve a good seed soil contact to maximise germination, this can be attained through several methods. A home made levelling bar would do and in the case of stubble, use tyre rollers. These methods prevent slicing of the soil and cloddiness on heavier soil. This can also be beneficial in weed control in the case of either pre and post emergent herbicides.

Canola varieties

INTRODUCTION

The word **'canola'** comes from the words **Can**ada and **ol**eic fatty **a**cid.

Canola has good yield and quality oil (less than two per cent erucic acid content), compared to *Brassica rapa*/Polish rapeseed with 23.5 per cent erucic acid content and to *Brassica napus*/Argentine rapeseed with 40 per cent erucic acid content. Canola varieties contain less than 30 micromoles of glucosinolates per gram of air-dried oil-free meal.

Most plants of the Cruciferae/mustard family contain glucosinolates, which are responsible for odour or sometimes palatability problems. **Glucosinolate content is high in the weed species of the Cruciferae family like wild turnip, wild radish**. Apart from being highly competitive weeds in canola these weeds are also serious contaminants of the harvested seed.

Canola variety decisions for 2001 is more complex with many new varieties to consider. Also the advent of seed and chemical variety packages like the CLEARFIELD system in 2000 adds to the growers choice. The past 2 years have seen a total of 25 new canola varieties released, including nine triazine tolerant (TT) varieties and four imidazolinone tolerant (CLEARFIELD) canola lines. As always management decisions will far out weigh any choice over variety. The critical factors to check when making a decision about varieties are; their relative maturities, resistance to disease and yield and oil content. All are genetically determined with the exception of the last two, where management and the environment can have a major effect.

OIL AND PROTEIN CONTENT

The oil is the most valuable component of canola seed and is directly influenced by the variety and the environment. The longer maturing varieties generally have higher oil contents than short season varieties and non-TT varieties have higher oil content that TT varieties.

Recent results have shown that apart from variety it is temperature and rainfall during flowering and pod fill are the second most important aspect affecting oil content.

Protein concentration in the meal which remains after extracting the oil is also important to the market because higher protein content makes it easier and more profitable to dispose of the meal as animal feed.

There is an inverse relationship in the seed between oil and protein concentration, as the protein increases the oil tends to fall. However, this is not always true and the plant breeders have begun to select varieties having both increased oil and protein.

DISEASE RESISTANCE

Resistance to the fungal disease called blackleg is the prime selection criteria for any new varieties released because blackleg is the most prevalent disease of canola in Australia. Current varieties vary in their levels of resistance to blackleg. Recent changes to the national variety registration system (ACARS) has seen the introduction of a national rating system for blackleg based on both seedling survival and stem canker ranking. In Western Australia we have been using the latter of these two for many years and it gives us an understanding of a varieties capacity to withstand the disease through to pod maturity. The higher the rating the better the resistance. However there was no measure of the number of plant survival. An additional measure has been introduced to include this year. In the Tables 4, the figures in brackets represents the new WA Blackleg Resistance Rating for canola varieties.

For more information on this, refer to Farmnote No. 139/2000: *Blackleg canker rating on canola varieties for 2001, and* Bulletin 4480, *Managing Blackleg,* for more information on managing blackleg disease in canola.

TRIAZINE TOLERANT VARIETIES

Triazine tolerant (TT) canola varieties are less energy efficient than non triazine tolerant canola and yield from 10 to 30% less. However, the better weed management these varieties allow growers to achieve with early sowing overrides this physiological disadvantage in yield. These varieties should be considered for early sowing and where there are problems with herbicide resistant weeds (e.g. SU, DIM and FOP resistant ryegrass), silver grass, water weeds, radish, mustard and turnip.

The genetic resistance to triazine herbicide in TT canola varieties was developed from naturally mutated plants found in Canada and can not be transferred by the pollen.

Refer to 'Best Management Practice for the use of Atrazine in TT canola', In the 'Weed Management' section of *Growing Golden Canola* manual.

VARIETIES TABLE

Table 4a. Triazine Tolerant (TT canola) varieties (Blackleg canker ranking according to WA standards)

Bugle	A new medium-maturity triazine tolerant variety from Ag-Seed Research. Higher oil content than Clancy and Drum. Suited to medium or medium-high rainfall zones, and has higher blackleg resistance than Hylite 200TT and Karoo (6). May be phased out in favour of Hyden.
Clancy	A mid-late season variety with improved blackleg resistance and yield over Drum but lower than Pinnacle. Only suited to the very high rainfall southern parts of the northern grainbelt (6).
Drum	Medium/early maturing variety with higher blackleg resistance than Karoo (6).
Hyden*	Medium-early maturity triazine tolerant variety from AgSeed Research. Flowers about 5 days later then Karoo, with higher blackleg resistance than Hylite 200TT and Karoo, and higher average oil content than Karoo. Suited to medium to low rainfall areas (5.5).
Hylite 200TT	A very early maturing variety with apetalous flowers (very few yellow petals) which increases the amount of light transmitted through the crop canopy. Higher oil and protein than Karoo. Probably being replaced by Surpass 300TT.
Karoo	Early maturing variety that performs well in the low-medium rainfall zones in Western Australia and has moderate blackleg resistance (4).
Pinnacle	Medium-late maturing variety with high yields and high-level blackleg resistance. Suited to the medium-high rainfall areas (6).
Surpass 300TT*	An early maturing TT canola by Pacific Seeds, first tested in WA this season. Looks very promising for low rainfall regions or late sowing (4).
Surpass 501TT*	A mid to early variety from Pacific Seeds, with the highest blackleg resistance available. Trial data from 1999 and 2000 have shown it to out yield Karoo by 5-15%. Has preformed well in the north of the State and is well suited to the mid and low rainfall regions. Surpass 501TT flowers 6-10 days later than Karoo (8+).
Surpass 600TT	Mid-late maturity triazine tolerant variety from Pacific Seeds, with high yield and oil content potential. Better blackleg resistance than Karoo (5).
TM 8	Medium-late maturity triazine tolerant variety from Agriculture Victoria. Similar maturity to Clancy, with higher blackleg resistance than Hylite 200TT and Karoo. Suited to medium to high rainfall areas (5).

* New varieties 2001.

Table 4b. Imidazolinone tolerant (CLEARFIELD) varieties

Pioneer 44C71	Medium maturity CLEARFIELD variety from Pioneer Seeds, available from CLEARFIELD accredited outlets. Medium blackleg resistance, and suited to areas where Karoo or Monty has been grown. Similar oil content to Monty (4).
Pioneer 44C73*	Early/medium maturity CLEARFIELD variety from Pioneer Seeds, available from CLEARFIELD accredited outlets. Medium blackleg resistance, and suited to areas where Karoo or Monty has been grown. Similar oil content to Monty (4).
Pioneer 46C72	Late maturity CLEARFIELD variety from Pioneer Seeds, available from CLEARFIELD accredited outlets. Moderate blackleg resistance, suited to medium to high rainfall areas. Higher oil content than Oscar. Considered to long seasoned for the northern grainbelt (3).
Pioneer 46C74*	Medium-late maturity CLEARFIELD variety from Pioneer Seeds, available from CLEARFIELD accredited outlets. Moderate blackleg resistance, suited to medium to high rainfall areas. Similar maturity and higher oil content than Pinnacle. More suited to the southern parts of the State with a longer growing season (3).
Surpass 402CL*	Early-mid-season maturity CLEARFIELD variety from Pacific Seeds, available from CLEARFIELD accredited outlets. High blackleg resistance, suited to medium to low rainfall areas. Higher oil content than Karoo or Mystic (7).
Surpass 603CL*	Mid-late maturity CLEARFIELD variety from Pacific Seeds, available from CLEARFIELD accredited outlets. High blackleg resistance, and suited to areas where Pinnacle has been grown. Higher oil content than Pinnacle or Oscar. Long seasoned more suited to the southern parts of the State (7).

* New varieties 2001.

PERFORMANCE OF NEW CANOLA VARIETIES IN AGWEST VARIETY TRIALS IN 2000

Over the past two years a great number of new canola varieties have been released. The 2000 season was difficult for crop performance and yield comparisons, with in most regions a late start to seeding, low rainfall during the season plus the damage to crops by insects, particularly in the northern region.

This summary records the relative performances of the new varieties in the season 2000, performances that have been influenced by interaction between variety maturity and low rainfall. In other years of better rainfall and earlier sowing, the performances of yield and oil may alter, especially in favour of the mid-maturity varieties.

Table 5a. Characteristics of triazine tolerant varieties

Variety	Height	Maturity	Oil concentration (1, low-9, high)	AGWEST blackleg rating[1]
Hylite 200TT	Short	Early	7	2
Surpass 300TT	Medium-short	Early	7	N/A[2]
ATR-Hyden	Medium	Early-medium	6	5P
Surpass 501TT	Medium	Early-medium	7	8+
Beacon	Medium	Early-medium	6	4P
Surpass 600TT	Tall	Medium-late	7	5
TM 8	Medium	Medium-late	6	5P
ATR-Grace	Medium	Late	6	N/A
Karoo	Medium-short	Early-medium	5	4

[1] The AGWEST ratings for resistance to blackleg combines both the plant survival and stem canker scores. 1 = highly susceptible, 8+ = highly resistant.

[2] Surpass 300TT has shown poor plant survival scores, select with caution.
N/A; Rating not available because of insufficient data.
P; Rating is Provisional, based on a minimum of data.

Table 5b. Characteristics of imidazolinone tolerant varieties in comparison with Karoo

Variety	Height	Maturity	Oil concentration (1-9; low-high)	AGWEST blackleg rating*
Surpass 402CL	Medium-tall	Early-medium	*	8+
44C73		Early-medium	7	N/A
Surpass 603CL	Medium	Medium	*	8+
44C71	Medium-short	Medium	6	4
46C72	Medium- short	Medium	7	4
46C74		Medium-late	6	N/A
Karoo	Medium- short	Early-medium	5	4

* High oil potential.

The Surpass lines have been bred by Pacific Seeds and appear to be well suited to the warmer, faster-growing region of the NAR. Variety trials show the performance of the Surpass lines is superior in the more northern regions of the State.

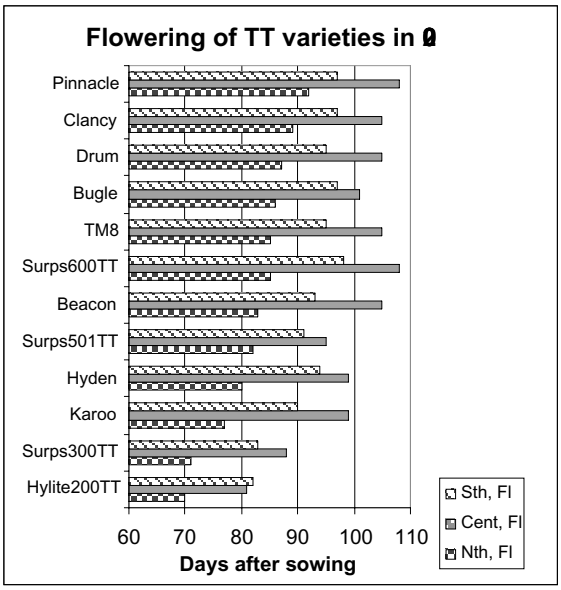


Figure 1. Comparative flowering dates for TT varieties in WA.

