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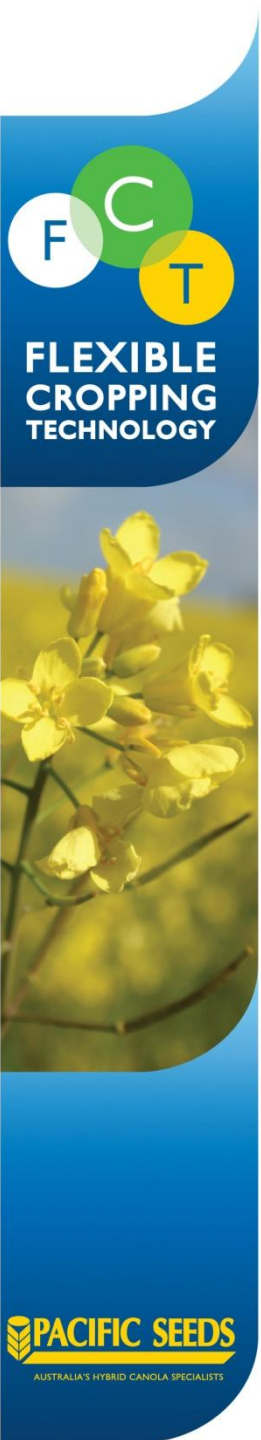
Blackleg resistance in Canola; its breakdown and latest strategies being adopted in Australia to manage the disease

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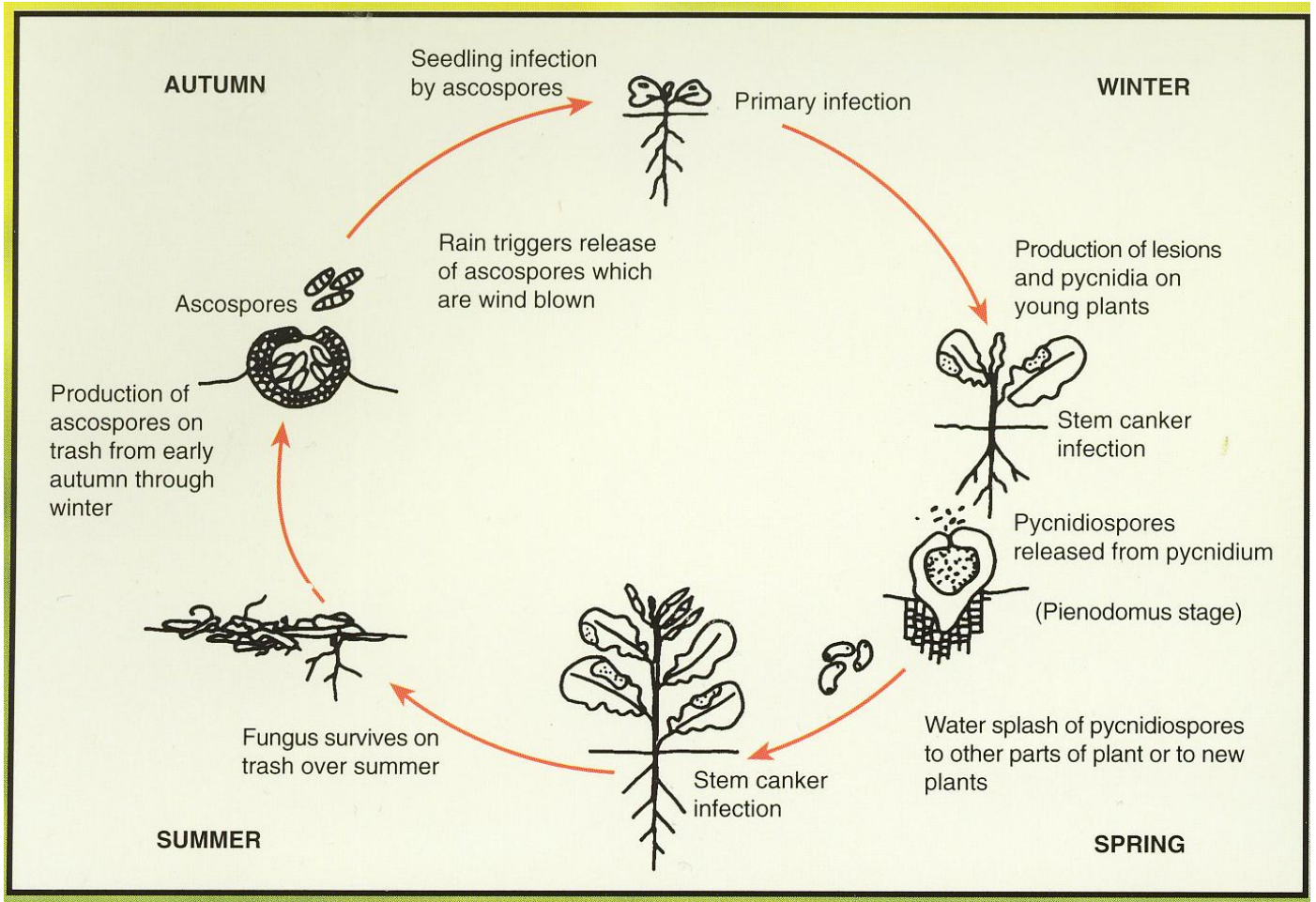
Blackleg

- Disease Lifecycle
- Factors affecting disease severity
- Types of resistance
- Disease screening methodology
- Blackleg Management Guide
- Blackleg resistance ratings and groupings



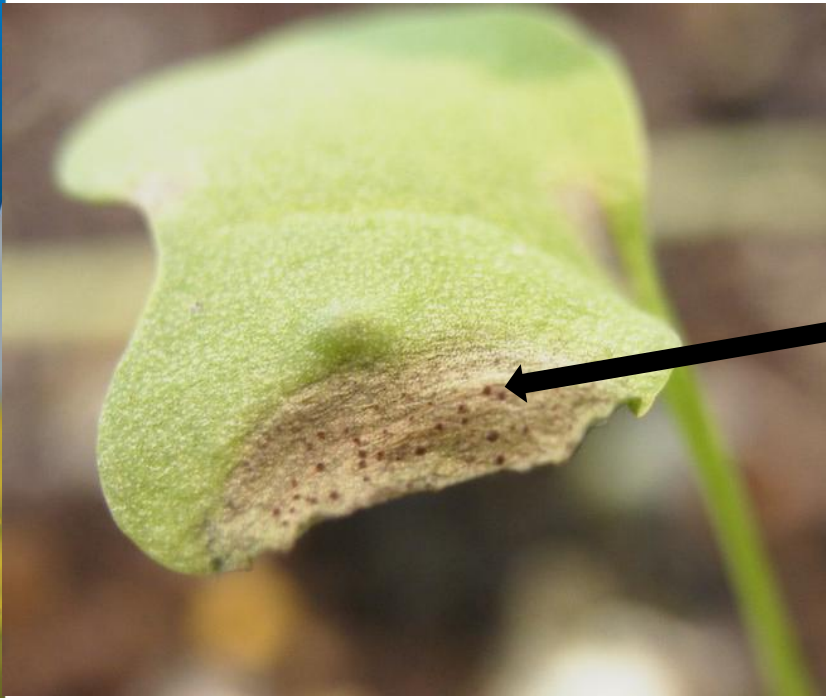
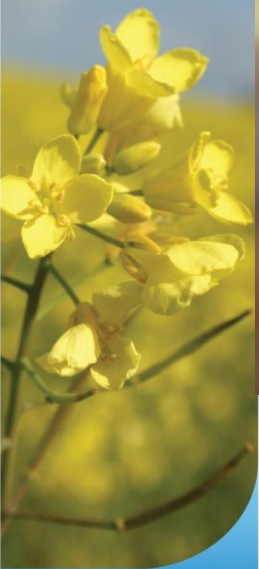
Blackleg Life Cycle

