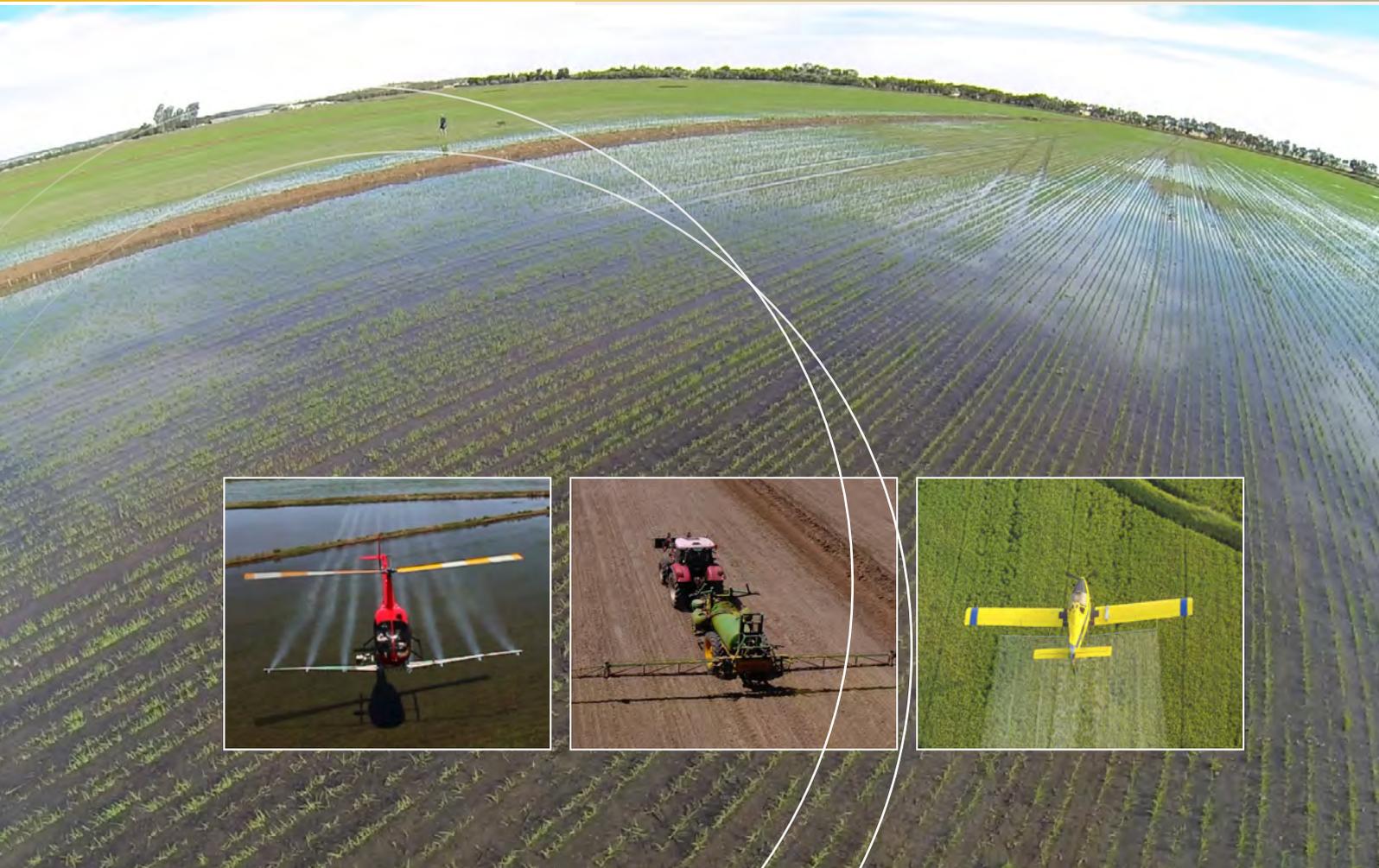




Department of
Primary Industries

Rice crop protection guide 2018–19

NSW DPI MANAGEMENT GUIDE





Department of
Primary Industries

Rice crop protection guide

2017–18

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Rice Extension

Funded by AgriFutures Australia

This book summarises the pesticides currently approved for use to control weeds and pests in NSW rice crops, and some issues important in their safe and effective use.

Acknowledgements

The rice weed management strategies and programs outlined in this booklet have been developed in conjunction with the Rice Crop Protection Working Group representing NSW Department of Primary Industries; John Fowler Murray LLS, Rice Research Australia Pty Ltd, Bayer Crop Science Pty Limited, BASF Australia Ltd, Dow AgroSciences Australia Ltd, DuPont (Australia) Ltd, FMC Chemicals Pty Ltd, Nufarm Australia Ltd, Agropraisals Pty Ltd, Charles Sturt University, Rice Extension, AgriFutures Australia Rice Advisory Panel Chair, aerial operators, NSW DPI Farm Chemical Unit and agribusiness in the MIA, CIA, and Murray Valley.

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ISSN 1832 – 6668

Job#: 14972

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Front cover: Main: Flushing rice (Photo: Vince Bucello). **Left:** TScwiirt4 helicopter (Photo: Gerry Wilcox). **Centre:** Ground spray (Photo: Rice Extension). **Right:** AT502 sprays rice (Photo: Fieldair).

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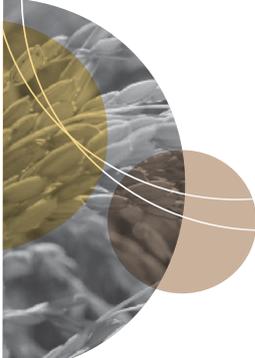
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Windspeeds must be **above 4 km/h** and **less than 15-20 km/h** (refer to label) blowing away from sensitive areas

Medium spray quality: Delta T: 2-10

Coarse spray quality: Delta T: 2-12

To start spraying, the sun should be about 20 degrees above the horizon, and wind speed and direction consistent for 30-40 minutes

SUNRISE

Windspeed should be **above 4-5 km/h** after Sunrise to start spraying

MIDDAY



Likely to be the best conditions for spraying

Be aware of higher evaporation risk and thermal activity after midday. Monitor plant stress.

Prepare to **STOP** all spraying if windspeeds start to drop

SUNSET



Often spraying into the early evening is possible in summer when air movement has continued to mix the air and prevent a surface temperature inversion forming.



Pay very close attention to changes in wind speed and wind direction throughout the evening.



CAUTION REQUIRED

Surface Inversion onset likely.

Wind must be **above 11-12 km/h**



***EXTREME CAUTION REQUIRED**

High inversion risk
Dangerous air movement

Plan NOT TO SPRAY during this period

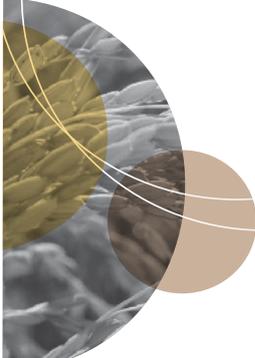


MIDNIGHT

Later in the evening air movement can become too unpredictable for safe spraying.
Often by 10-11 pm it has become unsafe.

Only use XC or UC spray quality, reduce spraying speed and boom height to minimise risk of droplets remaining airborne.

ALWAYS FOLLOW LABEL INSTRUCTIONS



Summary of changes to NSW Pesticides Regulation 2017

Ground applicators – From 1 July 2018 persons that spray weeds for fee or reward must hold a licence.

Ground applicator licences are for an individual (all persons employed within the business that apply chemicals must hold a licence, not just the owner). The only business licences in NSW at this time are for Aerial Applicator Businesses and RPA Applicator Businesses.

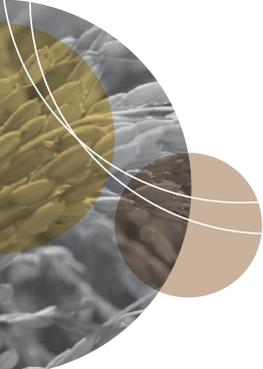
If you engage or contract a ground applicator, it is your responsibility to ensure they have the

appropriate licence. Penalties (fines) apply if you engage a person to apply pesticides who does not have the required training.

Spray drift issues onto sensitive crops can be minimised by understanding environmental conditions and how they affect the behaviour of the spray and whether the chemical is hitting the intended target.

The diagram below gives a good guide as to when spraying should occur to best avoid spray drift.

Figure 1. 24-hour risk profile for summer spraying. Source: Nufarm Australia



Outcomes and what's new

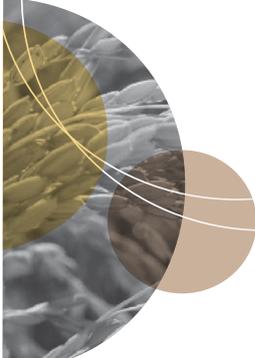
Outcomes from 2017–18 rice season

Shorter season varieties sown in warm conditions in November emerge quickly. The timing of the three-way mix is vital.