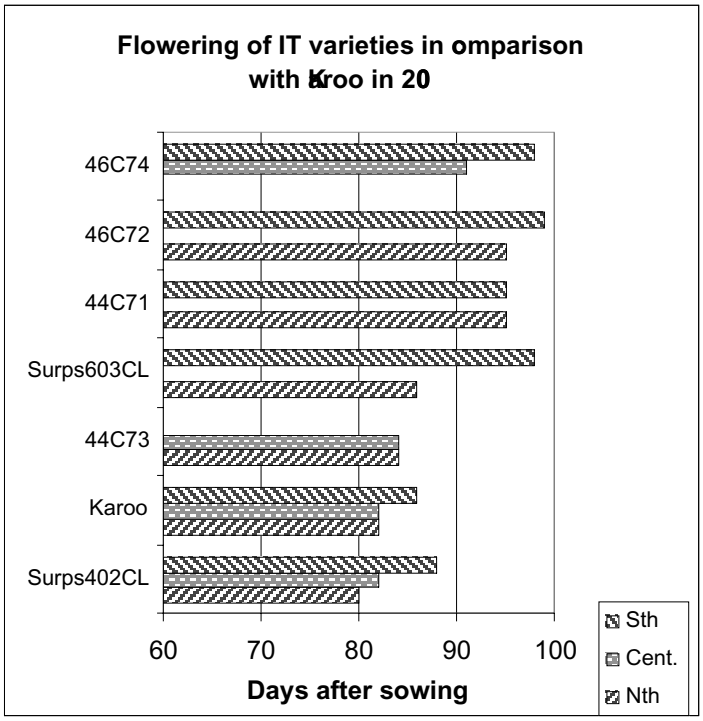


Figure 2. Comparative flowering dates for IT varieties in WA.

Data provided by Graham Walton, Senior Research Officer, South Perth.

A summary of the yield of varieties is presented in Table 6 as relative (percentage of) to Karoo for the herbicide resistant varieties The yields are grouped into geographic regions and average annual rainfall zones.

Table 6. Triazine tolerant varieties in the Northern and Central region

Variety	Northern			Central		
	High	Medium	Low	High	Medium	Low
Karoo	100	100	100	100	100	100
Beacon	100	100	79	118	102	101
Hyden	121	101	79	108	80	103
Bugle	87	81	31	90	59	74
Clancy	75	74	25	93	77	76
Drum	72	66	44	89	71	68
Hylite200TT	74	81	116	65	94	96
Pinnacle	86	72	38	97	54	70
Surps300TT	83	83	128	85	90	106
Surps501TT	91	106	119	110	101	78
Surps600TT	92	82	40	100	65	71
TM8	96	78	58	99	94	96
No. trials	1	3		2	3	2
LSD, p = 0.05	15	16		14	25	20

Northern trials were located at Geraldton, Mingenew, Coorow, Watheroo (sown between 10 and 29 May) and Mullewa (sown 15 June).

Central trials located at Badgingarra, York, Wongan Hills, Meckering, Kunjin (sown between 8 May and 15 June) and Merredin and Karlgarin (sown 18 and 31 May).

Table 7. Imidazoninone resistant varieties in the north and central regions

	North	Central	
Variety		**Medium**	**Low**
44C71	58	93	135
44C73	-	164	-
46C72	40	54	122
46C74	-	115	-
Surps402CL	162	113	92
Surps603CL	115		115
Karoo	100	100	100
No. trials	2	6	1
LSD p = 0.05	80	30	-

Trials located in north at Coorow and Mullewa (sown 15 May and 15 June), in central at Meckering, Kunjin, Avondale and Wongan Hills (sown between 31 May and 7 June), in south at Katanning and Wittenoom Hills (sown 14 June and 10 May).

NOTE: The comparison of varieties in these trials have been conducted without the use of the triazine or imidazolinone herbicide systems.

Choosing a variety in the Northern region

The Northern Agricultural region is different to any other canola growing region in Australia because season is drier, shorter and warmer. The far northern areas see very warm conditions at the start of the season, which often causes establishment problems due to the lack of moisture in the top soil reducing emergence. The warmer conditions during winter encourage more rapid growth. With early sown crops it is common to see the first flowers within 8 weeks of sowing. Varieties that initiate flowering early generally produce better oil and also have the ability to continue to flower if moisture is available in mid-spring.

Table 8. Choosing the right varieties for the Northern region

Rainfall	**Time of sowing**	
	Early (April - mid-May)	**Late (mid-May - mid-June)**
Low-Med. < 325-325 mm	Narendra, **Karoo***, , Monty, **Drum, Surpass 300, Surpass 501**	Narendra, , Monty, **Drum, Hylite 200TT, Surpass 300, Su** **501**
Med.-High 325-450 mm	Rainbow, Oscar, **Karoo**, Grouse, Drum, Clancy, Scoop, Pinnacle, 46CO1, Mystic, Surpass 600, **Surpass 600TT, Surpass 501, Surpass 300**, #Surpass 402 CL	, Rainbow, Monty, **Karoo, Surpass 300, Surpass 501**, #Surpass 402 CL
High > 450 mm	Oscar, Dunkeld, **Pinnacle**, Grouse, Scoop, Range, **Clancy**, 47CO2, Surpass 600TT, **Surpass 600TT, Bugle, TM8, TM5, Surpass 501**, #Surpass 402CL	Oscar, Rainbow, **Karoo**, Grouse, **Pinna** **Clancy**, Mystic, **Bugle, TM8, Surpass** **Surpass 501** #Surpass 402CL

- Note*: Triazine Tolerant varieties are shown in bold print.
- Note#: Varieties that have the Clearfield technology.

Not all varieties have the same level of Blackleg resistance, quality aspects or adaptability to seasonal differences.

New varieties showing good yield and blackleg characteristics in 2000 were:

Triazine tolerant

North and central regions; low to medium annual rainfall: Hyden, Surpass 300TT, Surpass 501TT.

North and central regions; high annual rainfall: Hyden, Surpass 501TT, Surpass 600TT.

Beacon gave good yield, but should not be used where the incidence of blackleg is likely to be high.

Imidazolinone tolerant

In the NAR Surpass 402CL is clearly superior to Karoo and on good fertile soils in the high to medium rainfall areas of the northern Agricultural zone will out yield all other varieties. Correct selection of soil type and sowing time are essential. Consideration of the weed control of the Clearfield system must be taken into account due to the levels of group B resistance in both rye grass and wild radish. On Duty herbicide is not effective against Group B resistant weeds.

Non-herbicide tolerant

In North and Central regions, the early-medium maturity varieties of Mystic, Monty, and Surpass 400 performed well. Ag-Outback and Georgie gave good yields but have lower resistance to blackleg disease. In general the Non TT canola varieties are not suitable for the northern grainbelt due to the inability to control wild radish and other broad leaf weeds.

CANOLA VARIETY GROSS MARGIN COMPARISON - CHAPMAN VALLEY SANDPLAIN

Prepared by Craig Topham, Agrarian Management, Geraldton

The trial was conducted with the assistance of Ray and Brady Green - Yuna.
Sowing date: 29 April 2000
Soil type: Sandy loam over gravel
Sowing rate: 6 kg/ha

Conditions at sowing: Seed sown onto good soil moisture to 25 mm of surface but surface dry at sowing. Good plant establishment was achieved considering the dry conditions that were experienced through May and June. Yield and oil figures are as follows:

Table 9.

Variety	Return/ha	Gross margin/ha	Breakeven yield	% GM of Karoo
Hylite 200	$515	$208	1.02 t/ha	80%
Karoo	$566	$259	1.04 t/ha	100%
Surpass 300 TT	$621	$314	1.01 t/ha	121%
Drum	$622	$315	1.03 t/ha	121%
TM8	$626	$319	1.02 t/ha	123%
Bugle	$639	$332	1.01 t/ha	128%
Pinnacle	$642	$335	1.03 t/ha	129%
Surpass 600	$653	$346	1.01 t/ha	133%
44C71	$672	$324	1.12 t/ha	125%
Surpass 501 TT	$709	$402	1.00 t/ha	155%
Surpass 402Z	$	$425	t/ha	%

Returns/ha for each variety has been calculated based on the canola cash price of $311/tonne + Oil % payments (Geraldton cash price 27 November 2000). $10/tonne freight and $3 levies have been deducted. For an explanation of the gross margin/ha calculations costs are shown in Appendix II.

Economic evaluation of Yuna 2000 trial

Increased returns are achievable with new canola varieties due to superior yield and oil characteristics. Surpass 501 TT performed well in all trials in the NAR for the last 2 seasons yielding significantly above Karoo with oil levels 2-3% above Karoo. Surpass 501 TT has superior Blackleg tolerance than Karoo. Its growing season is slightly longer than Karoo although it was swathed on the same day as Karoo in this trial.

As a short season TT variety Surpass 300 TT appears to be a better option than Hylite 200. Surpass 300 TT has out yielded Hylite 200 in a number of trials and has slightly better Blackleg tolerance. Both Surpass 300 TT and Hylite 200 are better suited to low rainfall areas where a very tight finish is expected or for late sowing. Experience has shown poor performance on sandplain.

The Clearfield canola variety (Imidazolinone Tolerant: IT) Pac176 in trials across the State this season has shown to be greater yielding than Triazine Tolerant (TT) varieties and in all trials has shown higher oil. The Clearfield system is more expensive to establish (see Appendix 1 for cost comparison) than for TT varieties. On high yielding low production risk canola paddocks a greater return can be achieved using the Clearfield system although economic risk is higher due to the increased establishment costs. An additional 100 kg/ha yield is required to cover the higher cost of the Clearfield system.

Breakeven yield varies with input costs and canola price. However at least 0.85 t/ha is required at price $300/t and 0.70 t/ha at $350/t. The average canola yield in the Geraldton Port Zone in 2000 was 0.66 t/ha and the long term average is 0.75 t/ha. Careful selection of soil types is needed to ensure that only paddocks with better than breakeven yield potential are sown.

Table 10. Sensitivity analysis looking at yield variation based on above actual costs and returns

Yield (t/ha)	Yuna	Mingenew
0.75	-$50.49	-$107.38
0.9	-$2.09	-$62.09
1.2	$94.72	$28.48
1.4	$159.64	$88.87
1.6	$223.80	$149.26

Operating Gross Margin for canola production Yuna Red Loam and Mingenew Sandplain. Figures based on yield oil payments and costs from case studies (Appendix 3).