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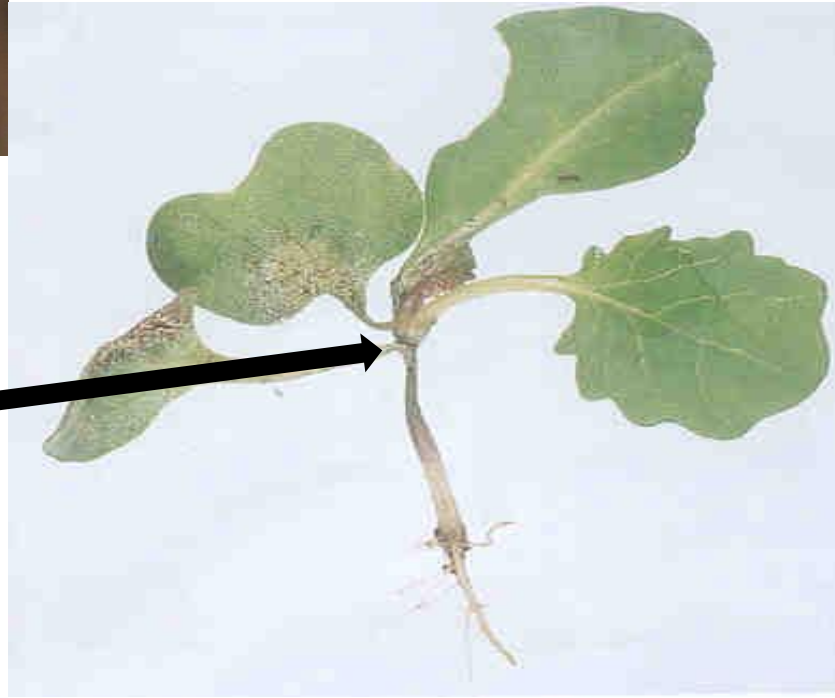
Blackleg Seedling Symptoms

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Pycnidia

**Constriction at base
of cotyledons**



Blackleg Adult Plant Symptoms



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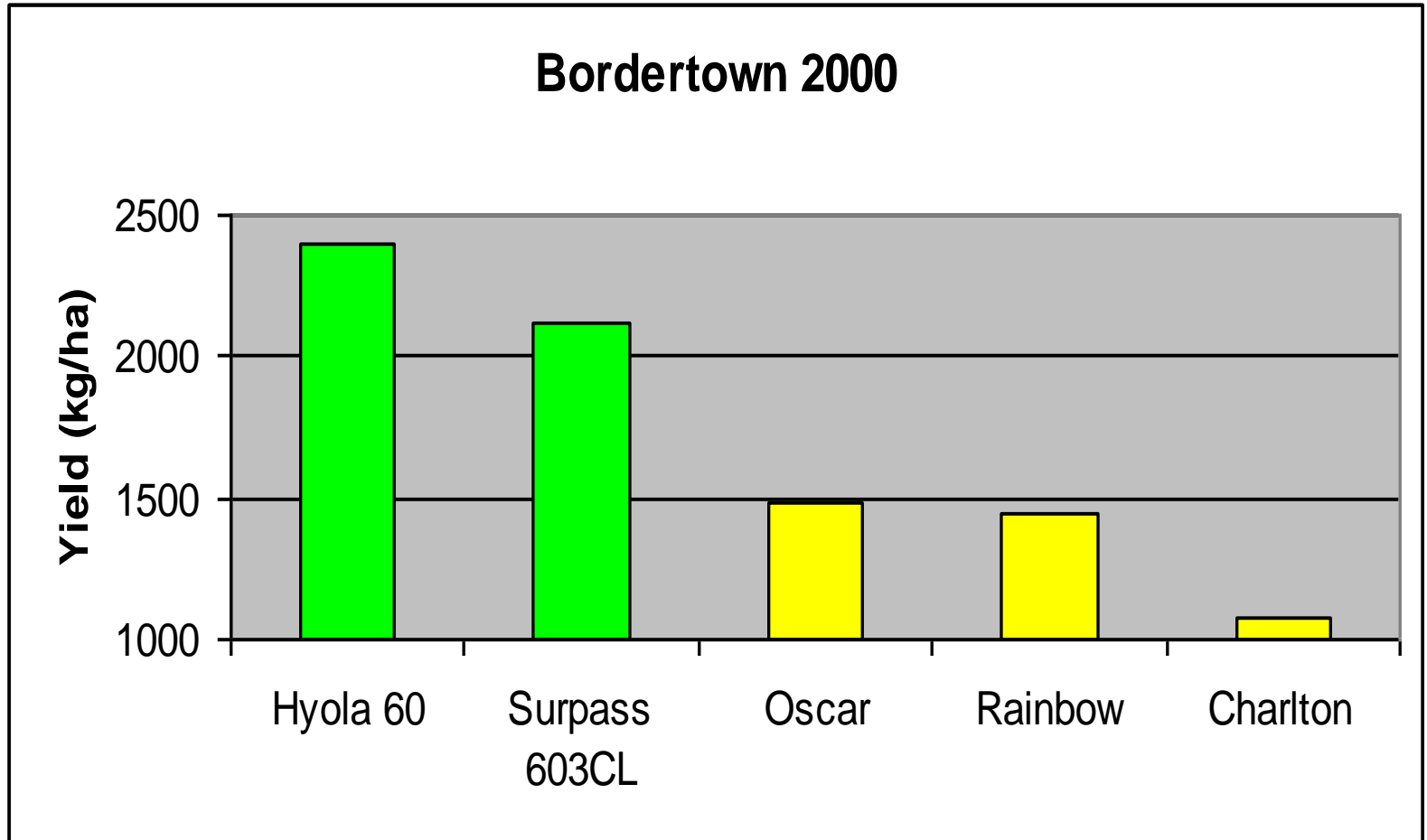
**Cankering at plant base
Death from flowering onwards**