- If rice emerges before application of three-way mix is applied remove the knockdown herbicide from the mix.
- Use other options for grass weed control such as Stam[®], Barnstorm[™] or Aura[®]. These should be applied when the weed is still small. Do not wait for the weed to tiller.
- Do not apply Barnstorm[™] or Aura[®] twice in the season.
- Keep the spray on target. Use drift management strategies and avoid spraying when inversion conditions exist.
- Early control of dirty dora is essential. MCPA might not be an option if near to sensitive crops.

New information this year

- Ubeniq[™] herbicide with Rinksor active (300 g/L Florypyrauxifen-benzyl) is now registered for use in water-seeded rice by aerial SCWIIRT or Bickley boom application as per label.
- Ubeniq[™] is best used in sequence after either Ordram[®]/Taipan or Ordram[®] (where dirty dora numbers are low). It should always be applied with Uptake, Hasten or MSO with LeciTech and premixed to allow coating of the herbicide before application into floodwater.
- Changes to pesticide regulation licences for ground applicators.
- Risk profile for summer spraying.
- Reglone[®] use as a desiccant to help harvest lodged crops. **Do not harvest within 5 days of application.**
- Crop damage can occur if rice drainage water treated with Magister[®] is used on sensitive crops.
- New identification photos for pests and weeds have been included in this year's guide.
- **Do not rely solely on Group A herbicides such as Barnstorm[™] and Aura[®]** as they are a **high risk** for herbicide resistance development. These herbicides should only be used as a secondary control measure after using one of the recommended programs where other modes of action have been used. Apply this backup treatment when the weeds are still small as control will be difficult once tillering starts.



Rice crop protection overview

Pesticide selection use

Integrated pest control using a combination of pesticides and non-pesticide options is an important component in all weed and pest management strategies. While weed and pest control is the principal objective of pesticide use, it is important to ensure all pesticides are used safely and efficiently for the user, the community and the environment.

The main issues for rice growers using pesticides on rice crops are:

Effective use: effectively controlling weeds and pests while minimising herbicide resistance.

1. **Safe use:** avoiding unintentional effects on humans, non-target crops and the environment.
2. **No residues in drainage water:** residues can be greatly minimised by not draining rice water into drains within 28 days of pesticide application.

Pesticide selection and use is the responsibility of each grower. Growers and users must carefully study the label on the pesticide container before use to ensure they are familiar with the specific instructions relating to use, rate, timing, application and safety. These instructions are designed to ensure pest control efficacy and economic benefits, and to avoid risks to the user, the community and the environment.

In selecting and using pesticides, growers need to answer some key questions.

- Has the weed or pest been properly identified, and are there sufficient weeds or pests to warrant control?
- What is the most appropriate pesticide or combination of pesticides to use, considering effectiveness, cost, crop, weed or pest stage, residual control, withholding periods, resistance strategy or drift hazards?
- What is the most appropriate rate of application within the label range?
- What are the management features of the pesticides to be used: which application techniques or equipment, warnings on use, or rice water management before and after use need to be considered?
- What are the hazards of using this pesticide: toxicity, drift hazards to non-target areas, or residues in drainage water?

Guidelines for spraying pesticides onto rice crops

Applying pesticides to rice crops requires care and attention at all times.

1. **READ THE LABEL** and understand what it says.
2. Appropriate chemical application training should be current before spraying.
3. Apply the correct rate of pesticide in the manner described on the label.
4. **Wear protective clothing** and use proper safety equipment (and supply it for employees) when handling and mixing pesticides.
5. **Talk with your neighbours** about your spray programs and potentially sensitive crops.
6. Inform your aerial operator of your needs well in advance of spray application so that delays due to unfavourable weather conditions do not affect spray results. Talk about spray directions, wind conditions and the location of dwellings and sensitive crops.
7. Ensure there are adequate **buffer zones** between the spraying target and non-target areas to protect dwellings, nature reserves, irrigation supply and drainage channels, watercourses, travelling stock routes, bees and sensitive crops. **Refer to the product label/s, where they are listed.**
8. *The Pesticides Act 1999* defines a '**consent zone of 150 metres**: you must not undertake aerial spraying closer to a dwelling than this without written consent of the occupier.
9. The rice pesticides used during the establishment of aerial sown rice, for example, Ordram®, Saturn®, Londax®, chlorpyrifos and trichlorfon, are applied to the water surface of the flooded field. **Coarse droplets** are all that is required to carry the pesticides into the water, and this will ensure drift hazards are minimised. The Bickley boom, SCWIIRT (soluble chemical water injection in rice technique) and helicopters provide techniques that minimise the drift hazards whilst maintaining effective pest control.
10. It is now recommended Ordram® be used through closed supply and delivery systems. Ordram® will therefore only be available in packaging fitted with industry standard micromatic fittings, in 200 L and 1000 L packs.
11. Particular care is required when using **MCPA** to avoid drift to non-target crops or areas.

Integrated weed management

Good weed control in rice involves integrated weed management, which is combining herbicides with other methods of weed control. The best weed management practices will depend on the characteristics of the various weed species, the seed bank and the level of infestation. The aim of weed management should be to avoid any surviving weeds replenishing seed into the soil.

Weed control can be part of many management practices including:

- **Sowing method** influences types and numbers of weeds. Ponding and draining associated with flushing for establishing drill-sown rice reduces aquatic weed numbers and growth. Permanent water for aerial sowing inhibits barnyard grass growth.
- **Crop rotation:** rotating rice with other summer or winter crops can help reduce weed numbers. Where high summer weed infestations occur, using broadleaf summer or winter crops or a long fallow with good weed control will reduce weed numbers before the rice phase.
- **Layout:** good layouts allow more even water depth and even weed germination, which allows easier and more effective herbicide timing.
- **Timely cultivations** with or without a knockdown herbicide, can be a valuable method for killing initial germinations of weeds such as barnyard grass. In drill sowing, harrowing barnyard grass after rice emergence is a possible option to reduce weed numbers.
- **Adequate sowing rates** and recommended plant populations are more able to compete with weeds than thin plant populations.
- **Burning rice stubble** helps to control populations of late-maturing weeds and seed.
- **Hygiene:** growers with localised or regional weed species should clean down equipment and harvesters between sites to reduce the movement of weed seeds into uncontaminated areas.
- **Rice pure seed scheme:** the scheme is operated by SunRice and the NSW Department of Primary Industries (NSW DPI). Farmers are not allowed to keep their own seed, with registered seed provided to farmers each season. This ensures seed is of high varietal purity and free of weed seeds.
- **Supply and drainage channel hygiene:** helps prevent new weed populations from building up and entering and building up in rice bays.
- **Green manuring and fodder conservation practices:** these practices allow weeds to be harvested before seed set, thus reducing weed seedbanks. **Cutting for rice hay** might be an option for any 'out of control' weedy bays.

Herbicide resistance management for weed control in rice

Good weed control in rice involves integrated weed management, the combination of cultural practices, herbicide use and water depth management before,

during and after herbicide application. The key strategies for managing herbicide resistance and achieving effective weed control in rice for 2018 are:

- **Maximise the effectiveness:** Use each herbicide alone, tank mixed or in programs at the approved label rate, timing and sequence.
- **Rotate sowing methods** between aerial and drill sowing as this allows the use of more modes of action and herbicide groups.
- **Rotating rice with other crops** or pastures, that is, avoiding rice-only rotations will help prevent the development of resistant weeds.
- **Use cultivation and knockdown herbicides** before sowing for example glyphosate or paraquat + diquat for grass control before rice emergence. They help to reduce reliance Group A herbicides, which have high resistance risk.
- **Use two different modes of action** for each weed. Applying two herbicides at label rates with at least two different modes of action for each weed ensures that weeds resistant to one herbicide are controlled by the other herbicide.
- For **broadleaf weeds** this means applying either MCPA or Basagran® M60, as the second herbicide in all the currently recommended herbicide programs.
- The rotation of herbicide groups is also the recommended practice for the control of **barnyard grasses**.
- **Rotate herbicides** in the following rice crop by using herbicides with a different mode of action. Rotating herbicides by using a different herbicide with a different mode of action on the target weeds when the next rice crop is grown delays the development of resistance i.e. where two herbicides are available to control a weed or weed group, alternate from one herbicide one year to the other herbicide the next.
- **Do not rely solely on Group A herbicides such as Barnstorm™ and Aura®** as CropLife Australia lists them as being at high risk for developing herbicide resistance. **Also do not rely solely on Group I herbicides such as Ubeniq™ with Rinskor™ active** as CropLife Australia lists them as being at moderate risk for developing herbicide resistance. These herbicides should only be used as a secondary control measure together with an integrated weed management strategy, which uses herbicides with other modes of action together and other non-herbicidal management techniques.
- **Prevent herbicide resistance:** Herbicide options are extremely limited so it is important to closely monitor and record weed burdens, herbicide usage patterns and spray results, to minimise the risk of herbicide resistance. Check crops for any weed escapes. Send seed samples from suspect sites to the Charles Sturt University seed testing service at: Herbicide Resistance Screening, Charles Sturt University, Locked Bag 588, Wagga Wagga, NSW, 2678. and contact David Troidahl at NSW DPI or Rice Extension.