Table 11. Average input costs per ha for high, medium and low rainfall zones

Input cost/ha ($)	High rainfall (450-750 mm)	Medium rainfall (325-450 mm)	Low rainfall (less than 325 mm)	Your figures
Seed (5 kg/ha)	12.50	12.50	12.50	
Impact-in-Furrow				
Fertiliser*	102	84	70	
Spread and freight	36	35	35	
Tillage	14	14	14	
Weed control	64	52	38	
Insect control	12	18	20	
Crop insurance	11	11	11	
Interest	11	11	11	
Contract swathing	20	20	20	
Contract harvesting	35	35	35	
Total	**$317.50**	**$292.50**	**$266.50**	

Fertiliser* For high rainfall 80 kg N, 15 kg P, 20 kg S (e.g. 80 kg DAPSZC, 100 kg Sulphate of Ammonia, 100 kg urea) + 25 kg K on light soils.
For low rainfall 60 kg N, 10 kg P, 20 kg S (e.g. 60 kg DAPSZC, 60 kg Sulphate of Ammonia, 80 kg urea). Fertiliser strategies vary widely according to soil test results.

Managing canola yield and oil

Local research results confirm the significant effect on canola yield and oil from a range of sowing dates and varieties. As the sowing date was delayed from late April/early May to June or July, yield fell on average 27-29 kg/ha/day and oil fell 3.5-4.5%. Monty gave 4% higher oil than Karoo at Mullewa and 2.4% higher oil at Wongan Hills, reflecting the environmental differences during flowering for both varieties. Whereas increasing the rate of urea fertiliser from 100 to 200 kg/ha gave no yield increase at Wongan Hills and a small (significant) increase at Mullewa, at both sites, the treatment gave significant falls in oil of 0.5% and 1.1%.

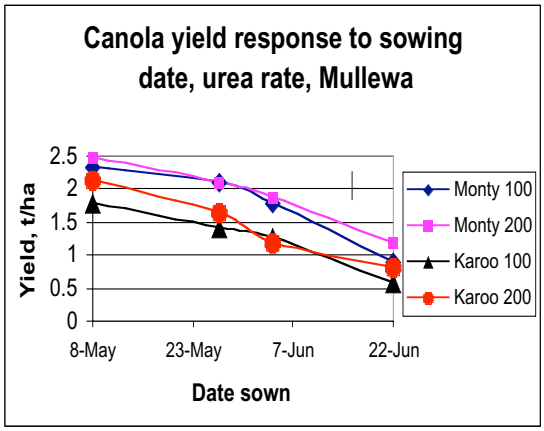


Figure 3a.

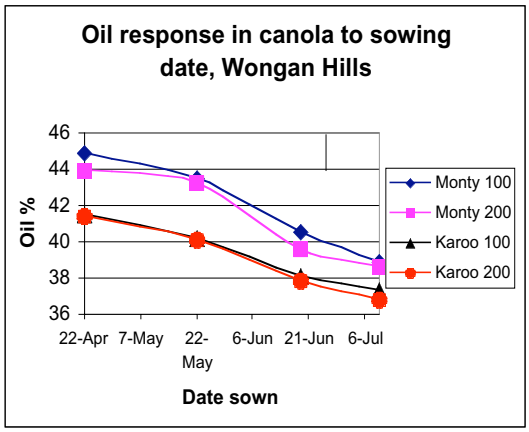


Figure 3b.

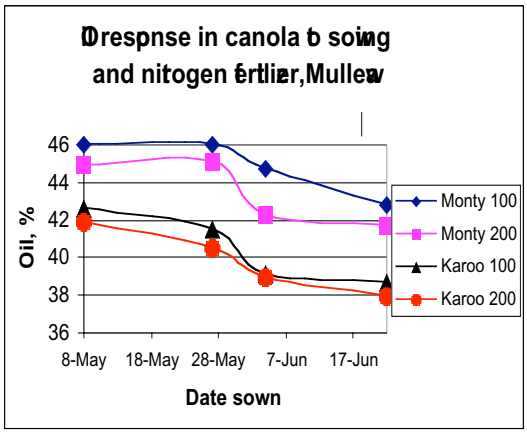


Figure 3c.

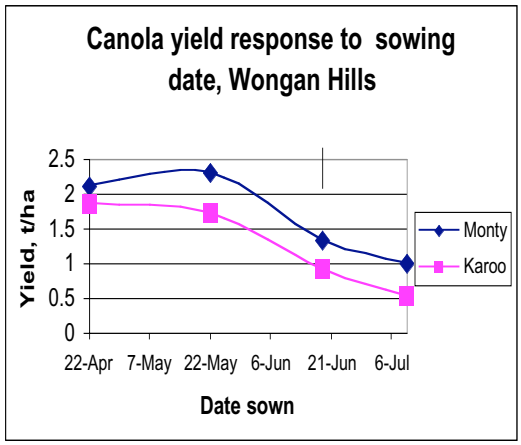


Figure 3d.

Diseases

MANAGING BLACKLEG

All canola stubbles of any age are a source of blackleg inoculum. An integrated strategy to minimise blackleg would include:

- select variety with highest Blackleg Resistance Rating;
- plant new crops as far away as possible from paddocks containing canola residue;
- remove canola residue from paddock if possible by grazing/burning/incorporation;
- keep rotations as far apart as possible, preferably one in four years;
- strategic use of Impact®.

When to use Impact®?

When sowing a variety with a resistance less than 6 (Karoo) in the medium and high rainfall region that has had canola sown less than 1 km away in the past three years.

Trials have failed to show significant results in the NAR with varieties with a rating above 5.

When is it NOT necessary to use Impact®?

When sowing a variety that has a resistance of 6 or greater (Surpass 501TT, Pinnacle) and is grown under low disease pressure.

When sowing a variety of stem canker resistance score of 5 or less in a high disease risk area.

Varieties	WA canker ranking	Low pressure	Moderate pressure	Severe pressure	Very severe pressure
TT					
Hylite 200 TT	3	15%	40%	70%	100%
Karoo	4	15%	35%	65%	100%
Surpass 600 TT	5	10%	30%	60%	90%
TM8	5	10%	85%	60%	90%
Bugle	6	5%	15%	50%	85%
Clancy	6	5%	15%	50%	85%
Drum	6	5%	15%	50%	85%
Pinnacle	6	5%	15%	50%	85%
IT Canola					
11C71	4	15%	35%	65%	100%
44C72	3	15%	40%	70%	100%

* Currently WA data not sufficient to rank these varieties.

Extract from *Managing Blackleg,* Bulletin No. 4480.

MONITORING FOR DISEASE

The key to monitoring blackleg disease is to note the changes in plant numbers over the first three (3) weeks after emergence. Inspect poor seedlings for any tapering of the young root at ground level (Rhizoctonia attacks below the ground surface).

Eliminate the possibility that losses may be from vegetable weevil and RLEM first. Levels of blackleg infection have increased and may be responsible for some of the poorer performances of canola in recent seasons. The introduction of varieties with very high levels of resistance to Blackleg may mean yield losses will not be as severe.

SCLEROTINIA STEM ROT

This disease is thought to be more prevalent in the northern region because of large areas of lupins, however losses are generally not severe. The stalks of plants rot 10-20 cm above soil level, causing wilting and premature ripening. Severely affected plants can lodge.

To control the disease, leave canola out of the rotation for as long as possible - as long as three years. Use rotations to break the cycle. Do NOT follow lupins or peas (which are very susceptible to the disease and are therefore a source of inoculum for next year), with canola. Use Sclerotinia free seed, and if possible incorporate the stubble of legume crops, to enhance breakdown of the spore bodies. Grow cereals and pastures free of capeweed, which also hosts the disease.

At present it is considered uneconomic to directly control the disease with fungicides. Cape Weed control, rotation with trash management are currently the best strategies for its control in the region.

OTHER FUNGAL DISEASES

Refer to the 'Growing Golden Canola Manual': *Fungal Diseases of Canola in Western Australia* and the Bulletin No. 4406 for further information.

VIRUSES IN CANOLA

Two **Viruses**, Beet Western Yellows (BWY) and cauliflower mosaic viruses are insidious diseases of canola crops in Western Australia. They are spread by aphids from infected weeds or plants to healthy plants. Beet Western Yellows is a luteovirus typified by being persistently aphid-transmitted. The Cauliflower Virus is non-persistently aphid-transmitted. Seed transmission in canola has not been investigated and is possible for cauliflower virus.

The symptoms of Beet Western Yellows virus is difficult to see in infected canola plants in the paddock. Mild plant dwarfing, leaf distortion and reddening or pallor of lower leaves are some of the symptoms. These mild symptoms are easily confused with those of nutritional disorders. Research is still been conducted to determine the effect of these viruses on the yield of canola in WA, however European work has found seed yield losses of 10-15 per cent associated with this virus disease in canola.

Weed management in canola

Weeds in canola depress yields. Early weed control is essential for high yields in the NAR. The control of all weeds prior to wet sowing with knockdowns is essential for the establishment of canola. Where tank mixes are used plant back periods must be taken into account particularly when SU or phenoxy herbicides are used for summer weed control. Transplants are the most expensive weeds to control, in terms of herbicide costs and yield loss. Atrazine is effective against small weeds only and has difficulty controlling weeds that have escaped a knockdown. Growing conventional canola faces many problem weeds, which are either difficult to control or unable to be controlled with current herbicides. For example, silver grass, radish and turnip devastate many early sown conventional canola crops. The only herbicides registered for conventional canola are the grass selective ones and Lontrel for limited broadleaf control. For this reason conventional canola is not recommended.

WEED CONTROL IN TRIAZINE TOLERANT CANOLA

The impetus behind the progress of canola in Western Australia has been the quick adoption of triazine tolerant (TT) weed control technology by growers. Triazines are the herbicides Atrazine and Simazine which require good soil moisture to be activated. TT canola allows growers to sow on or before opening rains and use Atrazine as the knockdown.

Lack of adequate soil moisture is often a source of poor weed control in the northern grainbelt. The benefit of Atrazine application is that it can be used after the emergence of TT canola without causing any damage. Atrazine absorbed through the foliage of the germinating weeds provides an effective weed control.

Group C (Simazine, Atrazine) herbicide resistance has developed in wild radish and annual rye grass. The spread of Group C resistance has the potential to limit the use of TT canola in this region.

EARLY PLANNING FOR WEED CONTROL

Pre-seeding strategies for controlling emerged weeds before a canola crop (using knockdown herbicides) are similar to those for most other crops. In very weedy paddocks, delay seeding until at least one germination of weeds has been controlled by a knockdown. With dry sowing this is not possible. The use of an earlier maturing variety on very dirty paddocks will allow for delayed sowing and the use of a knockdown. In medium to low rainfall areas, weeds can have a far greater impact on canola yield than delayed sowing.

Pre-seeding weed control is especially important in paddocks with a heavy burden of resistant ryegrass. Aim to reduce ryegrass numbers as much as possible before they are exposed to Atrazine. Atrazine cannot be expected to control large transplants, especially transplants that are stressed by

low moisture or from cultivation disturbance. Treat such plants with an adequate rate of Glyphosate before seeding, and reduce insect pest build-up.