Yield Under High Blackleg Pressure



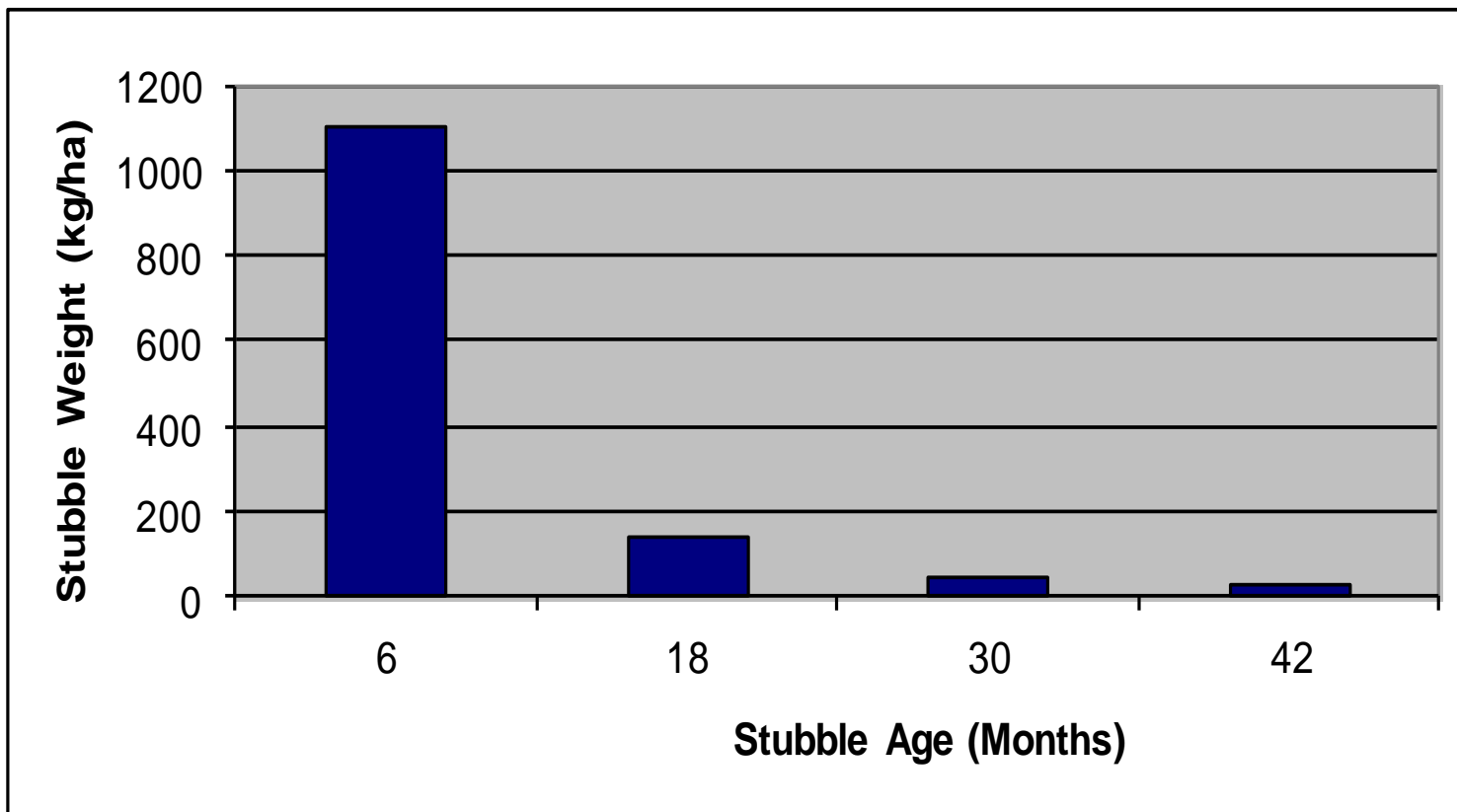
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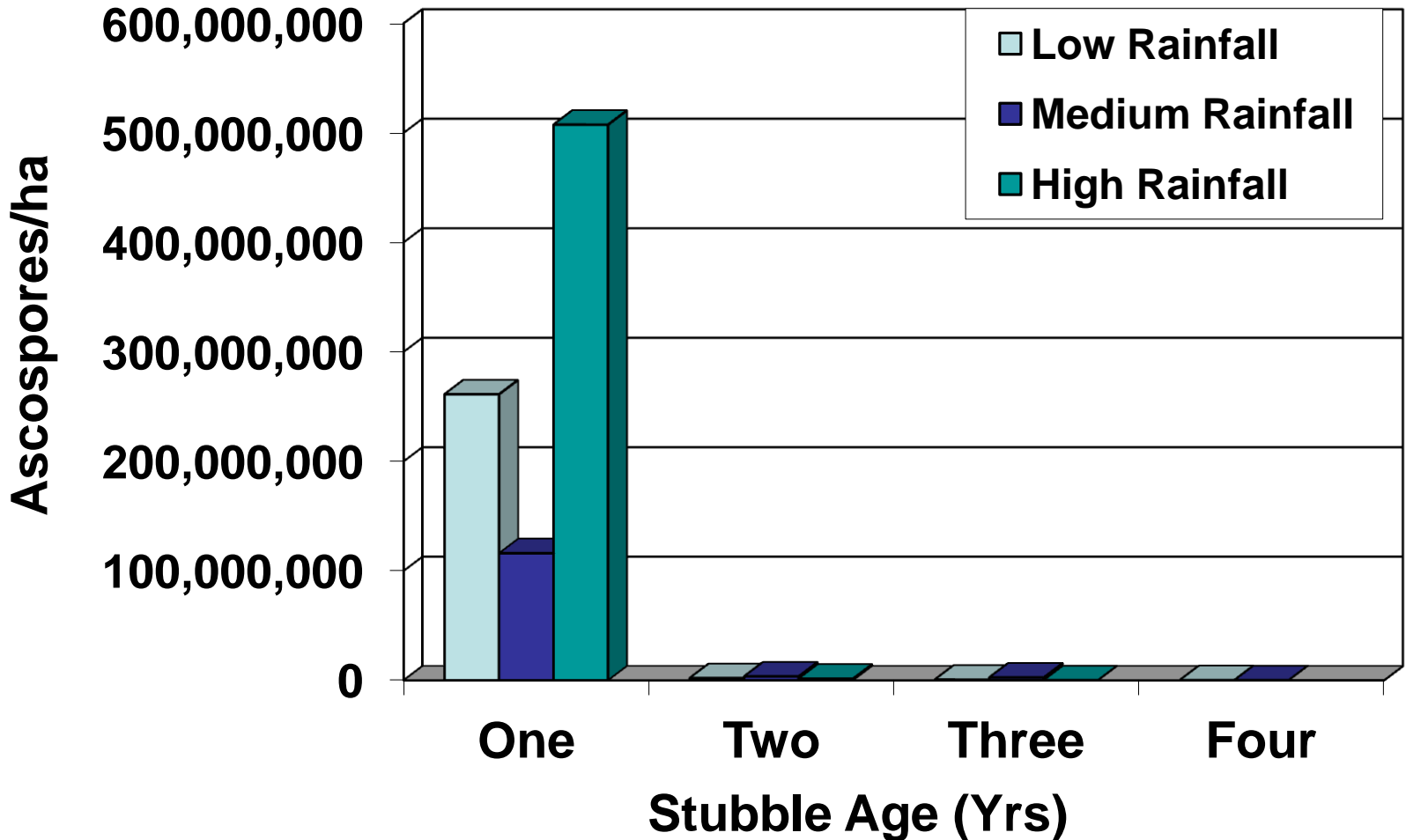
Effect of Time on Stubble Weight



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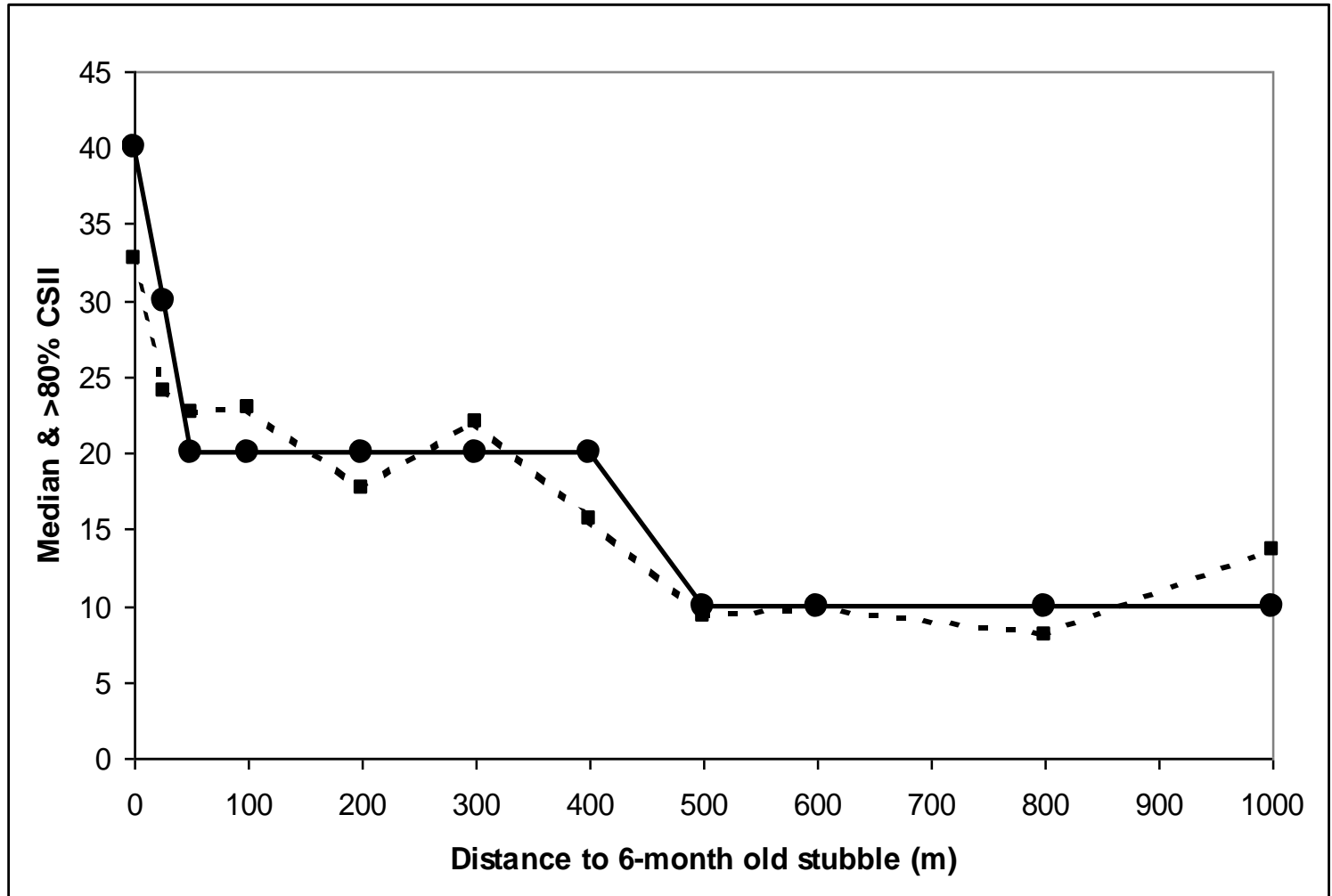
Effect of Time and Rainfall on Ascospore Release