Table 1. Mode of action groups for rice chemicals

Herbicide resistance risk	Chemical family	Active constituent	First trade name
High	Group A	cyhalofop butyl profoxydim	Barnstorm™ Aura®
High	Group B	azimsulfuron bensulfuron	Gulliver® Londax®
Moderate	Group C	propanil bentazone	Stam® Basagran® M60*
Moderate	Group D	pendimethalin	Stomp®
Moderate	Group G	carfentrazone ethyl	Gator H20®
Moderate	Group H	benzofenap	Taipan®
Moderate	Group I	MCPA dicamba florpyrauxifen-benzyl	Basagran® M60* Banvel® MCPA Ubeniq™
Moderate	Group J	molinate thiobencarb	Ordram® Saturn®
Moderate	Group L	diquat paraquat	Spray.Seed® Gramoxone®
Moderate	Group M	glyphosate	Roundup®
Moderate	Group N	glufosinate	Basta®
Moderate	Group Q	clomazone	Magister®

*This product contains more than one active constituent.

Source: CropLife Australia.

Which herbicide program?

In choosing which herbicide program to use, consider the following factors:

1. The weed species and density based on previous rice cropping and rotation.
 - Ponding and draining associated with flushing for establishment of drill-sown rice reduces aquatic weed numbers and growth.
 - Permanent water for aerial sowing inhibits barnyard grass growth.
2. The level of resistance to herbicides in each weed species observed or recorded in previous seasons.
3. The herbicide program used in the previous rice season.
4. The variety and establishment technique to be used.

Plantback guidelines

Rice can be damaged by herbicides applied to a previous summer or winter crop. Where rice is established after a failed winter crop that is sown the same year as the rice, there is a potential risk of damage from winter crop herbicides and growers need to seek advice from their agronomist. Table 2 presents the best available data for some of the main winter crop herbicides that might affect rice.

Table 2. Plantback guidelines

Active constituent, trade name	Plantback	Comments
Group A haloxyfops		
Group A herbicides may interfere with germination for a period after their application. This may not be on the label as these herbicides are used as selective post-emergence herbicides and the next crop is not normally sown until well after their plantback period has lapsed.		
haloxyfop, Verdict® 520	12 weeks	Cereal crops or grasses planted within twelve weeks of application may be damaged by the residual effects of this herbicide, particularly on light and red soils.
Group B sulfonylureas and imidazolinones		
The persistence of residual Group B herbicides is dependent on various environmental conditions such as soil pH, temperature, soil moisture and organic matter content.		
chlorsulfuron, Glean®	12 months	Higher soil pH leads to longer soil persistence.. Glean® should not be used on soil pH 8.6 or higher as extended soil residual activity could adversely affect crop rotation options beyond normal intervals.
metsulfuron, Ally®	6 weeks	Recropping interval varies dependant on pH, moisture and temperature. .
triasulfuron, Logran®	12 months	As pH increases the rate of breakdown decreases. Replanting can be up to 24 months or more depending on pH and rainfall.
imazethapyr, Spinnaker®	10 months	Under conditions which do not favour breakdown of this product, carry-over soil residues can affect susceptible follow crops. Recropping can be up to 34 months, depending on crop type and rainfall, with rainfall and/or irrigation from application to sowing at least 500 mm.
MCPA imazapic imazapyr, Midas®	10 months	Under conditions that DO NOT favour breakdown, such as impoverished soils low in organic matter, non-wetting sands, anaerobic situations such as waterlogging, and prolonged dry periods, soil residues will persist longer and may affect susceptible follow crops.
Group C triazines		
In addition to the triazine herbicides, other Group C herbicides also present potential rice plantback issues. Diuron, for example, presents a risk as aerially sown rice is known to be extremely sensitive to it.		
atrazine, Atrazine 500	6 months 18 months	To avoid carryover on acid soils (pH < 6.5) – The maximum rate of atrazine 500 g/L or simazine 500 g/L or a combination of the two products to be applied to the crop during the growing season is 4 L/ha. On alkaline soils (> 6.5) – The maximum rate of atrazine 500 g/L or simazine 500 g/L or a combination of the two products to be applied to the crop during the growing season is 2 L/ha. To avoid carryover with post-emergence use – It is recommended that atrazine 500 g/L only be used, and at rates of 2 L/ha or less, on either acid or alkaline soils.
Group K isoxazoline		
pyroxasulfone, Sakura®	21 months	Rainfall of less than the minimum interim rainfall required (550mm) may result in extended recropping intervals. Interim rainfall is the total rainfall between the application of Sakura and planting of the particular following crop. See label for more information.

Always consult the product label, your agronomist or the product manufacturer for plantback information.

Table 3. Rice herbicide/insecticide compatibilities

This is a guide only. Read all product labels if using mixtures.

Formulation	Active	Product	Herbicides										
			Gulliver®	Londax® DF	Basagran® M60	Taipan®	Gator H ₂ O ⁶	Magister®	Barnstorm™	Kamba® 500	Roundup® CT	Roundup Ultra® MAX	
Herbicides													
DF	azimsulfuron 500 g/kg	Gulliver®		✓									
DF	bensulfuron 600 g/kg	Londax® DF	✓		✓		✓	✓	✗ ⁴				
SL	bentazone 400 g/L, MCPA 60 g/L	Basagran® M60		✓					✗ ⁴				
SC	benzofenap 300 g/kg	Taipan®						✓ ³					
EC	carfentrazone-ethyl 240g/L	Gator H ₂ O ⁶		✓				✓					
EC	clomazone 480 g/L	Magister®		✓		✓ ³	✓		✗		✓		
EC	cyhalofop butyl 285 g/L	Barnstorm™		✗ ⁴	✗ ⁴				✗				
SL	dicamba 500 g/L	Kamba® 500									✓	✓	
SL	glyphosate 450 g/L	Roundup® CT						✓		✓			
SL	glyphosate 570 g/L	Roundup Ultra® MAX								✓			
SL	MCPA sodium salt 250 g/L	MCPA 250	✓		✓				✗ ⁴				
SL	MCPA dimethylamine 750 g/L	Agritone® 750	✓		✓				✗ ⁴	✓			
EC	molinate 960 g/L	Ordram® ¹		✓		✓		✓	✗	✓			
SL	paraquat 250 g/L	Gramoxone® 250						✓		✓			
SL	paraquat 135 g/L + diquat 115 g/L	Spray.Seed®								✓			
EC	pendimethalin 440 g/L	Stomp®						✓	✓		✓	✓	
EC	profoxydim 200 g/L	Aura®		✗ ⁴	✗ ⁴				✗ ⁴				
WC	propanil 480 g/L	Stam® ²		✓				✓					
EC	thiobencarb 800 g/L	Saturn® EC		✓		✗							
SC	florpyauxifen-benzyl 300 g/L	Ubeniq™											
SL	diquat 200 g/L	Reglone® ⁷											
Insecticides													
EC	alphacypermethrin 100 g/L	Dominex Duo®						✓					
EC	chlorpyrifos 500 g/L	Lorsban®		✓		✓		✓	✓				
SC	copper chelates	Coptrol®											
G	copper sulphate pentahydrate 250 g/kg	Various trade names (bluestone)											
EC	diazinon 800 g/L	Diazinon		✓									
SC	fipronil 500 g/L	Cosmos® ⁵											
EC	maldison 500 g/L	Maldison 500											
EC	trichlorfon 500 g/L	Lepidex®		✓		✓							

¹ Compatible with most pesticides used in rice provided correct mixing order is followed.

² Due to possible injury to rice do not mix other pesticides or liquid fertilisers with Stam®.

³ Only when applied by SCWIIRT from a motorbike or helicopter (min 5 L/ha water) or Bickley boom.

⁴ Separate application at least 7 days apart.

⁵ Seed treatment only.



Figure 2. Arrowhead. Photo: Rice extension



Figure 3. Arrowhead flower. Photo: Rice extension

Herbicides											Insecticides						
MCPA 250	Agritone® 750	Ordram® 1	Gramoxone® 250	Spray-Seed®	Stomp®	Aura®	Stam® 2	Satum® EC	Ubeniq™	Dominex Duo®	Lorsban®	Copper Sulphate	Diazinon	Cosmos®	Maldison 500	Lepidex®	
✓	✓																
		✓				x ⁴	✓	✓			✓		✓			✓	
✓	✓					x ⁴											
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							x										
							x										

⁶ Herbicidal symptoms may appear on the crop in the form of leaf yellowing on submerged leaves and bronzing on exposed leaves. Do not apply Gator H₂O® to the long grain rice variety Doongara. Due to possible injury to rice do not mix Gator H₂O® with spray oils and surfactant blends. Compatibilities based on label.

⁷ **New:** Reglone® may be used for crop desiccation to assist in harvesting lodged crops using a rate of 2-3 L/ha. Spray when the grain is mature- not more than 2–3% of the grain is still at the milky stage and the grain moisture content must be less than 25%. **Do not harvest for 5 days after application.**



Figure 4. Barnyard grass. Photo: Rice extension



Figure 5. Barnyard grass seed head. Photo: Rice extension

Aerial sown programs

Aerial sown herbicide resistance management programs

(see tables 4 and 5)

There are seven basic herbicide resistance management programs for aerial sown rice based on the main aquatic weed herbicides used: Taipan® and bensulfuron methyl (Londax®, Kendax®). The letter in brackets after each herbicide signifies the **mode of action group** to which the herbicide belongs:

Program 1 Taipan® (H) with Ordram® (J) or Magister® (Q)

Program 2 Taipan® (H) with Saturn® (J)

Program 3 Taipan® (H) with Ordram® (J) and Saturn® (J)

Program 4 Londax® (B) with Ordram® (J) or Magister® (Q) Once the most commonly used rice weed control program but now has widespread resistance to bensulfuron (Londax®, Kendax®). Rotate to a Taipan®

program where it has been used for two or three crops on the same field.