Table 12a. Directions for use - triazine tolerant canola only (Label Extract, 2001)

Situation	Weeds	Rate
Single application pre-emergence: Atrazine or Simazine or combination of both	Annual Ryegrass, Barley Grass, Capeweed, Charlock, Corn Cromwell, Doublegee, Fumitories, Geraniums, Ivy-leaf Speedwell, London Rocket, Mustards, Oats, Paterson's Curse, Shepherd's Purse, Soursob, Turnip Weed, Wild Radish, Wild Turnip, Winter Grass Suppression of: Clovers, Medics, Wireweed and Annual Grasses	1-2 kg active/ha
Single application post-emergence: Atrazine only (up to 4-6 leaf crop stage ie within 4-5 weeks of crop emergence)		500 g-1 kg active/ha
Split application: Pre-emergence - Atrazine or Simazine or combination of both PLUS Post-emergence - Atrazine only (up to 4-6 leaf crop stage, i.e. within 4-5 weeks of crop emergence)		500 g-1 kg active/ha (pre-emergence) PLUS 500 g-1 kg active/ha (post-emergence)

The **maximum** amount of active (Atrazine, Simazine or combination of both) to be applied to any one crop during its growing season is 2 kg per ha.

Warning: *This use may promote the development of herbicide resistance in weed populations. Persons must, when using chemical(s) in a manner covered by this label follow the guidelines and principles outlined in the Generic Integrated Weed Management Strategy for Triazine Tolerant Canola. This strategy was developed with the assistance of the Canola Association of Australia who also have copies of the strategy available.*

Full details of the label can be obtained from the Syngenta (formerly Novartis) web site **www.Syngenta.com.au**.

Table 12b. Example product rates

Product type	500 g-1 kg active/ha rate	1-2 kg grams active/ha rate
500 g/L active Gesaprim 500 SC Gesatop 500 SC	1-2 litres product per ha	2-4 litres product per ha
900 g/kg active Gesaprim Granules 900WG Gesatop Granules 900WG	555 g-11 kg of product/ha	1.1-2.2 kg product per ha

TIMING OF ATRAZINE FOR OPTIMUM WEED CONTROL

Triazines work most effectively when weeds are small, before they have developed extensive root systems. Thus the herbicide should be applied just before or just after seeding. If soil conditions allow a full cultivation, apply 2 L/ha just before seeding. Atrazine will then be incorporated by the seeder, however a rolling harrow will ensure more uniform incorporation. For zero tillage (triple disc) operations, apply the same rate immediately after seeding. This chemical will remain on the surface until sufficient rain falls to leach it into the root zone. In most situations it will be slightly less effective than if it were incorporated.

Most of the Atrazine that is sprayed on to stubble will be retained for some time. In the presence of heavy stubble, spraying pre- or post-seeding during rain will ensure that most chemical is washed onto the soil.

If a knockdown herbicide application has created a weed-free environment for seeding, delay the Atrazine application until the first weed seedlings appear. This will be three to four weeks after seeding. Applied post-emergent, with oil, this Atrazine application should be very effective.

Make a second application of Atrazine (plus oil) six to eight weeks after the first application if a second flush of weeds emerges. The paddock should remain free of weeds as the canola canopies over and smothers any further germinations.

For paddocks that have a heavy stubble cover, delay the second application until sufficient weed growth appears above the stubble to allow good uptake by the leaves.

Warning: *If rainfall is low, triazine residue carryover can reduce yields of cereal crops. Do not use any more than two applications in any season and restrict the total triazine application to 4 L/ha.*

Best practice for TT canola - overview

A Generic Integrated Weed Management Strategy has been developed by Syngenta (formerly Novartis) with the assistance and agreement of the Canola Association of Australia. A program has been developed that outlines sound agronomic practices and integrated weed management programs designed to optimise the performance of TT canola. It is a condition of sale that consultation on IWM be undertaken with an accredited agronomist prior to use of TT canola.

TO AVOID HERBICIDE RESISTANCE:

- Use a pre-plant knockdown or cultivation. Avoid dry sowing. Always wait for a weed germination after the opening rains. No weeds should be allowed to survive at this stage.
- Adapt the weed control program to the anticipated weed spectrum and pressure:
  Broadleaf weeds and ryegrass: Use GESATOP or GESAPRIM plus Trifluralin pre-emergence. A follow-up with a Group A herbicide (if ryegrass is susceptible) or GESAPRIM may be necessary.
  Broadleaf weeds only: Use GESAPRIM post-emergence.
- **DO NOT** use GESAPRIM or GESATOP if the area to be treated had a triazine herbicide applied to it last season.
- **DO NOT** use GESAPRIM and GESATOP on TT canola in a paddock with a long history of Group C herbicide use.
- **DO NOT** use GESAPRIM and GESATOP on TT canola more frequently than **two years in every four years** when TT canola is grown in rotation with other crops (e.g. wheat, legumes, oats, barley, grass seed crops and pasture).

CLEARFIELD! PRODUCTION SYSTEM

The CLEARFIELD! Production System for canola was introduced in 2000 by Pioneer Hi-Bred and Cyanamid. Growers must follow the CLEARFIELD! Management Practices.

ONDUTY is the first new herbicide to be registered by the NRA under new guidelines that require demonstrated strategies for sustainability and minimising the mismanagement of new chemicals. The herbicide is post-emergent, and is for application to weeds in the two to four leaf stage and must be applied with a wetting agent.

ONDUTY consists of two imidazolinone chemicals which improves it activity on weeds and further minimises the risk of resistance developing too rapidly. Weeds which already exhibit Group B resistance may exhibit a low level of resistance to ONDUTY .

Contact your BASF or local accredited agronomist for more information.

DEALING WITH RESIDUES

In years of patchy rain, enough residual Atrazine may carry over to the next season to affect wheat growth. Also, volunteer canola in the next year's pulse crop, being triazine-tolerant, may be very difficult to eradicate. These problems are considered in Farmnote No. 51/96 *Managing triazine residues in triazine-tolerant canola*.

On acid soils (pH less than 6.5) **-** The maximum rate of GESAPRIM or GESATOP or a combination of the two products to be applied to the crop during the growing season is **4 L/ha.**

On alkaline soils (pH greater than 6.5) **-** The maximum rate of GESAPRIM or GESATOP or a combination of the two products to be applied to the crop during the growing season is **2 L/ha.**

Post-emergent use **-** It is recommended that GESAPRIM only be used, and at rates of **2 L/ha** or less, on both acid or alkaline soils.

Further reading:

Weed management section: 'Growing Golden Canola ' (www.agric.wa.gov.au/canola/ggc)

Weed control in triazine-tolerant canola - Farmnote - 52/96

Practicalities of TT canola in NAR

- Simazine is less appropriate in the NAR than Atrazine for TT canola. Atrazine has the same weed control range as Simazine when applied at the pre-emergent stage and Atrazine can also be used as a foliar herbicide.
- When seeding with a 'full cut', apply 1 kg of Atrazine (active ingredient) per hectare before sowing to incorporate the herbicide. At this time Atrazine can be tank mixed with knock down herbicides.
- Spray Atrazine after seeding in the case of knifepoint seeding. Spraying Atrazine immediately after seeding utilises the soil moisture of the soil particles that have been turned onto the surface. Spray the Atrazine onto a clod free smooth soil surface.
- Postpone post-sowing Atrazine application until the soil surface becomes wet or spray just before a rain.
- Use a mineral-based oil additive of one per cent if some weeds have already emerged on the paddock. The advantage of the post-sowing application is the even cover of herbicide and the knock down of small weeds.
- Soils with low pH alter the residual effect of triazines. The lower the soil pH the shorter the life span and consequently the poorer the performance of triazines.
- Apply Atrazine at a rate of 1 kg per hectare with oil additives in the sensitive stages of the weeds (up to 2-4 leaf stages of broad leaf weeds and up to the height of 1-1.5 cm or 1-2 leaf stage of grass weeds). Knockdown is poor on larger weeds especially in dry conditions.
- Use a high water volume with a minimum of 50 L/ha. Use an additive with a wetter when you mix grass selective with Atrazine according to the label recommendations of the grass selective.
- The smooth soil surface and the compact seedbed make the germination of both the canola and the weeds even and allow us to choose the proper timing.
- Time is crucial in the case of post-emergent application of Atrazine. Ryegrass needs to be sprayed at no later than the 2 leaf stage for effective kill using Atrazine. Atrazine is not particularly good at controlling rye grass and in most situations a follow up grass selective will be needed.

ADJUVANTS

Adjuvants are very important in increasing the efficacy of post-emergent herbicides. When using tank mixes it is important to use the correct adjuvant. The use of large volume herbicides such as

Glyphosate and Atrazine together with insecticides and spray oils leaves little space for water when spray volumes are 30 L/ha or less. Higher volumes of 50 L/ha are needed and will also generally increase efficacy of the herbicides used.

BOOM HYGIENE

SU (Logan, Glean, Ally, Broadstrike, etc.) contamination of tanks is a potential problem, extremely low rates (20 mg/ha Logran) can devastate plants and yield. Booms, tanks and lines need to be cleaned and soaked overnight with chlorine after using the above herbicides. Some booms are more difficult to clean down that others, check with your reseller as to which booms are the best for avoiding these problems. Some properties have two spray rigs, one of which is solely used on canola and lupins and have no exposure to SU herbicides, while the other will be used for the cereal program.

Management of insect pests

Canola is very susceptible to insect attack in the first 6-8 weeks after sowing. The main insect problems in the northern grainbelt are redlegged earth mite (RLEM), Lucerne Flea, Vegetable Weevil, Bryobia Mite and Aphids. With early sown crops warm season insects such as Weed Web Moth and Cabbage Moth become a problem. The use of insecticides as 'bare earth' treatments gives some residual. Refer to the *Growing Golden Canola* Manual for details and colour photographs of the common pests. Some of the problem insects as well as their control are:

As the sowing window for canola has been pushed earlier we are seeing canola being sown onto sub soil moisture on early rains before the season gets cold. Therefore the traditional insects such as RLEM and Lucerne Flee are not a problem as they do not appear until the cold whether stimulates hatching. The warm season insects that build up in the warmer autumn months are now causing more damage to early sown northern crops.

Cypermethryn should be used with the knockdown if there has been summer rain prior to sowing. Talstar would not be required with early sown crops, as RLEM would not have hatched. A bare earth spray of Endosulfan gives good early control of most insects but tends to fail on Cabbage Moth. If cabbage moth is present then multiple sprays of Alpha-Cypermethryn and Buldock Duo may be needed. Constant monitoring will be essential in seasons when Cabbage Moth are present.

REDLEGGED EARTH MITE (RLEM)

Redlegged earth mites' cluster on the young seedlings, rupturing cells and sucking the juices. This leads to a silvery appearance, together with some shrivelling and a slowing of growth or even death of the plant. As redlegged earth mite is a regular pest of emerging canola crops, one of two strategies can be considered to control it.