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Effect of Distance on Disease Incidence



Source: Marcroft, S. DPI Vic. Average of low, med and high rainfall sites 2000/2001 data



Effect of Stubble Management on Ascospore Discharge



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Stubble Age (Months)	Stubble Treatment	Stubble Wt (kg/ha)	Ascospore Discharge/ha
6	Conserved	1213	765,896,000
	Destroyed	571	248,888,000
18	Conserved	108	2,463,000
	Destroyed	70	463,000
30	Conserved	29	13,000
	Destroyed	26	11,000

Types of Resistance

There are two types of resistance for Blackleg

- Qualitative or seedling stage resistance
- Quantitative or adult-stage resistance

To date thirteen major resistance genes have been reported

- *B. napus* = *Rlm1*, *Rlm2*, *Rlm3*, *Rlm4*, *Rlm7* and *Rlm9*
- *B. rapa* = *Rlm8*
- *B. rapa* subsp. *sylvestris* = *LepR1*, *LepR2*, *LepR3* & *LepR4*
- *B. juncea* = *Rlm5* and *Rlm6*



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Why is Blackleg Such a Successful Pathogen?

- Large inoculum loads present in crop stubble
- Sexual reproduction on stubble
 - Extremely large populations of genetically diverse wind-borne recombinant ascospores
- Prolific asexual spore production
- Populations readily adapt to selection pressure from extensive sowing of cultivars with same resistance genes
- Rapid virulent isolate frequency increases