Program 5 Londax® (B) with Saturn® (J)

Program 6 Londax® (B) with Ordram® (J) and Saturn® (J)

Program 7 Londax® (B) with split Saturn® (J)

The post emergent backup program for each of the aquatic weeds would include MCPA (Group I) Basagran® M60 (Group C/I) Or Ubeniq™ (Group I) used in sequence after either molinate/Taipan® or molinate to provide two modes of action.

Aura® (dim) and Barnstorm™ (fop) are the options for a post-emergent grass weed control backup treatment using another mode of action (Group A). This backup treatment needs to be when the weeds are still only small as control will be difficult once tillering starts.

Table 4. Control options for major weeds in aerial sown rice (to be read in conjunction with Table 5)

The letter in orange after the chemical rate in this table (i.e. a to p) refers to the appropriate part of the column headed 'Application: comments' in Table 5 (pp. 8–9). Rates of product are in L/ha unless otherwise indicated.

S – suppression only • – requires follow-up herbicide treatment # – requires a previous herbicide treatment.

Weed stage	Rice stage	molinate 960 g/L Ordram®	thiobencarb 800 g/L Saturn® EC	clomazone 480 g/L Magister®	propanil 480 g/L Stam®	cyhalofop butyl 285 g/L Barnstorm™ (requires Uptake®)	proxydim 200 g/L Aura® (requires Supercharge®)	azimsulfuron 500 g/kg Gulliver® (tank mixed with MCPA)	bensulfuron methyl 600 g/kg Londax® DF Kendax® 600WG	benzofenap 300 g/L Taipan®	MCPA sodium salt 250 g/L MCPA 250 MCPA	benazone 400 g/L MCPA 60 g/L Basagran® M60 Dictate® M60	carfentrazone ethyl 240g/L Gator H ₂ O®	dicamba 500 g/L Kamba® 500	Copper chelates Coptrol® copper ethanalamine complexes Cupricide®	florpyrauxifen-benzyl 300 g/L Ubeniq™
Grasses																
barnyard grass																
0	pre-sowing		1–1.5 • c													
pre-emergence	pre-sowing – 2 leaf			0.25–0.3 • d												
0–2 leaf	0–2 leaf	2.5 a														
0–3 leaf	1–2 leaf		2.75 # c													
0–3 leaf	1–2 leaf	2.5–3.75 # e	2.75–3.75 # e													
0–4 leaf	0–2 leaf			0.4–0.6 f												
1–4 leaf	pre-emergent – early tillering	3.75 a														
2–3 leaf	evenly germinated				7.5–8.5 g											
4–5 leaf	evenly germinated				12.5 g											
3–5 leaf	1–2 leaf – late tillering					0.75–1 h										
1–2 tillers	1–2 leaf – late tillering					1 h										
3–4 tillers	1–2 leaf – late tillering					1.5 h										
2 leaf – 6 tillers	3 leaf min						0.375 i									
3 leaf – 3 tillers	4 leaf – 3 tillers							40 g S j								

Weed stage	Rice stage	molinate 960 g/L Ordram®	thiobencarb 800 g/L Saturn® EC	clomazone 480 g/L Magister®	propanil 480 g/L Stam®	cyhalofop butyl 285 g/L Barnstorm™ (requires Uptake®)	proxydim 200 g/L Aura® (requires Supercharge®)	azimsulfuron 500 g/kg Gulliver® (tank mixed with MCPA)	bensulfuron methyl 600 g/kg Londax® DF Kendax® 600WG	benzofenap 300 g/L Taipan®	MCPA sodium salt 250 g/L MCPA 250 MCPA	bentazone 400 g/L MCPA 60 g/L Basagran® M60 Dictate® M60	carfentrazone ethyl 240 g/L Gator H ₂ O®	dicamba 500 g/L Kamba® 500	Copper chelates Coptrol® copper ethanolamine complexes Cupricide®	floryrauxifen-benzyl 300 g/L Ubeniq™	
silvertop grass																	
1–2 leaf	1–2 leaf	2.5–3.75 S # e		0.5–0.6 S f													
1–2 leaf	pre-emergent – early tillering	3.75 a															
3–5 leaf	1–2 leaf – late tillering					0.75–1 h											
1–2 tillers	1–2 leaf – late tillering					1 h											
2 leaf – 6 tillers	3 leaf min						0.375 i										
Broadleaf and sedges																	
alisma																	
pre-emergence to germinated	pre-sow to early post-sow									2 l							
4–6 leaves	4 leaf – 3 tillers						40 g j										
seedling (preflowering)	3 tillers – P.I.										1.4–2.7 m						
arrowhead																	
pre-emergence to germinated	pre-sow to early post-sow									2 l			0.420 q				
up to 4 leaf & <5 cm	3 leaf to early tillering															0.15 r	
4–6 leaf	early tillering (20–35 das) – P.I.											2–2.5 n					
4–8 leaves	4 leaf – 3 tillers						40 g j										
cumbungi																	
seedling	early tillering (20–35 das) – P.I.											2–2.5 n					
docks																	
small to large	seedling to early tillering														0.4–0.56 o		
dirty dora																	
pre-emergence to germinated	pre-sow to early post-sow									2 S l							
0–2 leaf	1–2 leaf		2.75 # c														
0–2 leaf	1–2 leaf		3.75 b														
up to 2 leaf & <3 cm	3 leaf to early tillering															0.15 S r	
0–3 leaf	2 leaf – mid tillering								50–85 g k								
0–4 leaf	2–4 leaf												0.630 S q				
3–6 leaf	4 leaf – 3 tillers						40 g j										
4–6 leaf	early tillering (20–35 das) – P.I.											2–2.5 n					
seedling (preflowering)	3 tillers – P.I.										1.4–2.7 m						
jerry jerry																	
up to 4 leaf & <5 cm	3 leaf to early tillering																0.15 r
spikerush																	
3–6 leaves	4 leaf – 3 tillers						40 g j										
starfruit																	
pre-emergence to germinated	pre-sow to early post-sow									2 l							
seedling to preflowering	3 tillers – P.I.											1.4–2.7 m					
4–6 leaf	4 leaf – 3 tillers						40 g j					2–2.5 n					
water plantain																	
pre-emergence to germinated	pre-sow to early post-sow									2 l							
up to 4 leaf & <5 cm	3 leaf to early tillering																0.15 r
4–6 leaf	4 leaf – 3 tillers						40 g j										
4–6 leaf	early tillering (20–35 das) – P.I.											2–2.5 n					
algae (green slime)																	
	sowing to early tillering																2–5 p

Table 5. Weed control options and herbicide combination options in aerial sown rice