- Spray canola on emergence with an insecticide and follow up with a second spray within two weeks of emergence; or
- Use a bare earth spray immediately after sowing and apply a follow up spray if required at two to three weeks. This is the most popular option.

Redlegged earth mite is the most serious pest of emerging canola crops, heavy infestation will set a canola crop back, increase susceptibility to disease, reducing crop density and yield.

Table 13. Insecticide recommendations for redlegged earth mite

Pest	Chemical	Trade name	Rate mL/ha	Note
RLEM	Dimethoate	Rogor	55-85	Contact effect
	Omethoate	Le Mat	100	Contact effect
	Chlorpyryrifos	Lorsban	140	Contact effect + Some residual effect
	Bifentrin	Talstar	50-100	Residual effect
	Alpha-Cypermethryn	Dominex/Fastac	50	Contact + Some residual effect

	Endosulfan		500	Longest Control on bare earth

BRYOBIA MITE

The Bryobia mite look almost the same as **RLEM** but have a grey muddy coloured body and very pale red legs. Under high magnification they are more easily distinguished and have longer legs to the front compared to RLEM.

Bryobia have attacked canola crops throughout the region in the last few seasons where crops have been sown early. This mite is usually only a problem in autumn with warm mild conditions after crop emergence. They should be less important when cold wet conditions occur.

Canola crop damage by Bryobia mite will leave pale 'tracking' marks across the upper surface of true leaves. The damage compared to RLEM is quite distinct, RLEM leave a silvering effect on the surface of the leaves which is not as damaging as the Bryobia.

The best control is to spray emerging crop as soon as the pest appears. Once the crop has reached the 3 to 4 leaf stage, it will soon grow away from the pest.

CUTWORMS AND BROWN PASTURE LOOPERS

Cutworms and brown pasture loopers may also chew and even kill young plants. Cutworms hide by day, but can be found by scratching the soil from the base of affected plants. Typically cutworm leave a 'stump' of the canola seedling after feeding at night. The brown pasture looper can be recognised by its stripes and looping motion. Loopers are sometimes only present around the edge of the crop, and are more common in canola that has been sown into pasture. They are easily controlled with synthetic pyrethroids.

BUDWORM AND DIAMOND BACK MOTH CONTROL IN CANOLA

Native Budworm (*Helicoverpa punctigera*) invasion into canola crops in the northern region has become a frequent event over the last few years as the area of canola has grown. This is especially true when summer rainfall in the pastoral areas encourage build up of the moths throughout the region. Generally they are not considered a major insect pest of canola. They attack canola usually during the podding stage of the crop. Canola will tolerate some feeding damage by **native budworm**, however, economic losses can occur if numbers become large during the podding stage. Native budworm can be distinguished from both the **diamond back moth** (*Plutella xylostella*) and **cabbage white butterfly** in the larva stage by its distinctive stripes on the body. Both diamond back moth and cabbage white butterfly are not considered serious pests of canola during podding, although isolated sporadic infestations can occur.

Diamond back moth (DBM) is a major vegetable pest over the warmer months and is difficult to control as it breeds prolifically and develops resistance to insecticides quickly. The presence of DBM has been steadily increasing over the last few seasons, with the increase in canola plantings to the point that widespread damage occurred in 2000. The seriousness of a DBM outbreak will be determined by the amount of summer rain received.

Chemical control in canola can be difficult if the population present is in a number of different stages of its life cycle. Eggs and pupa are not controlled by insecticides therefore the percentage of the population that is in the egg or pupa stage at the time of spraying will not be controlled. In these situations a follow up spray will be needed 10-14 days later top control the next stage of the population.

Table 14. Economic spray thresholds for the major caterpillar pests of canola during flowering to maturity in Western Australia. NOTE: Sample several areas in a crop and spray if you get the following average number of caterpillars. Thresholds are based on aerial application of insecticide at a total cost of $12 per hectare

Canola plant stage	*Thresholds for Heliothis*	*Threshold for DBM*
Foliage to mid-flowering	N/A	5 or more grubs/plant
Mid to late flowering	N/A	7 or more grubs/plant
Pod maturation	20 or more grubs/plant	10 or more grubs/plant

N/A. Not applicable or unlikely to occur.

SWEEP NET TECHNIQUE

Sweep netting offers the best method for growers to assess budworm larval densities because its precise estimate of numbers can be made very quickly. The crop should be swept at several locations to provide an estimate for the whole area.

The sweep net does not collect all the larvae from the plants that it passes over. The proportion of larvae it collects varies between crops and between different stands of the same crop. Experiments conducted have measured the collecting efficiency of the sweep-net and determine whether all sizes of larvae are equally represented in the sample. The sweep-net was found to collect a representative sample and was most efficient. In taller crops the sweep-net was less efficient and more variable. From canola it collected as few as one in 20 larva and in faba beans less than one in 30. Although inefficient, the sweep net is still effective at estimating larval abundance because relatively large areas can be sampled quickly and variations in collecting efficiency accounted for by noting the height and density of plants.

A proper sweep is a complete 180^0 sweep through the pod canopy of the crop. Twenty complete sweeps will represent approximately one square meter of crop canopy.

BUDWORM SPRAY THRESHOLDS

Sample several areas in a crop and spray if you get the following average number of caterpillars. Thresholds are based on aerial application of insecticide at a total cost of $12 per hectare (Table 15).

Pheromone traps can determine the timing and location of major flights of native Budworm moths. Previous work in WA has demonstrated that the pastoral regions are a source of moths that invade crops during winter and early spring. The timing of the first major flights can vary considerably between seasons; therefore, moth collections from a network of traps throughout the cropping region can be used by growers as to when to begin monitoring their crops.

Information on moth numbers in different localities is available weekly during the growing season via PestFax (a poll fax service) or the Agriculture Western Australia web site (www.agric.wa.gob.au/ento).

To obtain PestFax dial 1902 990 506 and when prompted by a voice message request Document No. 24001 or direct poll 1902 990 660.

Table 15. Spray threshold for budworm in canola and lupins

Crop	Spray threshold
Lupins	25 grubs in 20 sweeps (at first leaf drop).
Canola	20 grubs in 20 sweeps when the crop is maturing (podding).

APHIDS

Aphids are common pests of canola, but research is showing that their feeding damage has a minimal impact on crops. In the past few years many canola crops were attacked by heavy colonies of aphids. Most of these are turnip aphids, which build-up to large numbers on the buds and flowers of canola. Heavy colonies can result in visible damage to individual flowering stems, such as brown, withered buds that fail to flower. In both years canola was able to compensate for aphid damage, in high and low rainfall zones.

Trials in 1997 and 1998 showed that high levels of aphids (up to 140/main flowering stem) recorded during August and early September did not cause any yield losses, nor did they adversely affect oil content (Table 16). This finding supports other studies that show canola compensates for damage by a range of other insects and also by artificial damage. Compensation is particularly likely in high rainfall zones, where a good finish to the season is likely.

Table 16. Yields and oil content of canola cv. Karoo from recent trials comparing the effects of aphids on canola production at Badgingarra (high rainfall) and Mullewa (low rainfall)

	Yield (t/ha)	Oil at 8.5% moisture
1997 (high rainfall)	2.03-2.23	42.7
1998 (high rainfall)	1.78-2.05	40.8
1998 (low rainfall)	1.51-1.63	40.7

In both years, canola was able to compensate for aphid damage by producing more flowering stems and pods; in high and low rainfall zones. This finding supports studies else where that show canola compensates for damage by a range of other insects and also by artificial damage. Compensation is particularly likely in high rainfall zones, where a good finish to the season is likely.

Recommendation: The thresholds for aphids in canola are outlined in the following table:

Table 17. Aphid numbers that may require control to prevent feeding damage in Western Australia. Sample aphids by measuring the length of the dense colonies that form on the flowering head

	Rainfall zone (mean annual rainfall)		
	Low (< 325 mm)	**Medium (325-450 mm)**	**High (> 450 mm)**
Aphid numbers per budding/flowering head*	150 (7.5 mm length)	180 (9.0 mm length)	200 (10.0 mm length)

* Average number on a sample of at least 50 growing tips, looks at one flowering head per plant.

Explanation: Take 50 growing tips at random in the paddock. Measure the length of the aphid colony on the growing tip in mm. Divide the total length obtained by 50 to get the average length in mm per growing tip. If the result exceeds that shown in Table 17 then it will be justifiable to spray.

(For example say you took 10 growing tips (to make it easy) and measured the length of aphid colony. If we got 4 mm, 0 mm, 25 mm, 8 mm, 0 mm, 0 mm, 12 mm, 6 mm, 0 mm, 5 mm then the total is 60 mm. The average per growing tip is 60/10 = 6 mm. From the Table 17 in the low rainfall region you need more than 7.5 mm per growing tip to spray, **so you would not spray**.)

Note: *Mention of trade names does not imply endorsement or preference of any company's product by Agriculture Western Australia, and any omission of a trade name is unintentional. Recommendations are current at the time of printing.*

See Agriculture Western Australia website http://www.agric.wa.gov.au/ento for more information and colour pictures of these insect pests in canola.

Nutrient management of canola

As is the case with all crops, the key to making the most of your fertiliser dollar lies in identifying the most limiting nutrients in each situation. The required rates and the likely response to applied nutrients will be greatly influenced by the achievable yield of the crop. The realistic target yield of canola is roughly the half the yield achievable for wheat in the NAR.

Table 18. Essential nutrient for canola growth

The macronutrients or elements required in relatively large amounts		The micronutrients or elements required in small amounts	
Nitrogen	(N)	Boron	(B)
Phosphorus	(P)	Chlorine	(Cl)
Potassium	(K)	Copper	(Cu)
Sulphur	(S)	Iron	(Fe)
Calcium	(Ca)	Manganese	(Mn)
Magnesium	(Mg)	Molybdenum	(Mo)
		Zinc	(Zn)

NUTRIENTS REMOVED BY CANOLA

Table 19. Nutrition content/removal in one tonne of wheat and canola grain and stubble

	Nitrogen kg/ha		Phosphate kg/ha		Potassium kg/ha		Sulphur kg/ha	
	Seed	**Straw**	**Seed**	**Straw**	**Seed**	**Straw**	**Seed**	**Straw**
Wheat	17-23	4- 6	2-4	0.5-1.0	4- 6	10-14	1.5-3	1-1.8
Canola	15-41	4-10	4-7	2-4	8-10	25-31	2-10	3-12

Source: Western Australian Growing Golden Canola Manual.

Calculating a crops nutrient budget by determining nutrient removal and what we estimate to be available to the plant in the soil is the best technique we currently have in WA to determine what amount of fertiliser we need to add to realise our crop's potential. Canola nutrition trials have been run in parallel to wheat nutrition trial to determine the relative response of canola compared to wheat to different nutrients. This means we are able to extrapolate canola responses from wheat trials conducted in WA.