→ **Resistance Breakdown**

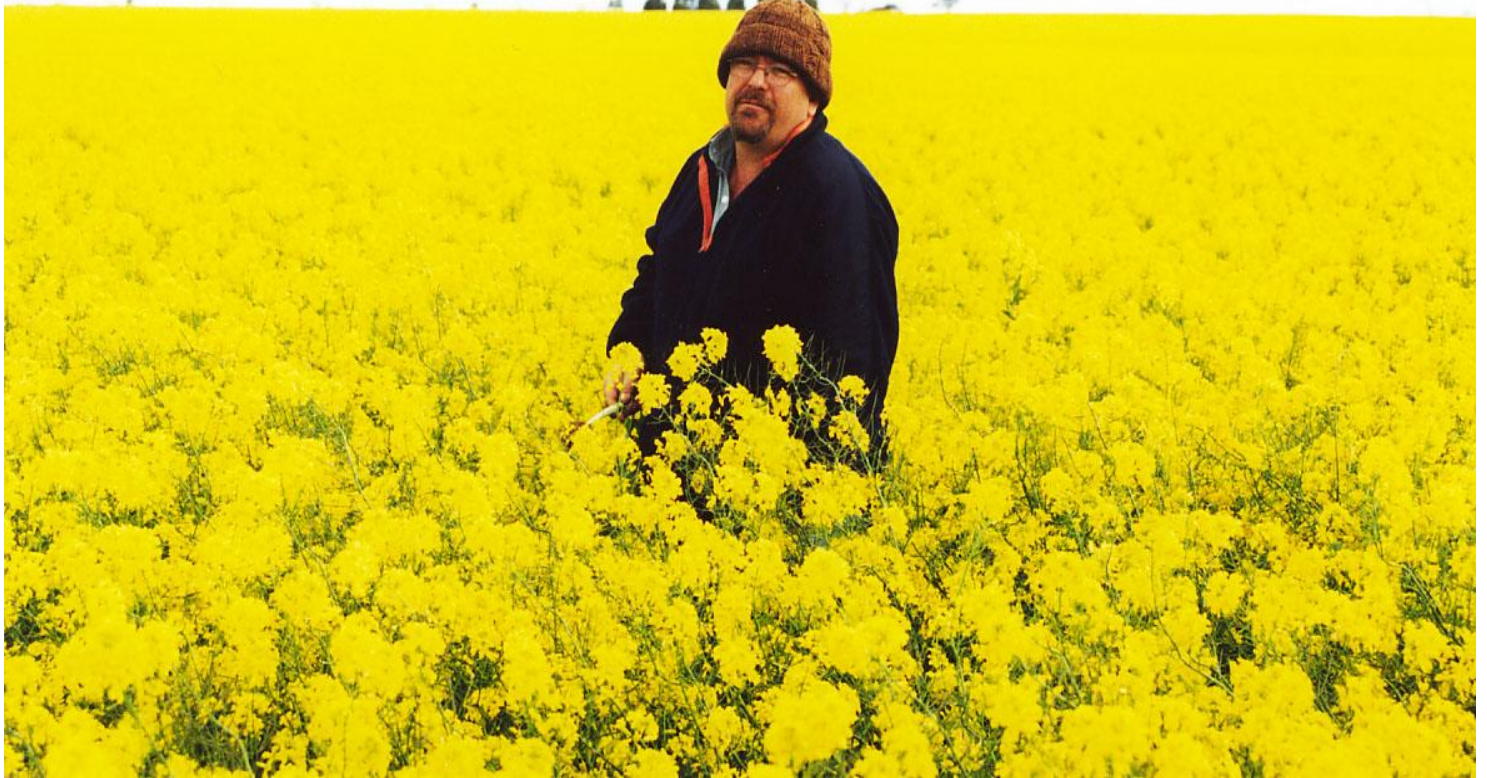


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Cummins 2002

Surpass 400



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Cummins 2003

Tornado TT

Surpass 400



1 Oct 2003

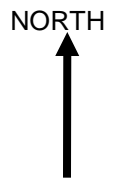
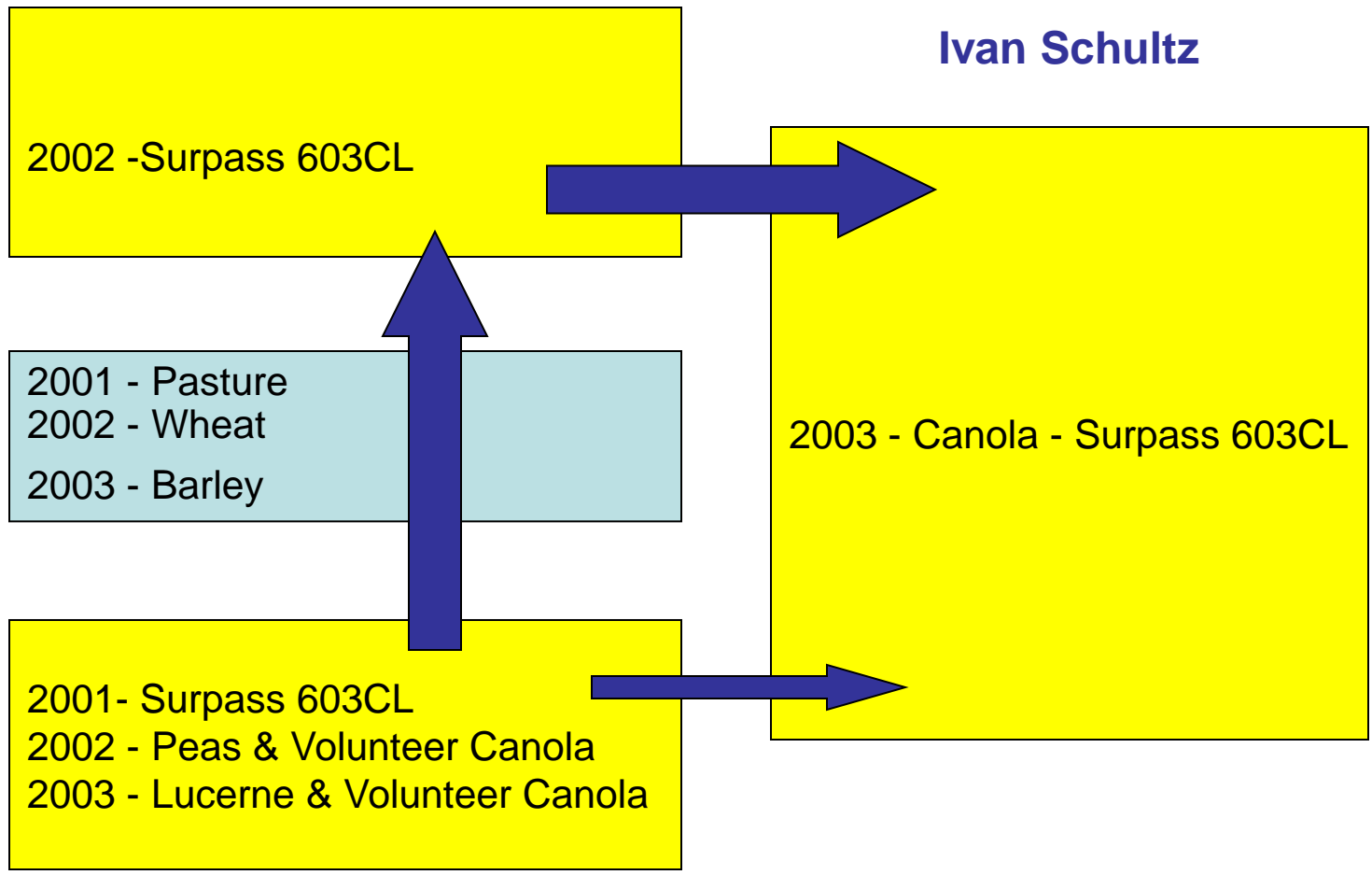
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Cropping History



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Single Spore Isolate Screening Methodology



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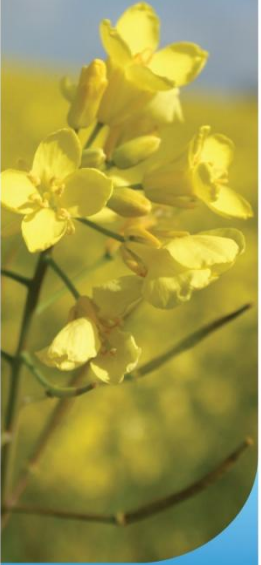


Growing *L. maculans* single spore
isolate on agar plate

Single Spore Isolate Screening Methodology

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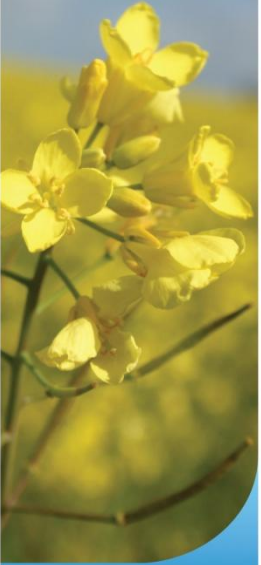
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Stubble Type Screening Methodology

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Assessing Adult Plant Resistance



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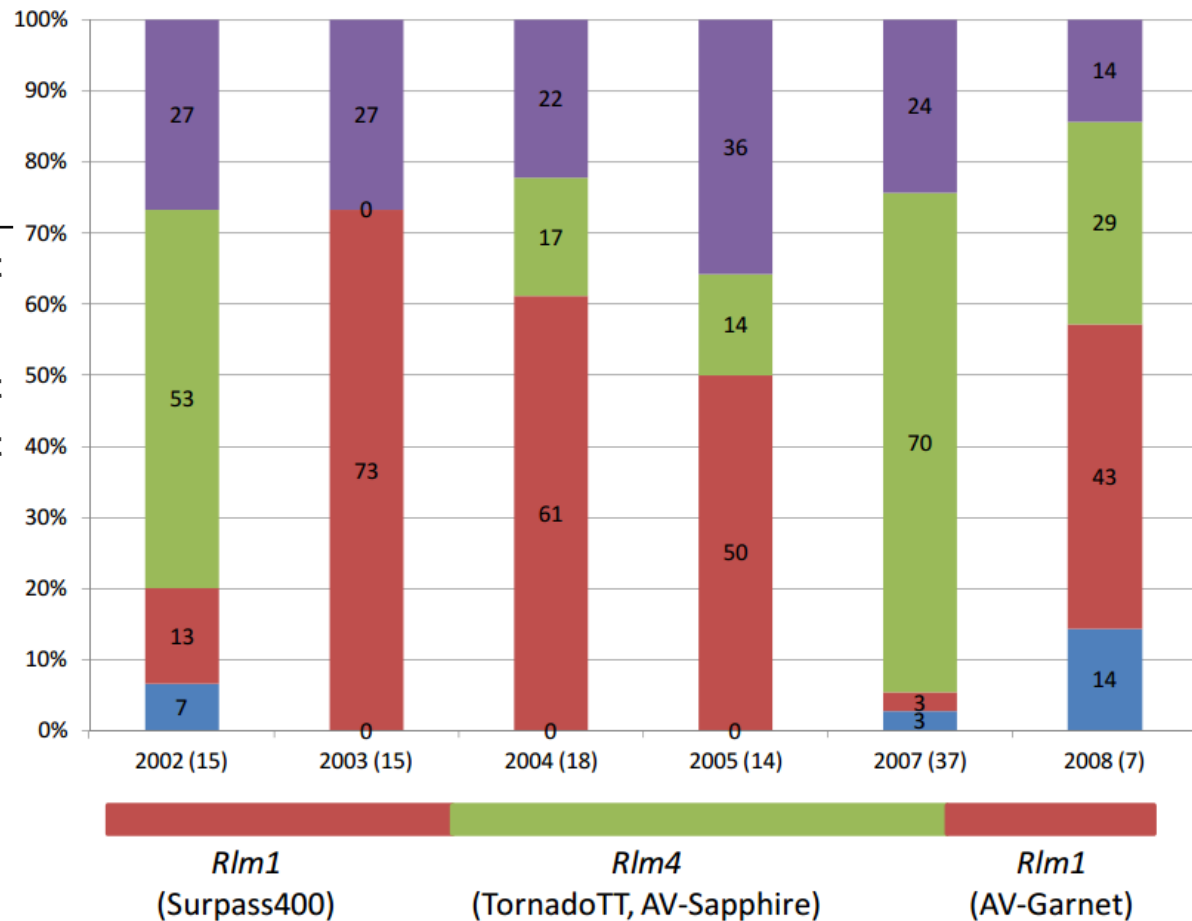
Variety Effect on Blackleg Population Dynamics



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	Rlm1	Rlm4
	Virulent	Avirulent
	Avirulent	Virulent
	Virulent	Avirulent
	Avirulent	Avirulent



Blackleg Management Guide – Step 1

STEP 1: Use Table 1 to determine your farm's blackleg risk

Table 1 Regional blackleg factors.

Environmental factors that determine risk of severe blackleg infection	Blackleg severity risk factor								
	High risk			Medium risk			Low risk		
Regional canola intensity (% area sown to canola)	above 20	16-20	15	11-14	11-14	10	6-9	5	below 5
Annual rainfall (mm)	above 600	551-600	501-550	451-500	401-450	351-400	301-350	251-300	below 250
Total rainfall received Mar–May prior to sowing (mm)	above 100	above 100	above 100	above 100	91-100	81-90	71-80	61-70	below 60

Combined high canola intensity and adequate rainfall increases the probability of severe blackleg infection.