Weed stage	Rice stage	Herbicide	Rate/ha	Application: comments
barnyard grass, <i>Echinochloa</i> spp., silvertop grass, <i>Leptochloa fusca</i>				
0 to 2-leaf	sowing to 2-leaf	molinate 960 g/L Ordram®	2.5 L	(a) Apply to permanent water by aircraft, from completion of initial flooding to as soon as possible after sowing. Water movement to and within bays should cease two hours before application and for three days after application but permanent flood maintained.
1 to 4-leaf	pre-emergent to early tillering		3.75 L	
silvertop grass 1 to 2-leaf	pre-emergent to early tillering		3.75 L	
barnyard grass, <i>Echinochloa</i> spp.; dirty dora, <i>Cyperus difformis</i>				
barnyard grass 0 to 3-leaf dirty dora 0 to 2-leaf	Early post-sowing 1 to 2-leaf	thiobencarb 800 g/L Saturn® EC	3.75 L	(b) Apply by air or 4-wheel bike to flooded bays when the secondary (fibrous) roots of the rice seedling are developing and firmly attached to the soil surface. Water movement to and within bays should cease 6–12 hours before application and for 3 days after application, but permanent flood maintained.
no weeds present	just before sowing	Split Saturn® thiobencarb 800 g/L Saturn® EC	1 to 1.5 L	(c) Note: Not recommended for long grain varieties. Apply by air or 4-wheel bike to flooded bays. Apply first application within 7 days of commencement of bay filling. (c) Apply second application when the secondary (fibrous) roots of the rice seedling are developing and firmly attached to the soil surface. Water movement to and within bays should cease before application and for 3 days after application, but maintaining permanent flood.
barnyard grass 0 to 3-leaf dirty dora 0 to 2-leaf	1 to 2-leaf		followed by 2.75 L	
barnyard grass, <i>Echinochloa</i> spp.; suppression only: silvertop grass, <i>Leptochloa fusca</i>				
barnyard grass pre-emergence	pre-sowing to 2-leaf	clomazone 480 g/L Magister® plus	0.25 to 0.3 L	(d) Apply to newly flooded bays before weed germination. Apply by helicopter, tractor or 4-wheel bike or fixed wing aircraft fitted with a Bickley boom. When using the Bickley boom, add 41-A drift retardant for Magister®.
		benzofenap Taipan® followed by	2 L	(d) Follow Taipan® label directions.
barnyard grass 0 to 3-leaf	post-sowing	thiobencarb 800 g/L Saturn® or	2.75 to 3.75 L	(e) Follow Saturn® label directions.
		molinate 960 g/L Ordram®	2.5 to 3.7 L	(e) Follow Ordram® label directions.
barnyard grass, <i>Echinochloa</i> spp.; silvertop grass, <i>Leptochloa fusca</i>				
barnyard grass pre-emergence to 4-leaf silvertop grass up to 2-leaf growth can be suppressed	pre-sow to 2-leaf	clomazone 480 g/L Magister®	0.4 to 0.6 L	(f) Ensure seedbed is free of germinated grasses before flooding. Apply by fixed wing aircraft fitted with a Bickley boom or by drifter (SCWIIRT method) using a helicopter, tractor or 4-wheel agbike to permanent water. When using the Bickley boom, always add 41-A drift retardant for Magister®. Water movement must cease before application and for 3 days after, ensure sufficient water to maintain permanent flood. Magister® can be applied by drip application at initial flooding at the 0.6 L rate. Note: Do not apply to Illabong if dry broadcast sowing.
barnyard grass, <i>Echinochloa</i> spp.				
2 to 3-leaf 4 to 5-leaf	evenly germinated rice	propanil 480 g/L Stam®	7.5 to 8.5 L 12.5 L	(g) Apply by fixed wing aircraft or helicopter or tractor boom sprayer or by knapsack sprayers. Works by direct contact with weeds. Drain field thoroughly before application and flood within 5 days of application. Only spray under ideal conditions, preferably with temperatures above 25 °C.
barnyard grass, <i>Echinochloa</i> spp.; silvertop grass, <i>Leptochloa fusca</i>				
3 to 5-leaf 1 to 2 tillers	1–2 leaf to late tillering	cyhalofop butyl 285 g/L Barnstorm™	0.75 to 1 L plus 1 L/ha Uptake® spraying oil	(h) Apply by fixed wing aircraft, helicopter or boom sprayer to partially drained fields, maintaining at least 1–2 cm water depth and ensuring that at least 75% of the weed foliage is exposed to the spray. Works by direct contact with weeds. Re-flood after 2 hours and fill as soon as possible to limit germination of new weeds. Only use 0.75 L/ha rate where you have light infestations, excellent soil moisture and good crop competition. (h) Use 1.5 L/ha to treat larger weeds.
3 to 4 tillers (barnyard grass only)			1 L plus 1 L/ha Uptake® spraying oil	
2-leaf to 6 tiller	3-leaf minimum	profoxydim 200 g/L Aura®	375 mL plus 1 L/100 L Supercharge®	(i) Apply by aircraft, helicopter or ground boom to partially drained bays containing 1–2 cm water onto actively growing weeds with sufficient foliage exposed for adequate coverage. Re-flood after 2 hours and fill as soon as possible to limit germination of new weeds and maximise weed control. Avoid treating dense weed populations and preferably apply Aura® after a foundation herbicide effective on the target weed.
barnyard grass, <i>Echinochloa</i> spp.; dirty dora, <i>Cyperus difformis</i>; starfruit, <i>Damasonium minus</i>; arrowhead, <i>Sagittaria montevidensis</i>; alisma, <i>Alisma lanceolatum</i>; water plantain, <i>Alisma plantago-aquatica</i>; spike rush, <i>Eleocharis acuta</i>				
barnyard grass 4-leaf to 4 stems or shoots alisma 4–6 leaves arrowhead 4–8 leaves dirty dora, spikerush 3–6 leaves starfruit 4 leaves to bolting water plantain 4–6 leaves	4 to 5-leaf, up to 3 tillers	azimsulfuron 500 g/kg Gulliver®	40 g/ha plus 1.6–2.7 L MCPA 250 plus non-ionic surfactant	(j) Always apply in mixtures with MCPA. Always add a non-ionic surfactant. Apply as a foliar spray in a minimum spray volume of 40 L/ha. Ensure water is removed from bays and at least three-quarters of the weeds are exposed (on the low side of the bay) enabling direct contact by the spray. Water depth should be 1–2 cm deep, or at least the soil must be kept saturated. DO NOT allow the soil to dry out. For resistance management the application of an alternate mode of action grass herbicide as a presowing or at-sowing treatment is recommended. Note: will only suppress barnyard grass.

Weed stage	Rice stage	Herbicide	Rate/ha	Application: comments
dirty dora, <i>Cyperus difformis</i>; starfruit, <i>Damasonium minus</i>; arrowhead, <i>Sagittaria montevidensis</i>; Cumbungi and spike rush suppression only				
up to 3-leaf	2-leaf up to mid-tillering	bensulfuron methyl 600 g/kg Londax® DF Kendax® 600WG	50 to 85 g	(k) Apply by air to flooded bays. Use higher rate where flood water is muddy or weeds are large. Water movement to and within bays should cease before application and for 5 days after application, but maintaining permanent flood.
arrowhead, <i>Sagittaria montevidensis</i>, dirty dora, <i>Cyperus difformis</i> and starfruit, <i>Damasonium minus</i>;				
Up to 6 leaf arrowhead Up to 4 leaf dirty dora (suppression only)	2-4 leaf	carfentrazone ethyl 240 g/L Gator H ₂ O®	420 mL 630 mL	(q) Apply to permanent flood by SCWIIRT method on tractor, 4 wheel bike or helicopter or by boom spray application using ground rig or aircraft. Lock up bays 1 day before application and 5 days after application. Due to possible injury to rice do not mix Gator H ₂ O® with spray oils and surfactant blends. Note: will only suppress dirty dora, will not control starfruit
Up to 6 leaf arrowhead Up to 4 leaf dirty dora and starfruit	2.5-4 leaf	carfentrazone ethyl 240g/L Gator H ₂ O®	630 mL + 50g Londax® DF	(q) Apply to permanent flood by SCWIIRT method on tractor, 4 wheel bike or helicopter or by boom spray application using ground rig or aircraft. Lock up bays 1 day before application and 5 days after application. Herbicidal symptoms may appear on the crop in the form of leaf yellowing on submerged leaves and bronzing on exposed leaves. Do not apply Gator H ₂ O® to the long grain rice variety Doongara.
dirty dora, <i>Cyperus difformis</i>; starfruit, <i>Damasonium minus</i>; arrowhead, <i>Sagittaria montevidensis</i>; alisma, <i>Alisma lanceolatum</i>; water plantain, <i>Alisma plantago-aquatica</i>				
pre-emergence to germinated	pre-sow to early post-sow	benzofenap 300 g/kg Taipan®	2 L	(l) Apply by air or by SCWIIRT using a 4-wheel bike or helicopter to flooded bays within 10 days of commencement of flooding. Water movement to and within bays should cease 12 hours before application and for 5 days after application, but maintaining permanent flood. Note: will only suppress dirty dora <ul style="list-style-type: none"> will only control starfruit for up to 28 days will only control seedlings of alisma and water plantain.
dirty dora, <i>Cyperus difformis</i>; starfruit, <i>Damasonium minus</i>; alisma, <i>Alisma lanceolatum</i>				
seedling but before flowering	mid-tillering (3 tillers, 45 days or more after sowing) but not later than panicle initiation.	MCPA sodium salt 250 g/L MCPA 250 MCPA	1.4 to 2.7 L	(m) MCPA needs to contact the leaves. Before application, lower water levels to expose more than 2/3 of the weed growth to direct contact with the spray. MCPA will suppress the alisma and reduce competition to the rice. Late seeding may still occur. Note: May be used at 2 tiller stage of rice (around 35 days after sowing) at 1.4 L/ha.
dirty dora, <i>Cyperus difformis</i>; starfruit, <i>Damasonium minus</i>; arrowhead, <i>Sagittaria montevidensis</i>; water plantain, <i>Alisma plantago-aquatica</i>; seedling cumbungi, <i>Typha</i> spp.				
4 to 6 leaves	early tillering (20 to 35 days after sowing) but not later than panicle initiation.	bentazone 400 g/L and MCPA 60 g/L Basagran® M60	2 to 2.5 L	(n) MCPA needs to contact the leaves. Lower water levels to expose all weeds and soil surface before application. Submerged weeds will not be controlled. Can be applied at an earlier stage to rice than MCPA. For optimum dirty dora control, apply in a program after an aquatic herbicide effective on this weed, and apply to younger weeds up to 35 DAS. On late or denser dirty dora populations, use 2.5 L/ha Basagran® M60 and add up to 1 L/ha MCPA 25%.
docks, <i>Rumex</i> spp.				
small to large	seedling to early tillering	dicamba 500 g/L Kamba® 500	0.4 to 0.56 L	(o) Dicamba needs to contact the leaves. Before application, lower water levels to expose the weed leaves to direct contact with the spray.
arrowhead, <i>Sagittaria montevidensis</i>; dirty dora (suppression only), <i>Cyperus difformis</i>; jerry jerry, <i>Ammannia multiflora</i>; starfruit, <i>Damasonium minus</i>; water plantain, <i>Alisma plantago-aquatica</i>				
2–4 leaf, less than 5 cm (DD 2 leaf, <3 cm)	3 leaf to tillering	Ubeniq™	0.15 L	(r) Always use Ubeniq™ in sequence after foundation herbicides that have a different MOA. Always apply with Uptake™ spraying oil, Hasten® spray adjuvant or Loveland™ products MSO™ with LeciTech™ spray adjuvant at 2–4 L/ha in total spray volume of 5–20 L/ha. Premix Ubeniq thoroughly in oil, then once fully dispersed, add remaining water to make up total spray mix volume.
algae, green slime				
not apparent to developing on soil	sowing to early tillering	copper chelates Coptrol® copper ethanolamine complexes Cupricide®	2 to 5 L	(p) Rate of application depends on depth of water and level of algal infestation. See product label. Note: There is no registration or permit for the use of copper sulfate against algae in rice crops so its use cannot be recommended.