NITROGEN

Nitrogen is a very important nutrient for canola growth and high yields. It is important in the production of many compounds in the plant, including protein and chlorophyll. Therefore, a shortage of this nutrient results in very pale plants. Nitrogen is an important component of protein in canola meal and can impact upon the oil content of the seed. Although canola is often considered to have a high requirement for nitrogen than cereals on a tonne for tonne basis of N removal, on a comparative yield basis, wheat and canola have similar requirements for nitrogen.

Nitrogen is also very mobile in the plant. During a period of deficiency, nitrogen is remobilised in older leaves and moved to the younger growing tissue of the canola plant. As a result, deficiency symptoms first show up in the oldest leaves.

Inadequate or application poor timing nitrogen is a major reason why many canola crops fail to reach their yield potential. Insufficient nitrogen also means the returns on other investments in the canola crop, including other nutrients, are not as high as they could have otherwise been.

Table 20. Best bet guide to N fertiliser for canola under different rotations and rainfalls

	Rate of nitrogen (kg/ha)	
	Medium rainfall **460-330 mm**	***Low rainfall*** **< 330 mm**
Previous phase Canola following	1.8-1.2 Yield potential (t/ha) 1.2-0.6	
Cereal	45-70	30-40
Legume/pasture	20-50	20-40

Make use of the TOPCROP West Nitrogen Wheel to calculate your best rate for canola taking into account summer rainfall and soil type. Contact your local TOPCROP Coordinator or agronomist for further details.

Unlike cereals, canola does not 'hay off' when too much nitrogen has been applied therefore fertilise according to the crops potential and soil nitrogen status.

Timing of application

The yield potential for canola is established during stem elongation and the budding stage, therefore, all N should be applied before this stage of growth, that is 4-8 weeks after seeding depending on location.

Application options:

- In heavier soils all N can be applied at seeding. Apply less than 15 N/ha with seed. Broadcast the balance before seeding so that seeder will bury most of the N.
- In high leaching situations it would be better to split the application. Apply a starter N of less than 15 N/ha with seeding. Broadcast the balance 4-8 weeks from seeding before stem elongation.
- In the lower rainfall areas more N can be added if the crop looks likely to have a high yield potential.

Canola seed is very sensitive to nitrogen fertiliser toxicity. Do not exceed 15 kg N/ha with seed. Under dry or drying conditions toxicity increases. Note that 100 kg/ha of Agras or Agstar or equivalent exceeds the 15 kg/ha of nitrogen with the seed.

Calculating your canola Nitrogen input according to yield potential and oil content

When planning inputs to a canola crop, none are more critical that nitrogen both in terms of the impact it can have on yield but also the impact it can have on your profits. Nutrition is a close second to time of sowing in terms of the effect on yield. Oil percentage is proportional to the yield potential of the crop but is often inversely proportional to its nitrogen status. Excessive nitrogen may increase vegetative growth and grain yield but protein and oil content will be lower.

The tables below allow a farmer to read off the expected yield and oil% for any canola crop, given an estimate of the yield potential and soil nitrogen status. Changes in yield and oil when different levels of nitrogen fertiliser are applied, can also be determined.

The tables can be used to see the impact of changing any of: time of sowing, variety, soil type, level of other nutrients location and seasonal conditions on the yield and oil of canola.

The steps to follow: Refer to Table 22 on page 29

1. Using your rainfall zone and cropping history, read off the estimated nitrogen supply from soil plus crop residues (Table 21).
2. Estimate the nitrogen non-limiting yield potential from PYCAL, the TopCrop handbook or else use your target yield multiplied by 1.2.
3. At the intersection of nitrogen supply and potential yield, read off grain yield from the upper table and oil % from the lower table on the next page. If you know your region has cool and or mild finishes to the season, then increase the oil% by 2 units.
4. Now add some units of fertiliser nitrogen (standard efficiency) to your original N supply.
5. Read off the grain yield and oil % for that level of nitrogen application.

Table 21. Nitrogen supply from soil and residues

Crop history		Rainfall zone		
Last year	**Year before**	**(< 350 mm) Low**	**(350-450 mm) Medium kg nitrogen/ha**	**(> 450 mm) High**
Non legume	Non legume	30	40	80
Non legume	Legume	40	50	100
Legume	Non legume	70	100	160
Legume	Legume	90	140	200

PHOSPHORUS

Phosphorus plays an important part in energy storage and use. Lack of available phosphorus restricts root growth. This results in poorly developed root systems; spindly, thin stems with few branches and

small narrow leaves. A severe phosphorus deficiency may cause a dark bluish colouration of leaves, often accompanied with purple or reddish colouration as well.

Soil phosphorus occurs in both organic and inorganic forms. Roots absorb only inorganic phosphorus present in the soil solution. The release of the bound form of phosphorus is influenced by many factors including the pH. Phosphorus should be placed close to the seed to obtain a starter effect. Canola has the ability to start absorbing banded fertiliser phosphorus in large amounts from early stage, and generally absorbs more total phosphorus than cereals. Canola is a better scavenger of phosphorus than cereals

The phosphorus requirement of canola is usually met by sowing the seed with an appropriate rate of a phosphorus-based fertiliser, determined by soil sample analysis. Apply 10-12 kg P for the medium to low rainfall regions. It is important for canola to have the phosphorus close to the seed, within 2-3 cm, as canola seed has very little P in reserve, but remember that fertiliser toxicity occurs if more than 15 kg/ha of nitrogen is applied near the seed.

SULPHUR

Canola has a high sulphur requirement because S is crucial to the synthesis of oil and proteins in canola as well as plant development. Sulphur is needed in the formation of chlorophyll for the photosynthesis. Plants can only use sulphur in the sulphate form. Most of the sulphur in the soil is contained in organic matter as proteins, amino acids and other compounds available to plants.

During the cool wet months of July and August, sulphur mineralisation is low (due to low soil micro-organism activity) and root exploration of the soil volume is low. This can result in the plants being unable to access sufficient sulphur, resulting in a temporary deficiency symptoms showing in patches. Later when the soil warms up there is sufficient sulphur mineralisation to provide enough of the mineral to the growing plant. At least 15 kg/ha S should be applied to canola, either at sowing or at commencement of flowering.

If sulphur deficiency persists then apply sulphur in the sulphate form, at about 10 kg S/ha.

Sulphur deficiency in canola crops is more common on sandplain soils and where leaching has moved residual sulphur from the root zone. Paddocks with a history of low sulphur fertiliser usage are also at risk.

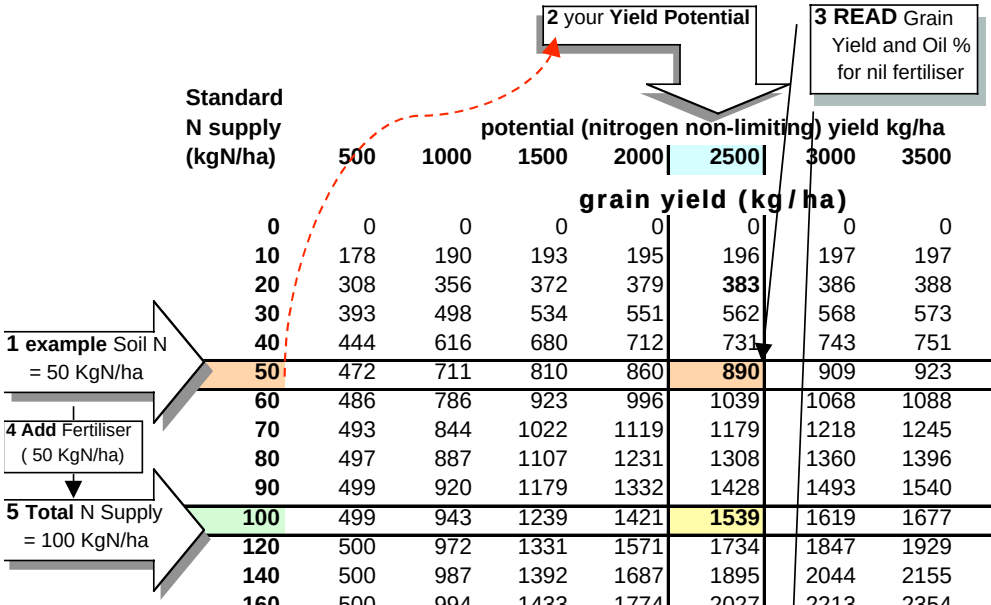
Increasing soil disturbance during cropping helps make sulphur more available as organic matter breaks down and releases useable sulphate. A trend towards direct drill and no-till may explain why there is increasing occurrence of sulphur deficiency in canola in some districts. After the heavy rainfall that was received in 1999 sulphur deficiency was widespread due the amounts that had been leach out with the rain. Cereals following canola often show deficiencies if adequate levels have not been applied.

Apply at least 15 kg S/ha for medium to low regions, this may need to be increased to 20 kg/ha on the high rainfall light soils of the Northern Agricultural region. Two common sources of sulphur are gypsum and ammonium sulphate. Gypsum is a good source of sulphur (16-18 per cent S) because unlike sulphate of ammonia it does not cause acidification of the soil.

POTASSIUM

Adequate supply of potassium provides plants with increased disease, frost and drought resistance, and increased starch production. Canola crops take up large amounts of potassium (K) during growth, but only a small proportion of this is removed in the seed. Few responses to potassium fertiliser in seed or oil yield have been recorded. Deficiencies are more likely to occur in the high rainfall areas on sandy surfaced soils where the depth to gravel or clay is more than 40-50 cm and the soil potassium test is below 50 ppm (data from Brennan and Edward, Agriculture Western Australia). Refer to the *Growing Golden Canola* manual for more information on addressing nutrient deficiencies in canola.