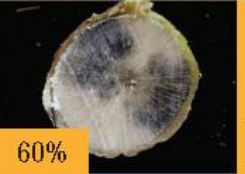



Blackleg Management Guide – Step 2

STEP 2: Determine each crop's blackleg severity

- ▶ Assess the level of disease in your current crop. Sample the crop anytime from the end of flowering to windrowing (swathing). Pull 60 randomly chosen stalks out of the ground, cut off the roots with a pair of secateurs and, using the reference photos in Table 2, below, estimate the amount of disease in the stem cross-section. Yield loss occurs when more than half the cross-section is discoloured.
- ▶ A dark-coloured stem is a symptom of blackleg (Table 2). Stem cankers are clearly visible at the crown of the plant. Severe cankers may cause the plant to fall over as the roots become separated from the stem.
- ▶ If you have identified that you are in a high-risk situation (Steps 1 and 2), use Steps 3 and 4 to reduce your risk of blackleg for future seasons.



Table 2 Crop blackleg severity.

High risk		Medium risk		Low risk		
						
Cankered	100%	80%	60%	40%	20%	0%

Yield loss occurs when more than half of the cross-section is discoloured.

Blackleg Management Guide – Step 3

STEP 3: Management practices can reduce the risk of blackleg infection

If your crop monitoring (see Step 2) showed yield loss in the previous year, the following practices can be used to reduce blackleg severity. Complete the following process for each canola paddock to be sown.

- For each of the seven management factors listed below, circle where each canola paddock fits to determine the risk of blackleg. For example, Blackleg rating: if your cultivar is AV-Garnet, circle MR indicating a low risk of blackleg; or Distance from last year's canola stubble: if your proposed canola crop is 200 metres away, high risk is indicated.
- Complete all seven management factors to determine which practices are causing increased risk and how they can be reduced. For example, for Distance from last year's canola stubble, choose a different paddock, at least 500m away from last year's stubble, reducing the risk from high to low.

WARNING: 'CANOLA ON CANOLA' WILL CAUSE A SIGNIFICANT YIELD LOSS AND WILL REDUCE THE EFFECTIVE LIFE OF CANOLA CULTIVARS AND FUNGICIDES.

Blackleg management practices that determine risk of blackleg infection, from highest to lowest effectiveness are:

Blackleg ratings

The cultivar blackleg rating is the most important blackleg management tool. If your previous crop had a high level of disease, choose a cultivar with a higher blackleg rating. The 2014 Blackleg Ratings are listed in Table 3 Section A on page 4.

	High risk		Medium risk			Low risk		
VS	S-VS	S	MS-S	MS	MR-MS	MR	R-MR	R

*VS = very susceptible; S = susceptible; MS = moderately susceptible; MR = moderately resistant; R = resistant; P = provisional rating

Distance from last year's canola stubble

The distance of your current crop to last year's canola stubble will determine disease severity. NEVER sow your canola crop into last year's canola stubble. Distances from last year's stubble up to 500m will reduce blackleg severity.

	High risk		Medium risk			Low risk		
0m	100m	200m	300m	400m	500m	>500m		

Fungicide use

Fungicides will provide an economic return only if your crop is at high risk of yield loss. Fungicides complement other management practices, never rely solely on fungicides.

RELiance ON FUNGICIDES TO CONTROL DISEASE POSES A HIGH RISK OF FUNGICIDE RESISTANCE.

	High risk		Medium risk			Low risk		
No fungicide		Foliar applied fungicide		Seed dressing fungicide	Fertiliser applied fungicide	Seed dressing + fertiliser applied fungicide	Seed dressing or fertiliser applied + foliar fungicide	

Blackleg Management Guide – Step 3

► Years of same cultivar grown

The blackleg pathogen will overcome cultivar resistance genes if the same genes are used each year. By sowing a cultivar based on different resistance genes, the ability of the pathogen to overcome resistance will be reduced. All cultivars have been placed into different blackleg resistance groups based on their resistance complement (see Table 3).

If you have:

- high or increasing levels of blackleg in your crop (from monitoring disease levels each year);
- used the management practices outlined here in Step 3; and
- sown cultivars from the same resistance group in close proximity (within 2km) for three or more years,

then sow a cultivar from a different resistance group (see next page – Blackleg Resistance Groups).

High risk			Medium risk			Low risk		
Sown the same cultivar- resistance group for more than 3 years			Sown the same cultivar- resistance group for 3 years			Sown the same cultivar- resistance group for 2 years	Sown the same cultivar- resistance group the previous year	Sown cultivar from a different resistance group

► Distance from two-year-old canola stubble

Stubble older than two years produces fewer blackleg spores and will normally have minimal effects on blackleg severity, even where canola is sown into two-year-old stubble. However, two-year-old stubble may cause disease if inter-row sowing canola (see below, Canola stubble conservation) or if the cultivar resistance has been overcome.

Medium risk			Low risk		
	0m	100m	250m	500m	>500m

► Canola stubble conservation

Stubble destruction is not effective in reducing blackleg infection. Inter-row sowing canola into two-year-old canola stubble where germinating seedlings are immediately next to standing stubble may result in higher levels of blackleg infection.

Medium risk			Low risk		
Inter-row sowing	Disc tillage	Knife point tillage	Burning/ burying tillage		

► Month sown

Canola is most vulnerable to blackleg as a seedling. If crops are sown early into warmer conditions and get through the seedling growth stage quickly, they may escape high blackleg severity.

Medium risk			Low risk		
June to August	May 15 to 31	May 1 to 14	April 15 to 30		

Blackleg Management Guide – Step 3

STEP 4: Blackleg resistance groups

Canola cultivars have different combinations of blackleg resistance genes. Over time, growing cultivars with the same blackleg resistance genes has led to changes in the blackleg pathogen's virulence which has enabled it to overcome cultivar blackleg resistance. By rotating between cultivars with different resistance genes, you can reduce the probability of resistance breakdown and reduce disease severity.

Based on Steps 1 to 3, are you in a high risk region or have been observing increasing blackleg severity and have been growing the same cultivar in close proximity for three years or more?

- **No** - Your current management practices should be sufficient to adequately manage blackleg resistance.
- **Yes** - You may be at risk of the blackleg fungus overcoming the blackleg resistance of your cultivar and it is recommended you grow a cultivar with a different combination of blackleg resistance genes.
- To facilitate this process, all cultivars have been placed into groups (A to G) based on their resistance genes in **Table 3**.
- **You do not need to change resistance groups (cultivars) every year.**

Using Table 3

- **1.** Identify the resistance group of your previously grown cultivar using the column labelled **Section B – 'Resistance group of cultivar'** (shaded in Light Purple). Note; Some cultivars belong to multiple groups. Some cultivars have not yet been classified and rotation recommendations cannot be made for these cultivars.