Table 6. Herbicide resistance management programs: Taipan®-based programs

All rates in these tables are per hectare

Program	safe for medium grains	safe for long grains	Modes of action per weed				
			DD	SF	AH	A, WP	BYG
Consult labels of individual products for details of rates, application and weeds controlled.							
Program 1: Taipan® with Ordram® or Magister® • To be effective, Taipan® needs a weed-free seed bed before flooding, to be applied within 10 days of the start of flooding and good water management. • MCPA, Basagran® M60 or Ubeniq™ provide a second herbicide action and cleanup and escapes for all aquatic weeds. Barnstorm™ and Aura® provide a second herbicide action and cleanup for all grass weeds. • For Basagran® M60 or MCPA, lower water level and apply to weed foliage.	yes	yes	?✓	✓?	✓✓	✓✓	✓✓
Program 2: Taipan® with Standard Saturn® • Taipan®, MCPA, Basagran® M60, Ubeniq™, Barnstorm™, Aura®: Comments as above. • Saturn®: Apply when DD is in the 0–2 leaf stage and BYG is 0–3 leaf stage. Rice must have secondary (fibrous) roots.	yes	yes	?✓✓	✓✓	✓✓✓	✓✓	✓✓
Program 3: Taipan® with Standard Saturn® and Ordram® • A robust program where weed pressures are high. • Ordram®: Apply to newly flooded weed-free fields before rice sowing. • Taipan®, Saturn®, MCPA, Basagran® M60, Ubeniq™, Barnstorm™, Aura®: Comments as above.	yes	no	?✓✓	✓✓	✓✓	✓✓	✓✓

✓ – each mode of action per species is one tick ✓✓ – at least 2 ticks is desirable for sound resistance management of aquatic weeds.
 ? A mode of action where the herbicide used might only suppress the weed or might not carry a label claim for control of that weed species.

The number of modes of action

assumes no significant resistance to Londax® is present.

DD – dirty dora, SF – starfruit, AH – arrowhead, A – alisma, WP – water plantain, BYG – barnyard grass

Table 7. Herbicide resistance management programs: Londax® based

Program	safe for medium grains	safe for long grains	Modes of action per weed				
			DD	SF	AH	A, WP	BYG
Consult labels of individual products for details of rates, application and weeds controlled.							
Program 4: Londax® with Ordram® or Magister® • Once the most commonly used rice weed control program but now has widespread resistance to bensulfuron (Londax®, Kendax®). Rotate to a Taipan® program where it has been used for two or three crops on the same field. • 3.75 L of Ordram® is the preferred rate in most situations. • MCPA, Basagran® M60, or Gulliver® plus MCPA provide a second herbicide action and cleanup and escapes for all aquatic weeds. Barnstorm™ and Aura® provide a second herbicide action and cleanup for all grass weeds. For MCPA or Basagran® M60, lower water level and apply to weed foliage.	yes	yes	✓✓	✓✓	✓✓	??	✓✓
Program 5: Londax® with Standard Saturn® • Londax®: comments as above. • Narrow window of Saturn® application is the main limitation. • Tank mixtures of Londax® plus Saturn® may reduce BYG control with Saturn®. • For long grains, ensure Saturn® is applied before and separately to Londax®, to avoid damage. • MCPA, Basagran® M60, Gulliver® plus MCPA provide a second herbicide action where aquatic weeds other than DD are present. Lower water level and apply to weed foliage. Barnstorm™ and Aura®: comments as above.	yes	yes	✓✓✓	✓✓	✓✓	✓?	✓✓
Program 6: Londax® with Standard Saturn® and Ordram® • This program is for high weed pressures. • Londax®: comments as above. • Ordram®: Apply to newly flooded fields before rice sowing. • Can injure long grain varieties excessively. • MCPA, Basagran® M60, Gulliver® plus MCPA, Barnstorm™ and Aura®: comments as above.	yes	no	✓✓✓	✓✓	✓✓	✓?	✓✓
Program 7: Londax® with Split Saturn® • Londax®: comments as above. • The Saturn® primer rate widens the application window for the main postsowing Saturn® application. The two sequential Saturn® treatments are essential parts of this strategy. • Not for long grain varieties or where weeds germinate before flooding. • MCPA, Basagran® M60, Barnstorm™ and Aura®: comments as above.	yes	no	✓✓✓	✓✓	✓✓	✓?	✓✓

										
	filling up	seed	coleoptile	1 leaf	2 leaf	3-4 leaf	1st tiller	early tiller	mid tillering	panicle initiation
	Taipan® 2 L @ pre-sow to early post-sow			Barnstorm™ 0.75 to 1.5 L @ 1-2 leaf to late tillered rice		Aura® 0.375 L @ 3 leaf to late tillered rice				
	Plus Ordram® 2.5-3.75 L @ pre- to post-sowing.						Gulliver® 40 g with 1.6-2.7 MCPA 250 @ 4-5 leaf stage to 3 tiller		Basagran® M60 2 to 2.5 L @ 1-2 tillered rice OR MCPA 2.7 L @ 3 tillered rice	
	Apply Ordram® when BYG is at the 0-4 leaf stage OR Magister® 0.4 to 0.6 L @ pre-sow to 2 leaf stage rice.						Ubeniq™ 150 mL @ 3 leaf stage to early tillering			
	Apply Magister® when BYG is at the 0-3 leaf stage									
	Taipan® 2 L @ pre-sow to early post-sowing			Barnstorm™ 0.75 to 1.5 L @ 1-2 leaf to late tillered rice		Aura® 0.375 L @ 3 leaf stage to late tillered rice				
						Saturn® 3.75 L @ secondary (fibrous) root rice stage. Apply when DD is 0-2 leaf stage, and BYG is 0-3 leaf				
						Ubeniq™ 150 mL @ 3 leaf stage to early tillering				
								Gulliver® 40 g with 1.6-2.7 MCPA 250 @ 4-5 leaf stage to 3 tiller		
								Basagran® M60 2 to 2.5 L @ 1-2 tillered rice		OR MCPA 2.7 L @ 3 tillered rice
	Taipan® 2 L @ pre-sow to early post-sow			Barnstorm™ 0.75 to 1.5 L @ 1-2 leaf to late tillered rice		Aura® 0.375 L @ 3 leaf stage to late tillered rice				
						Ubeniq™ 150 mL @ 3 leaf stage to early tillering				
	Plus Ordram® 2.5 L @ pre-sow.					Saturn® 3.75 L @ secondary (fibrous) root rice stage				
	Apply to weed-free, newly flooded fields before sowing					Apply when DD is 0-2 leaf stage, and BYG is 0-3 leaf				
								Gulliver® 40 g with 1.6-2.7 MCPA 250 @ 4-5 leaf stage to 3 tiller		
								Basagran® M60 2 to 2.5 L @ 1-2 tillered rice		OR MCPA 2.7 L @ 3 tillered rice