Table 22. Calculating your N requirement for canola according to yield potential and target oil content



Standard N supply (kgN/ha)	potential (nitrogen non-limiting) yield kg/ha									
	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
	grain yield (kg/ha)									
0	0	0	0	0	0	0	0	0	0	0
10	178	190	193	195	196	197	197	198	198	198
20	308	356	372	379	**383**	386	388	390	391	392
30	393	498	534	551	562	568	573	577	579	582
40	444	616	680	712	731	743	751	758	763	767
50	472	711	810	860	**890**	909	923	933	941	947
60	486	786	923	996	1039	1068	1088	1103	1114	1123
70	493	844	1022	1119	1179	1218	1245	1266	1282	1294
80	497	887	1107	1231	1308	1360	1396	1423	1444	1461
90	499	920	1179	1332	1428	1493	1540	1575	1601	1622
100	499	943	1239	1421	**1539**	1619	1677	1720	1753	1779
120	500	972	1331	1571	1734	1847	1929	1991	2039	2078
140	500	987	1392	1687	1895	2044	2155	2239	2304	2357
160	500	994	1433	1774	2027	2213	2354	2462	2548	2616
180	500	997	1459	1839	2133	2357	2529	2663	2770	2856
200	500	999	1475	1886	2218	2478	2682	2843	2972	3078
220	500	999	1485	1920	2285	2578	2813	3002	3155	3281
240	500	1000	1491	1945	2337	2661	2927	3143	3320	3467
260	500	1000	1495	1962	2377	2729	3023	3266	3468	3636
280	500	1000	1497	1974	2407	2785	3105	3374	3600	3790
300	500	1000	1498	1982	2431	2830	3174	3468	3717	3928

Standard N supply (kgN/ha)	potential (nitrogen non-limiting) yield kg/ha									
	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
	oil %									
0	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2
10	43.5	43.9	44.0	44.0	44.1	44.1	44.1	44.1	44.1	44.1
20	42.6	43.5	43.8	43.9	**44.0**	44.0	44.0	44.0	44.1	44.1
30	41.4	43.1	43.5	43.7	43.8	43.9	43.9	44.0	44.0	44.0
40	40.3	42.6	43.2	43.5	43.7	43.8	43.8	43.9	43.9	44.0
50	39.2	42.0	42.9	43.3	**43.5**	43.6	43.7	43.8	43.8	43.9
60	38.2	41.4	42.6	43.1	43.3	43.5	43.6	43.7	43.8	43.8
70	37.5	40.9	42.2	42.8	43.2	43.4	43.5	43.6	43.7	43.7
80	36.9	40.3	41.8	42.6	43.0	43.2	43.4	43.5	43.6	43.7
90	36.4	39.7	41.4	42.3	42.8	43.1	43.3	43.4	43.5	43.6
100	36.1	39.2	41.1	42.0	**42.6**	42.9	43.1	43.3	43.4	43.5
120	35.7	38.2	40.3	41.4	42.1	42.6	42.9	43.1	43.2	43.3
140	35.6	37.5	39.5	40.9	41.7	42.2	42.6	42.8	43.0	43.2
160	35.5	36.9	38.8	40.3	41.2	41.8	42.3	42.6	42.8	43.0
180	35.5	36.4	38.2	39.7	40.7	41.4	41.9	42.3	42.6	42.8
200	35.4	36.1	37.7	39.2	40.3	41.1	41.6	42.0	42.3	42.6
220	35.4	35.9	37.2	38.7	39.8	40.7	41.3	41.7	42.1	42.3
240	35.4	35.7	36.9	38.2	39.4	40.3	40.9	41.4	41.8	42.1
260	35.4	35.6	36.6	37.8	39.0	39.9	40.6	41.2	41.6	41.9
280	35.4	35.6	36.3	37.5	38.6	39.5	40.3	40.9	41.3	41.7
300	35.4	35.5	36.1	37.1	38.2	39.2	40.0	40.6	41.1	41.4

Add 2% oil if season has a very early start and/or a mild (long, cool) finish

MICRONUTRIENTS

There is a limited amount of information for micronutrient responses in canola throughout Western Australia. Until further trial data can establish what effect they have on oil and yield, growers are advised to apply micronutrients as they would for wheat in a similar situation.

Soil pH affects micronutrient availability and may result in problems with zinc, molybdenum and possibly boron deficiencies for canola. The micronutrient requirement of canola with marginal fertility soils in Western Australia needs further investigation, although Copper, Zinc and Molybdenum deficiencies have been diagnosed in soils low in these elements. Boron may be limiting on sandplain soils. In the NAR nutrient disorders may sometimes be due to low soil moisture making the nutrients unavailable to be taken up by the plant roots.

LIME AND SOIL ACIDITY

Canola has a similar tolerance to acidity as Barley and a range of tolerance has been observed in breeding material. Canola's preferred pH range is above 5.5. However, profitable crops are being grown on soils with much lower pH **(4.7 in 0–10 cm and 4.3 in the 10–20 cm, measured in calcium chloride $CaCl_2$)**. Profitability is unlikely if canola is sown on soils where the pH range drops below these levels.

Growers should monitor soil pH values and should be considering liming (apply 1-2 t lime/ha) if the pH is below 4.7, particularly if canola is part of the rotation. Acid Wodjil soils in are considered largely unsuitable for profitable canola production.

SALINITY

The presence of excess soluble salts is harmful to plants. Soils high in soluble salts are called 'saline'. The term 'alkali' is often incorrectly used to refer to saline soils. The degree of salinity or total soluble salt concentration in a soil can be measured with conductivity. If the soil analysis rates the soil at 0-2 conductivity, the soil is slightly saline, at 5-10 conductivity the soil is moderately saline, at 11-16 very saline, and over 16 extremely saline. Canola is considered moderately tolerant and can tolerant salinity up to levels of 5-6 conductivity. Farmers often comment that canola will grow in similar conditions to that of barley.

SOIL NUTRIENT CONTENT AND SOIL TESTING

The most commonly deficient nutrients in Western Australian soils are nitrogen and phosphorus. Potassium deficiencies are likely occur on sandy soils and possibly on some duplex soils of the Great Southern where wheat has shown responses. Canola has higher requirement for sulphur than cereals because of higher protein content in the seed.

Calcium and magnesium are generally not limiting to crop growth in Western Australia.

Variations in soil nutrient levels occur from year to year and may also vary within paddocks, even those areas that appear to be a uniform soil. Paddocks should be regularly soil tested to give an appreciation of its general nutrient status.

PLANT TISSUE ANALYSIS

Plant tissue analysis does not in any way diminish the importance of soil testing. Plant tissue analysis allows a producer to evaluate the effectiveness of fertiliser recommendations provided by a soil-testing laboratory. Plant tissue analysis may be a 'post-mortem' analysis if not done at the correct time to allow the farmer to apply the essential nutrient before growth is affected. Results may only be useful in determining management strategies to rescue a crop or to avoid problems in a subsequent crop.

Harvest management

SWATHING

For most high and medium rainfall districts, large crop areas and high yield crops are better managed by swathing before harvest. The crop will dry more evenly allowing earlier harvest, and reduce losses due to shattering. Canola has reached physiological maturity and is ready to swath when either the seed moisture content is between 30-40% or the seed colour change has reached 40-70%. Swathing at too high a moisture content, when the seed is immature, will adversely affect seed size, oil content and yield. The crop will be ready to swath 18-21 days from the end of flowering in the northern region.

Refer to 'Reaping the Good Oil' brochure, and video.

DIRECT HARVESTING

Direct harvesting canola is an alternative option for small areas or low yielding crops (< 0.7 t/ha).

The crop will be ready when the majority of pods are dry and rattle when shaken.

It is increasing in popularity as growers become confident in their harvest management of canola and are aware of the risks.

CANOLA DESSICATION - For improved harvesting

Chemical desiccation of the canola crop may be an option for harvest management, in cases where herbicide resistant weeds are a problem, where there is an uneven ripening within the paddock, or access to a swather is limited.

Reglone is the only chemical registered for use as a desiccant on canola. Other chemicals have been trialed (Roundup , Basta) with varying success rates.

- Apply Reglone by air at 1-1.5 L/ha ($18.80-$28.20 plus application cost).
- Apply when 80 per cent of seeds have changed colour, this can be between 30-36 days after the end flowering (depending on the area of the State grown).
- The crop will be ready to harvest after 3-5 days, or when the moisture content is at 8.5%.
- There is a withholding period of 4 days before seed can be delivered, once the chemical is applied.

The action of desiccation is quick and therefore the risk of pod shatter due to strong winds (Wongan Hills results showed swathing yields of 1.0 t/ha compared to 0.40 t/ha for the chemical treated areas.), is much greater than for one left to dry down naturally before direct harvesting. The additional cost needs to be considered also, and the availability of aircraft.

The best option at present for maximum yields and quality is SWATHING.

HARVEST

Ensure moisture meter is calibrated. Harvest when moisture content is below **8.5 per cent**. Harvest approximately 2 to 3 weeks after windrowing. Expect to take more time harvesting canola compared to a cereal crop. Moisture levels in canola are lower after mid-morning and remain so well into the evening.

Seed can be graded to remove weed seed such as ryegrass and radish in the harvest sample, which if left unchecked, will lead to poor germination.

Refer to the Bulletin 'Reaping the Good Oil', and the Video of the same name.

STORAGE

Quality canola stores well if its moisture and temperature are properly maintained. Storage of canola on-farm should only be for a maximum period of up to two months before being marketed.

Marketing

Canola producers can participate in a pooling system where grain income is received over 15 months or sell canola for cash at harvest. Cash contracts usually become available up to 14 months prior to harvest. Growers should exercise caution in contracting more that 25% of their expected canola production before sowing, as late opening rains may cause a material reduction in area of canola sown and lower yields.

Table 23. GPWA Canola receival standards 2001 in brief - oil content only

Oil %	Bonus/discount per % oil	Bonus/discount per clean seed tonne
42%	+ 1.75%	43% oil = +5.25%
42% to 41%	+ 1.75%	41% oil = + 1.75%
41% to 40%	+ 1.75%	40% oil = No + or -
40% to 39%	- 2.0%	39% oil = - 2.0%
39% to 38%	- 2.0%	38% oil = - 4.0%
38% to 37%	- 2.5%	37% oil = - 6.5%
37% to 36%	- 2.5%	36% oil = - 9.0%
36% to 35%	- 2.5%	35% oil = - 11.5%

Admixture penalties are on a basis of 1% with a 1% premium for 0%. As the admixture increases, the deduction s are graduated out to 30% which is the maximum allowable. Refer to Grain Pool of WA for further details on receival standards for 2001/2002.

CASE STUDY 1: Wongan Hills

MICHAEL BRENNAN, WONGAN HILLS

Time growing canola: Since 1994.

Average yield: 1.2 t/ha (~ 41% oil).

Best-worst (paddock): 2.0 t/ha-0.63 t/ha. Best yields red loams, worst yields light sandplain.

Best-worst (program): 1.6 t/ha-0.63 t/ha. Best year 1999 on red loams, worst year 1994 first year growing canola very dry and inexperienced with harvest and swathing.

Variety: Mainly Karoo with Surpass 501TT and Surpass402 Clearfield this season.

Area sown: 56-859 ha. Smaller area sown 1994 when grown for first time. Average area 534 ha.

Seeding date: Earliest 21 April - Latest 20 May.

Lupins and canola are both sown whether dry or wet starting around 20 April.

Seeding rate: 5-7 kg/ha depending on soil moisture conditions and soil type.

Seed quality: All retained seed is tested for germination and vigour. All retained seed is graded to achieve large seed size.

Paddock preparation: Lime 1 t/ha applied to paddock prior to sowing and gypsum 200 kg/ha spread before sowing.

Fertiliser:
Soil phosphate levels 20-35 ppm

P	10 kg/ha
N	60-80 kg/ha depending on rotation
S	> 20 kg/ha
K	50 kg/ha (on sand only)

Major weeds: Ryegrass, wild radish.

Seeding: One pass seeding with Flexi Coil bar fitted with Maxi points 19 cm (7") row spacing with primary sales split boots. Rolling harrows on bar.

Swathing: Own swather.

Harvest: Gleaner header with pickup front.