Examples: AV-Garnet belongs to Resistance Group A

Hyola 50 belongs to resistance Groups A and D

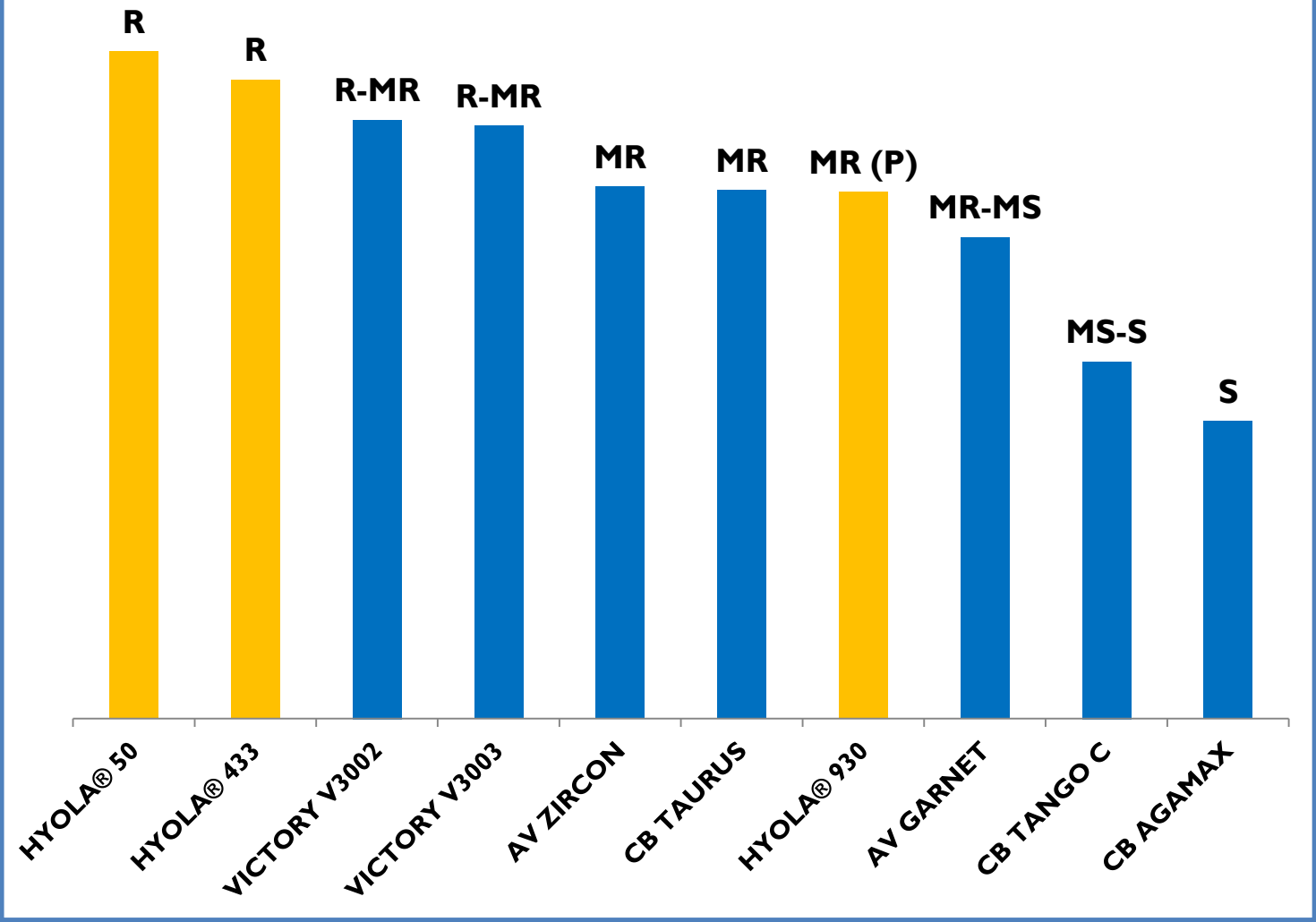
- **2.** Using **Section C** look down the column with the resistance group of the variety grown previously (e.g. Column A if ATR-Garnet was grown previously, or Column AD if Hyola 50 was grown previously) to identify cultivars with reduced risk. ■ Green = best possible rotation (no resistance genes in common), ■ Blue = OK rotation (at least 1 resistance gene not in common), ■ Orange = not advised (all resistance genes in common).



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NATIONAL 2013 CONVENTIONAL CAA BLACKLEG RATINGS



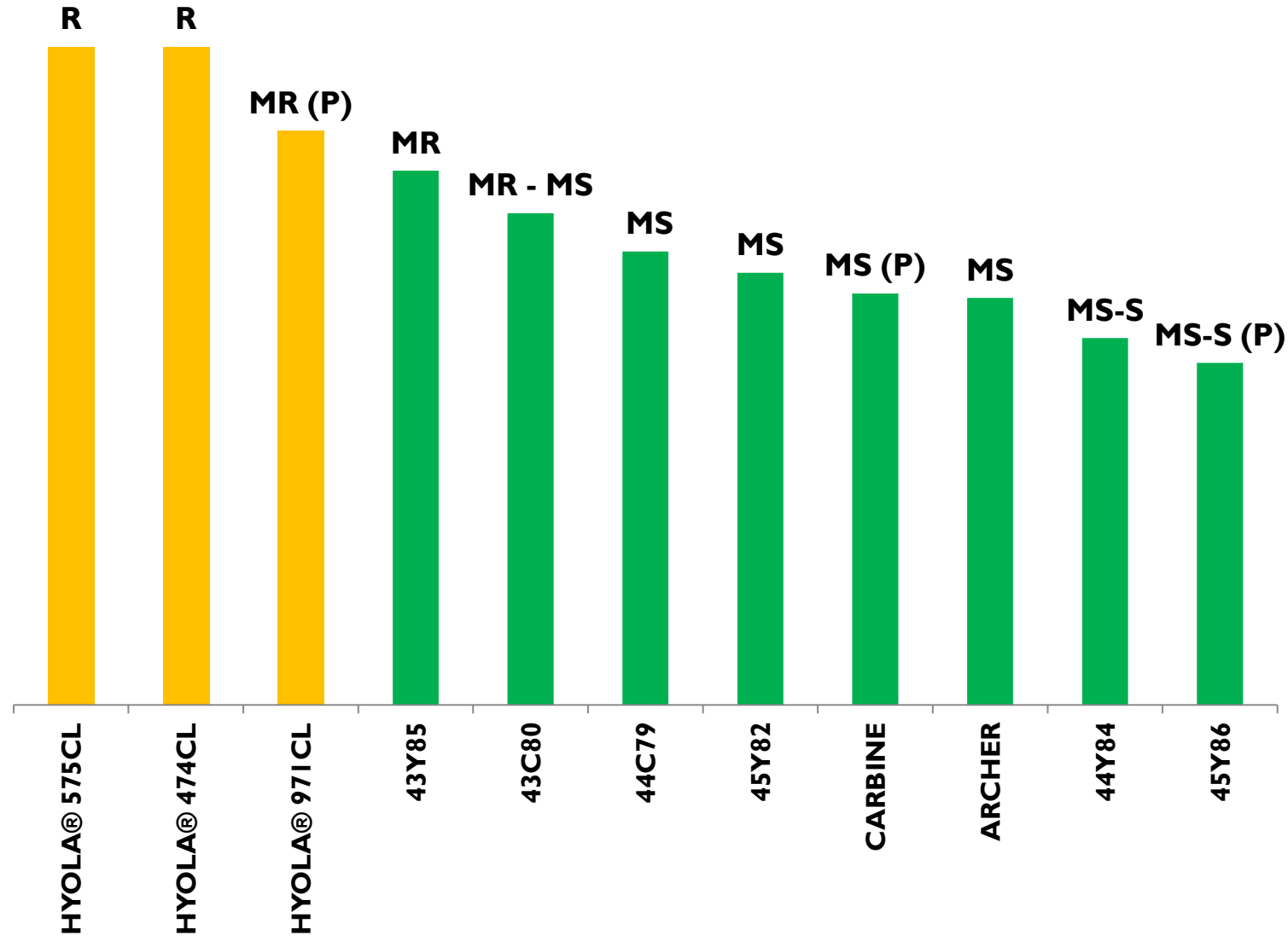
Source: GRDC 2013 Blackleg Management Guide Fact Sheet