										
	filling up	seed	coleoptile	1 leaf	2 leaf	3-4 leaf	1st tiller	early tiller	mid tillering	panicle initiation
	Ordram® 2.5 to 3.75 L @ pre to post sowing.						Gulliver® 40 g with 1.6-2.7 MCPA 250 @ 4 leaf stage to 3 tiller		Basagran® M60 2 to 2.5 L @ 1 to 2 tillered rice OR MCPA 2.7 L @ 3 tillered rice	
	Apply Ordram® when BYG is at 0-4 leaf stage OR Magister® 0.4-0.6 L @ pre-sow to 2 leaf stage rice.									
	Apply Magister® when BYG is at 0-3 leaf stage									
				Barnstorm™ 0.75 to 1.5 L @ 1-2 leaf to late tillered rice		Aura® 0.375 L @ 3 leaf stage to late tillered rice				
						Londax®/Kendax® 50 to 85 g @ 2 leaf stage rice. Apply when weeds are small, up to 3 leaf stage				
				Barnstorm™ 0.75 to 1.5 L @ 1-2 leaf to late tillered rice		Aura® 0.375 L @ 3 leaf stage to late tillered rice				
						Saturn® 3.75 L @ secondary (fibrous) root rice stage. Apply when DD is 0-2 leaf stage, and BYG is 0-3 leaf				
						Londax®/Kendax® 50-85 g @ 2 leaf stage rice (apply as above)				
								Gulliver® 40 g with 1.6-2.7 MCPA 250 @ 4 leaf stage to 3 tiller		
								Basagran® M60 2-2.5 L @ 1-2 tillered rice		OR MCPA 2.7 L @ 3 tillered rice
	Ordram® 2.5 L @ pre-sow			Barnstorm™ 0.75-1.5 L @ 1-2 leaf stage to late tillered rice		Aura® 0.375 L @ 3 leaf stage to late tillered rice				
	Apply to newly flooded fields before sowing					Saturn® 3.75 L @ secondary (fibrous) root rice stage (apply as above)				
						Londax®/Kendax® 50-85 g @ 2 leaf stage rice (apply as above)				
								Gulliver® 40 g with 1.6-2.7 MCPA 250 @ 4 leaf stage to 3 tiller		
								Basagran® M60 2-2.5 L @ 1-2 tillered rice		OR MCPA 2.7 L @ 3 tillered rice
	Saturn® 1 to 1.5 L @ pre-sow.			Barnstorm™ 0.75-1.5 L @ 1-2 LS		Aura® 0.375 L @ 3 leaf stage to late tillered rice				
	Apply to weed-free, newly flooded fields before sowing					Saturn® 3.75 L @ secondary (fibrous) root rice stage (apply as above)				
						Londax®/Kendax® 50-85 g @ 2 leaf stage rice (apply as above)				
								Gulliver® 40 g with 1.6-2.7 MCPA 250 C @ 4 leaf stage to 3 tiller		
								Basagran® M60 2-2.5 L @ 1-2 tillered rice		OR MCPA 2.7 L @ 3 tillered rice

Table 8. Recommended chemical programs for aerial sown rice-costs

Herbicide resistance management program	Chemical	Commonly used rate (L/ha or g/ha)	\$/L or \$/g	\$/ha	Fixed wing aerial application \$/ha	Total program cost (\$/ha)
Program 1: Rotate from Taipan® program after 2-3 crops to avoid resistance	Taipan®	2.0	71.00	142	21	291
	Ordram®	3.75	34.00	128		
	Taipan®	2.0	71.00	142	21	199
	Magister®	0.5	72.00	36		
Program 2: Rice must have secondary (fibrous) roots before application of Saturn®	Taipan®	2.0	71.00	142	21	268
	Saturn®	3.75	28.00	105		
Program 3: This program is for high weed pressure	Taipan®	2.0	71.00	142	21	374
	Ordram®	2.5	34.00	85		
	Saturn®	3.75	28.00	105		
Program 4: Rotate from Londax® program every 2-3 crops to avoid resistance	Londax®	70	0.26	18	21	167
	Ordram®	3.75	34.00	128		
	Londax®	70	0.26	18		
	Magister®	0.5	72.00	36		
Program 5: Narrow window of Saturn® application main limitation	Londax®	70	0.26	18	21	144
	Saturn®	3.75	28.00	105		
Program 6: This program is for high weed pressure	Londax®	70	0.26	18	21	250
	Ordram®	2.5	34.00	85		
	Saturn®	3.75	28.00	105		
Program 7: Not for long grain varieties or where weeds have germinated before flooding	Londax®	70	0.26	18	21	179
	Saturn®	1.5	28.00	42		
	Saturn®	2.75	28.00	77		
All programs should ideally include MCPA or Basagran M60 to provide 2 modes of action on each aquatic weed, costs:						
Backup sprays using secondary mode of action	MCPA	2.7	7.00	19	21	40
	Basagran® M60	2.5	7.00	19		

Note: Indicative costs only. Prices are average retail (excluding GST), from resellers in the Murrumbidgee and Murray Valley, as at 1 July 2018. They are to be used as guide only. Prices will vary depending on location, availability and quantity purchased. Ubeniq™ price unavailable at the time of printing.



Figure 6. Aerial sowing. Photo: John Fowler

Weed and pest identification

Identifying and controlling weeds early in the paddock is essential. Knowing the weed you have and identifying the best control strategy will lead to cleaner crops and less resistance issues. The following pages show photos of some important weeds at various growth stages as well as the symptoms you might encounter from some pests in emerging rice crops.

Arrowhead

Arrowhead seedling leaves are similar to starfruit narrow; straplike, 20–30mm long but mature leaves are arrow shaped. Seed germinates quickly on newly flooded bays.

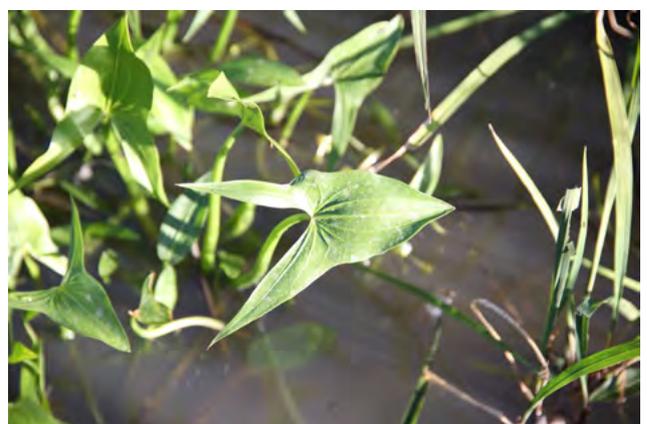


Figure 7. Arrowhead from seedling to flower.
Photos: John Broster & Allison Chambers (CSU)

Barnyard grass

Barnyard grass seedlings are hairless and bright green to blueish often with distinctive red markings. No ligules or auricles present, which distinguishes it from rice. The plant might be erect or prostrate depending on the species. Controlling barnyard grass in seasons before sowing is very important.



Figure 8. Barnyard grass identification from seedling to maturity.
Photos: John Broster & Allison Chambers (CSU)

Silvertop grass

Silvertop grass seedlings have narrow and often droopy, dull green leaves with pronounced white mid vein, membranous ligule but no auricles at leaf-stem junction. Seeds germinate readily on still water surface at 25°C then sink and establish.



Figure 9. Silvertop grass from seedling to maturity. Photo: John Broster, Allison Chambers (CSU), David Troidahl & Agropraisals Pty Ltd.

Dirty dora

Dirty dora has triangular, hairless and bright green stems. Seeds germinate quickly in shallow water. Seedlings require moist or wet conditions to survive.

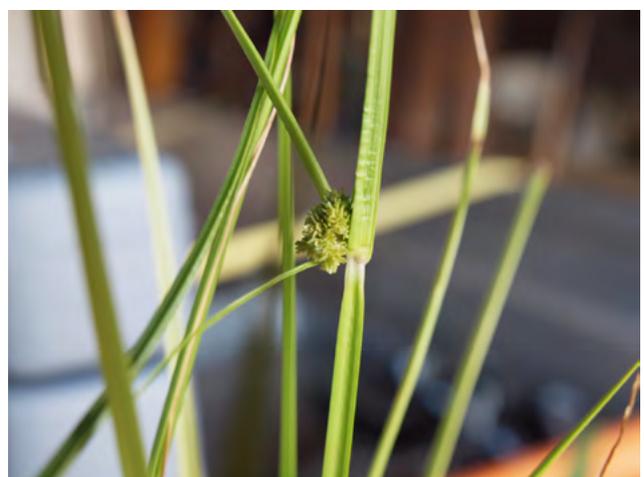


Figure 10. Dirty Dora identification from seedling to maturity.
Photos: John Broster & Allison Chambers (CSU)

Jerry jerry

Erect, rigidly branched plant, grows to 60 cm high, lanceolate leaves to 50 mm long and 8 mm wide, leaves paired on stem, purple to brown seeds.



Figure 11. Jerry jerry identification from seedling to maturity.
Photos: John Broster & Allison Chambers (CSU)

Starfruit

Starfruit seedling leaves are narrow and straplike, radiating from the centre of the plant. Fruit is star shaped. Seedlings germinate on soil surface after several days of continuous flooding.



Figure 12. Starfruit identification from seedling to maturity.
Photos: John Broster & Allison Chambers (CSU)

Water plantain

Water plantain is closely related to alisma, but has broader leaves with seven prominent parallel veins, connected by numerous transverse veins. Leaves are attached to a long stem it reproduces from both seeds and corms. Seeds are spread in irrigation water on machinery and by birds.