Rotation: Crop area 3,500 ha total each season with approximately 50% broadleaf crops (lupins and canola). Rotation is principally LWCB. Most paddocks have been in continuous crop for 10 years. This allows us to maintain a three year break between canola crops.

Reasons for growing canola:

- LWCB rotation appears to have a good fit in terms of both disease and weed control. Profitability has also increased over this rotation. Lupin yields have improved markedly with the longer disease break.
- The ability to use other herbicide groups and swathing to assist in radish and ryegrass management.
- TT varieties can be sown either dry or immediately after opening rains while waiting for weeds to germinate on cereal paddocks. Therefore timeliness of cereal sowing is improved.
- Timeliness of harvesting the entire crop program is better as can commence harvesting the canola section earlier.
- Some of the best wheat crops on the farm have come after growing Canola.

Herbicides: Knockdowns and atrazine pre-seeding. Atrazine plus oil post emergent. Generally use Select for improved ryegrass control 2 weeks after post atrazine. Atrazine proves to be very poor on Rye grass.

Major insect threat: Native budworm prior to swathing (1 in 4 years). Redlegged earth mite and lucerne flea in the establishment phase. Lucerne flea is the most significant pest on heavy country.

Insecticides: Cypermethrin or Alphacypermethrin for budworm. Endosulphan for RLEM and lucerne flea. Will use chlorpyrifos in place of endosulphan early post emergent this year.

Blackleg control: Blackleg does not appear to be a major limiting factor for us with our rotations and location. Plan to grow better varieties for oil content and blackleg tolerance. Have observed increased blackleg pressure in crops.

Critical comments

Sow early but not before mid-April.

Early insect control is critical to the success of the crop.

Monitor regularly through the season. At weekly early post seeding and monthly there after.

Case Study by David Williams, Agrarian Management, Wongan Hills.

CASE STUDY 2: Tenindewa

MURRAY AND BETTY AND BRAD AND NARELLE SMITH, TENINDEWA

Time growing canola: Since 1997.

Average yield: 1.0 t/ha (~ 41.5% oil).

Best-worst (paddock): 1.8 t/ha-0.5 t/ha. Best yields red sandy loams, worst yields light fluffy sandplain.

Best-worst (program): 1.5 t/ha-0.8 t/ha. Best year 1997 on red sandy loams, worst year 1999 extremely wet year on sandplain.

Variety: Mainly Karoo.

Area sown: 300-1700 ha. Smaller area sown 1997 when grown for first time. Average area 800 ha.

Seeding date: Earliest 16 April - Latest 25 May (2000). When soil conditions wet, sow canola first. When dry, sow lupins first in the programme.

Seeding rate: 6 kg/ha.

Paddock preparation: Lime applied to paddock the previous season (pH ~ 4.8 CaCl2) and gypsum 200 kg/ha spread before sowing.

Fertiliser: Soil test results average as follows - P 16 ppm, K 85 ppm, S 3 ppm organic carbon 0.3%.

Applied nutrition generally as follows:

P	10 kg/ha
N	80 kg/ha
S	> 20 kg/ha
K	25 kg/ha

Fertilisers used vary according to cost effectiveness from year to year.

Major weeds: Ryegrass, wild radish and brome grass.

Seeding: One pass seeding mainly with Shearer 50' Sabre bar fitted with coulters and press wheels into wheat stubble, 24 cm (9.5") row spaces.

Swathing: Marshall Bros contractors.

Harvest: New Holland headers with pickup fronts.

Rotation: Crop area > 6,500 ha total each season with approximately 50% broadleaf crops (lupins and canola). Rotation is principally LWCW. Most paddocks have been in continuous crop for 25 years. This allows us to maintain a three year break between canola crops.

Reasons for growing canola:

- After lengthy LWLW rotation brown leaf spot (BLS) increased to extreme levels which reduced lupin profitability. LWW rotation resolved BLS but favoured brome grass populations. LWCW rotation appears to have a good fit in terms of both disease and weed control. Lupin yields have improved markedly with the longer disease break. Timeliness of harvesting the entire crop program is better as can commence harvesting the canola section earlier.
- The ability to use other herbicide groups and swathing to assist in radish and ryegrass.
- TT varieties can be sown either dry or immediately after opening rains while waiting for weeds to germinate on cereal paddocks. Therefore timeliness of cereal sowing is improved.
- Timeliness of harvesting the entire crop program is better as can commence harvesting the canola section earlier.

Herbicides: Knockdowns pre-seeding. Atrazine pre-sowing. Atrazine plus oil post emergent. Generally include grass selective herbicides for improved grass control especially when grasses are beyond the two leaf stage.

Major insect threat: Native budworm prior to swathing.

Insecticides: Cypermethrin or Alphacypermethrin depending on cost for budworm. RLEM and lucerne flea not usually a problem.

Blackleg control: Blackleg does not appear to be an economic issue for us with our rotations and location. Plan to grow better varieties for oil content and blackleg tolerance.

Critical comments

Sow early but not before mid-April.

Dry sowing is very risky because wind and/or heavy rain can cause furrow fill and disrupt seed depth which results in very poor emergence and low plant densities.

Monitor regularly through the season. At weekly early post seeding and monthly there after.

Case Study by Paul McKenzie, Agrarian Management, Geraldton 2001.

APPENDIX

APPENDIX 1: GROSS MARGIN COMPARISON TRIAZINE TOLERANT vs IMIDAZOLINONE TOLERANT CANOLA

Fertiliser and herbicide rates and prices used are an average of what is commonly used in the area on similar soil types to the trial site. The intention of the comparison is to evaluate the cost effectiveness and production risk of both canola systems.

Input costs/ha	Triazine	Imidazolinone
Pre-season Knockdown Roundup 1 L/ha	$5.00	$5.00
Bare earth Insecticide Talstar 50 mL/ha	$5.50	$5.50
Atrazine Pre and Post 2 L (4 L/ha)	$20.00	
Grass Selective Select 250 mL/ha	$22.50	
Lontral 100 mL/ha	$5.00	
Trifluralin Pre-sowing (2 L/ha)		$15.00
On Duty Herbicide and Seed (4 kg/ha sowing rate)		$90.00
Extra 2 kg Clearfield Seed @ ($4/kg) to get Total 6 kg/ha sowing rate		$8.00
Late Season Insecticide Fastac 250 mL/ha	$4.50	$4.50
New TT Variety Seed (6 kg/ha) @ $4.20/kg	$25.20	
Sub total	**($92.70)**	**($128.00)**
Fertiliser costs:		
Agstar 120 kg/ha (price inc. freight to farm)	$49.60	$49.60
Urea 120 kg/ha (price inc. freight to farm)	$46.55	$46.55
Sub total	**($96.15)**	**($96.15)**
Operating costs:		
Swathing	$20.00	$20.00
Harvesting	$25.00	$25.00
Fuel (extra fuel for TT due to extra spray applications)	$25.00	$23.00
Repairs and maintenance	$25.00	$25.00
Insurance	$4.00	$4.00
Labour	$10.00	$10.00
Sub total	**($109.00)**	**($107.00)**
Seasonal Interest (6 months @ 10%)	$14.89	$16.57
Total costs/ha	**$312.69**	**$347.72**

Supplied by Agrian Management, Geraldton

APPENDIX II: CASE STUDY OF ACTUAL COSTS AND RETURNS LOW TO MEDIUM (YUNA) AND HIGH RAINFALL (MINGENEW) ZONES OF THE NORTHERN AGRICULTURAL REGION

- Yuna Paddock Red loam continuous crop country in the low to medium rainfall zone. This area in most summers will receive at lest 50-150 mm of summer rain, and in 2000 received 183 mm, as a result Cabbage Moth and other warm season insects are becoming a problem.
- Mingenew paddock typical Mingenew sandplain long history of continuous crop in the high rainfall zone of the northern Wheatbelt. Summer rainfall is not as common in this area hence the insect pressure is not as great.
- Both paddocks sown onto Wheat stubble, on typical paddocks for there area with a moderate level of resistant Rye Grass. Rye Grass numbers a lot higher at Mingenew and lighter soil results in multiple germinations of Rye Grass, hence the need for Trifluralin to be added to the pre emergent Atrazine.

Input costs/ha	Yuna	Mingenew
Pre season Knockdown Roundup 1 L/ha	$5.00	$5.00
Insecticide added to Knockdown Chlorpyrifos 200 mL/ha	$2.50	
Bare earth Insecticide Thiodan 500 mL/ha	$7.00	
Atrazine Pre and Post 2 L (4 L/ha)	$20.00	$20.00
Grass Selective Select 250 mL/ha	$22.50	$22.50
Lontral 100 mL/ha	$5.00	$5.00
Trifluralin Pre Sowing (2 L/ha)		$15.00
Post em Insecticide for Cabbage moth Control 300 mL Buldock Duo/ha	$6.00	
Late Season Insecticide Fastac 250 mL/ha	$4.50	$4.50
New TT Variety Seed (6 kg/ha Mingenew, 4 kg/ha Yuna) @ $4.95/kg	$19.80	$29.70
Sub total	**($92.30)**	**($101.70)**
Fertiliser costs:		
Agstar 100 kg/ha (price inc. freight to farm)	$41.30	$41.30
Urea 100 kg/ha Yuna (price inc. freight to farm)	$36.00	
N/S 41 150 kg/ha Mingenew (price inc. freight to farm)		$48.90
Potash 50 kg/ha (light soils only)		$19.05
Sub total	**($77.30)**	**($109.25)**
Operating costs:		
Swathing	$20.00	$20.00
Harvesting	$25.00	$25.00
Fuel (extra fuel for Yuna due to extra spray applications)	$25.00	$23.00
Repairs and Maintenance	$25.00	$25.00
Insurance	$4.00	$4.00
Labour	$10.00	$10.00
Sub total	**($109.00)**	**($107.00)**
Seasonal interest (6 months @ 10%)	$13.93	$15.89
Total costs/ha	**$292.53**	**$333.84**
Yield	1.3 t/ha 42% oil	1.2 t/ha 43.3% oil
Total income/ha	**$387.26**	**$362.33**
Gross margin/ha	**$94.73**	**$28.49**

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Further reading and research

'Growing Golden Canola' Manual	(Available through Kondinin Group or Rural Connect 1 800 11 00 44 or phone AGWEST, Publications 08 9368 3279.)

Some useful Internet sites on canola are:

AGWEST:	**www.agric.wa.gov.au**
SARDI:	**www.sardi.sa.gov.au/crops/oilseeds/canola.html**
Canola Council of Canada site:	**www.canola_council.org**
Alberta Agriculture:	**www.agric.gov.ab.ca/crops/canola/harvest1.html**
Farmnotes: 139/2000	'Blackleg canker rating on canola varieties for 2001'
12/2001	'Canola varieties - 2001'
013/2001	'Weed control in triazine tolerant canola'
Bulletin No. 4482	Crop Variety Sowing Guide 2001
Bulletin No. 4406	Fungal Disease of Canola in WA

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