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NATIONAL 2013 CLEARFIELD TECHNOLOGY CAA BLACKLEG RATINGS

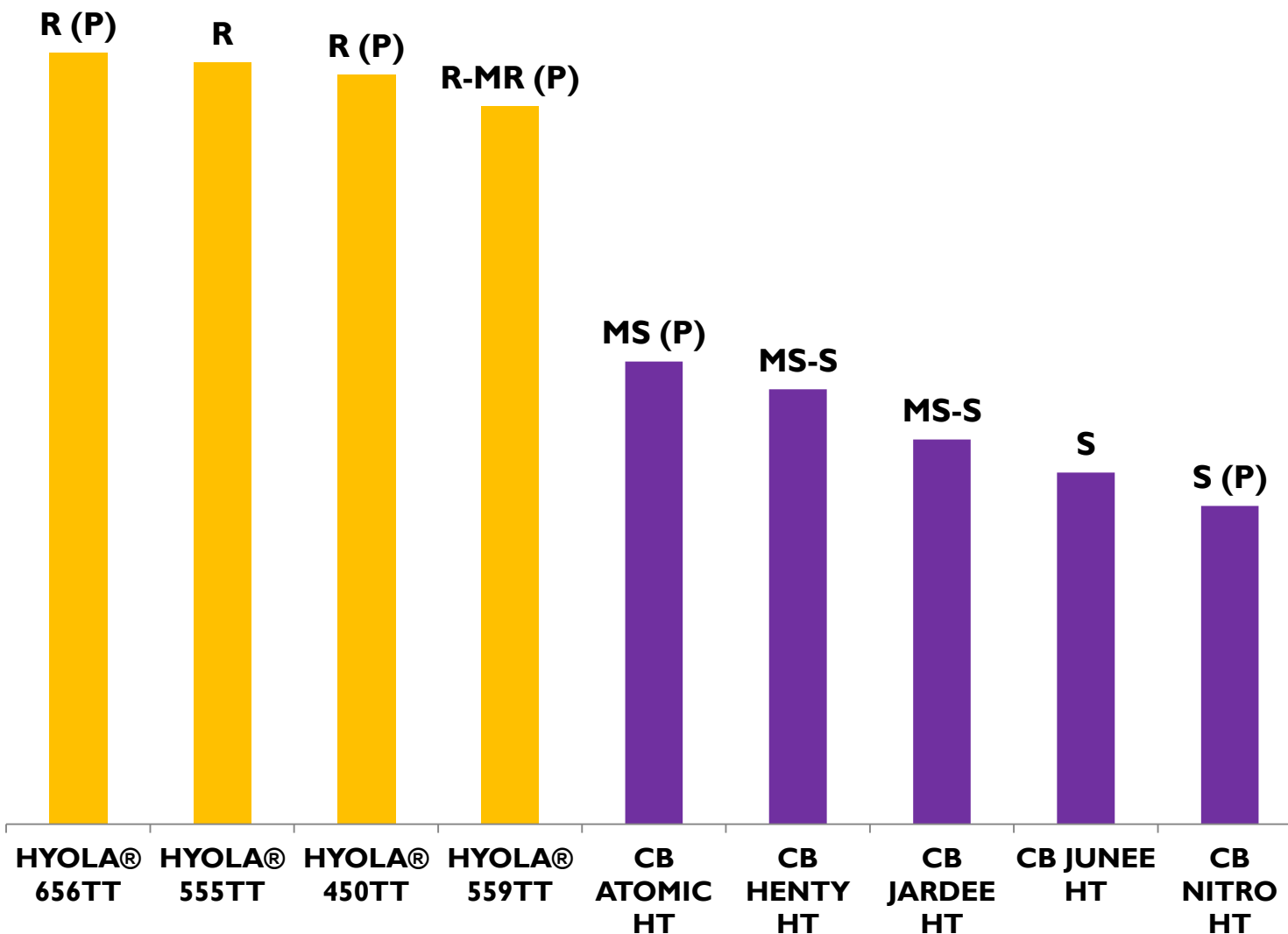


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PACIFIC SEEDS
AUSTRALIA'S HYBRID CANOLA SPECIALISTS

NATIONAL 2013 HYBRID TRIAZINE TECHNOLOGY CAA CANOLA BLACKLEG RATINGS

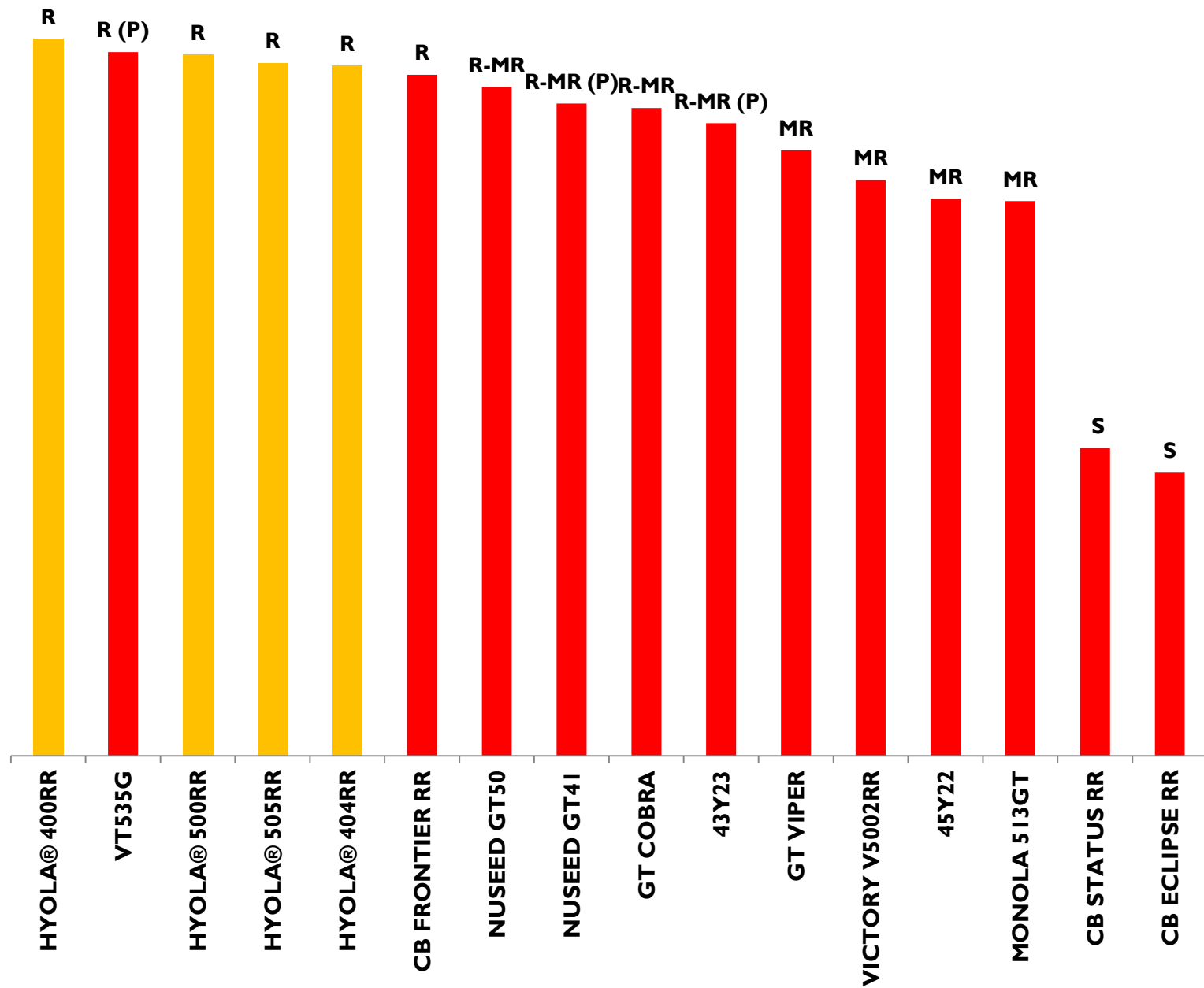




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NATIONAL 2013 RR TECHNOLOGY - CAA BLACKLEG RATINGS



Hyola Blackleg Information



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	Resistance Rating	Resistance Group
Hyola 401	VS	-
Hyola 50	R	AD
Hyola 61	MR	C?
Hyola 76	R	AD
Hyola 433	R	D
Hyola 571CL	R	B,F?

Blackleg Summary

- Fungal disease which can be devastating
- Cool showery conditions favour disease
- Severity affected by numerous factors
 - Age of stubble
 - Rainfall
 - Proximity of crop to stubble
 - Stubble management practices
 - Rotation History
 - Genetic Resistance
- Seedling and adult plant resistance mechanisms
- Hyola hybrids have best resistance available