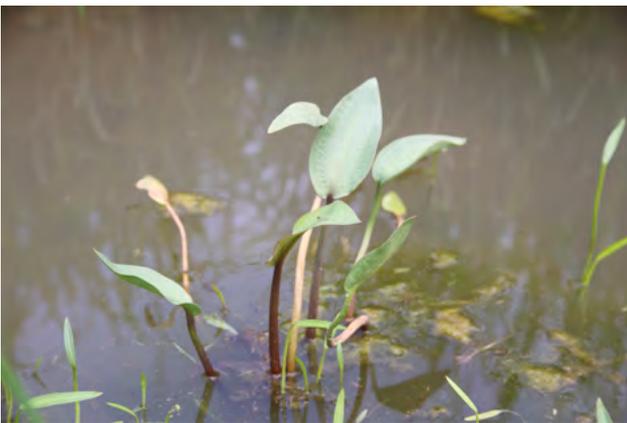
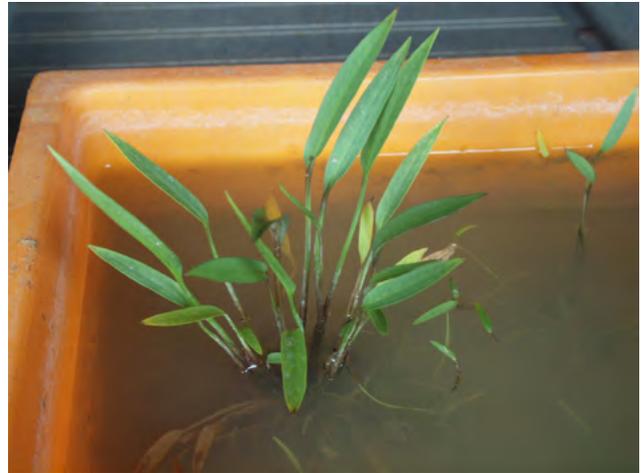
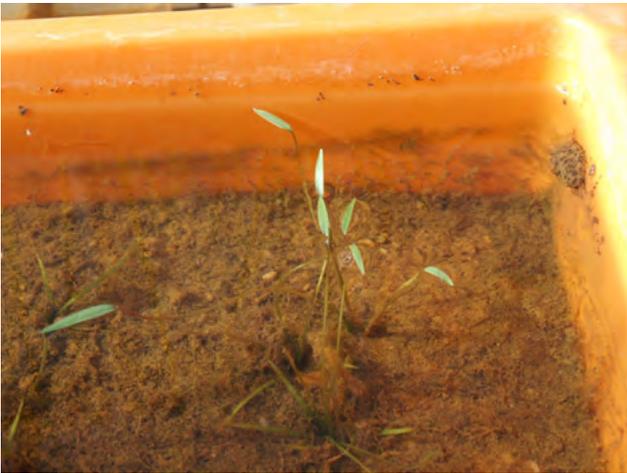


Figure 13. Waterplantain identification from seedling to maturity.
Photos: John Broster & Allison Chambers(CSU)

Leafminer

Leafminers cause the leaf to collapse and lie flat on the water surface, and the leaf tip to decay. Plants are most vulnerable before tillering.



Figure 14. Leafminer symptoms in rice (top and centre). Photos: David Troidahl; and pupae on rice plants (bottom). Photo: Glen Warren

Drill sown programs

Drill sown herbicide resistance management programs (see tables 9 and 10)

Grass weed control in the paddock over the previous 18 months and during fallow is essential to minimize grass weeds in the crop. This is even more important if considering a delayed permanent water crop. There are five drill sown herbicide programs. The first three are based on Ordram®. The letter in brackets after each herbicide signifies the mode of action group to which the herbicide belongs.

Program 1 Gramoxone® (L) followed by Saturn® (J) with Stam® (C) followed by Ordram® (J) This backup treatment needs to be when the weeds are small as control will be difficult once tillering has started.

Program 2 Gramoxone® (L) followed by Ordram® (J)

Program 3 Gramoxone® (L) followed by Magister® (Q) followed by Ordram® (J)

Program 4 Recommended program for drill sown rice: tank mixture of Gramoxone® (L) mixed with Magister® (Q) and Stomp® (D) all applied post sowing to pre-rice emergence. The post emergent backup program for each of the aquatic weeds would include MCPA (Group I) or Basagran® M60 (Group C/I) to provide two modes of action.

Program 5 Tank mixture of Stam® (C) Magister® (Q) and Stomp® (D) all applied post sowing but where rice has emerged.

Aura® (dim) and Barnstorm™ (fop) are the options for a post-emergent grass weed control backup

treatment using another mode of action (Group A). This backup treatment needs to be when the weeds are small as control will be difficult once tillering has started.

When using Program 4 and Program 5 and looking to extend the residual weed control before flood (Delayed Permanent Water), crops should be monitored carefully after 14 days. New germinations of grass weeds will need to be treated with appropriate herbicides which may include: Stam®, Stam® and Saturn®, Stam® and Stomp®, Stam® and Magister® or Barnstorm™ or Aura®.

Some herbicides e.g. Stomp® and Saturn® will bind with organic matter and ash left on the surface and this will reduce efficacy.

When using a program including Magister® do not use drainage water on corn or other sensitive crops.



Figure 15. Drill sowing rice. Photo: Vince Bucello

Table 9. Control options for major weeds in drill sown rice (to be read in conjunction with Table 10)

The orange letter in brackets after the chemical rate in this table (i.e. a to s) refers to the appropriate part of the column headed 'Application: comments in Table 10 (pp. 26). Rates of product are in L/ha unless otherwise indicated.

S – suppression only, • – requires follow up herbicide treatment, # – requires a previous herbicide treatment

Weed stage	Rice stage	glyphosate 450 g/L Roundup® CT	glyphosate 570 g/L Roundup Ultra® MAX	paraquat 135 g/L diquat 115 g/L SpraySeed® 250	paraquat 250 g/L Gramoxone® 250	molinate 960 g/L Ordram®	thiobencarb 800 g/L Saturn® EC	clomazone 480 g/L Magister®	propanil 480 g/L Stam®	pendimethalin 440 g/L Stomp® 440	cyhalofop butyl 285 g/L Barnstorm™ (requires Uptake®)	profloroxim 200 g/L Aura® (requires Super-charge®)	dicamba 500 g/L Kamba® 500
annual winter pasture													
6–8 cm b	1–14 day pre-sowing	0.8–1 a	0.795–0.95 b										
well grazed	pre or post sowing before rice emerges			1.6–3.2 c									
barnyard grass													
1–3 leaf	pre-emergence			1.7–2.2 e	0.8–1.6 d								
1–4 leaf	up to early tillering					3.75 f							
0–3 leaf	up to early tillering						5 g						
0–5 leaf	up to early tillering						5 + Stam® h						
0–5 leaf	emerging											0.75–1 i	
0–4 leaf	pre-sow							0.5–0.6 + paraquat j					
0–4 leaf	post sowing to rice emergence							0.5–0.6 + Stam® k	7.5 + clomazone k				
1–2 leaf	0–4 leaf							0.6 l					
2–3 up to 5 leaf	evenly germinated								7.5–12.5 m				
1–3 leaf	after 1st flush before rice emergence				0.8 + Stomp® n						3.4 + paraquat n		
0–3 leaf	after 1st flush before rice emergence				0.8 + clomazone & Stomp® o			0.4 + Stomp® & paraquat o			3.4 + clomazone & paraquat o		
0–3 leaf	after 1st flush where rice has emerged							0.4 + Stomp® & Stam® s	3.75 + Stomp® & Magister® s		3.4 + Magister® & Stam® s		
3–5 leaf	1–2 leaf to late tillering											0.75–1 p	
1–2 tillers	1–2 leaf to late tillering											1 p	
3–4 tillers	1–2 leaf to late tillering											1.5 p	
2 leaf–6 tillers	min 3 leaf												375 mL q
past 5 leaf	1–2 leaf minimum					up to 5.2 L/ha							
silvertop grass													
0–4 leaf	pre-sow							0.5–0.6 + paraquat j					
0–4 leaf	post sowing to rice emergence							0.5–0.6 + Stam® k	7.5 + clomazone k				
1–2 leaf	0–4 leaf							0.6 l					
2–3 up to 5 leaf	evenly germinated								7.5–12.5 m				
0–3 leaf	after 1st flush before rice emergence				0.8 + clomazone & Stomp® o			0.4 + Stomp® & paraquat o			3.4 + clomazone & paraquat o		
0–3 leaf	after 1st flush where rice has emerged							0.4 + Stomp® & Stam® s	3.75 + Stomp® & Magister® s		3.4 + Magister® & Stam® s		
3–5 leaf	1–2 leaf to late tillering											0.75–1 p	
1–2 tillers	1–2 leaf to late tillering											1 p	
2 leaf–6 tillers	min 3 leaf												375 mL q
docks													
small to large	seedling–early tillering												0.4–0.56 r



Figure 16. Rice head at grain fill.



Figure 17. Drill sown rice.

Table 10. Weed control options and herbicide combination options in drill sown rice

The letter in orange below (i.e. a to r) refers to the orange letter in Table 9 to be read in conjunction.

Weed stage	Rice stage	Herbicide	Rate/ha	Application: comments
Annual winter pasture for sodseeding of rice (annual ryegrass, barley grass, subterranean clover, annual medic)				
6 to 8 cm high and actively growing	1 to 14 days before sowing	glyphosate 450 g/L e.g. Roundup® CT, Glyphosate 450	0.8 to 1 L	(a) Use higher rate where annual ryegrass is dominant. For subterranean clover dominant pastures or where improved clover/medic control is required, add dicamba 0.5 L/ha.
6 to 8 cm high and actively growing	1 to 14 days before sowing	glyphosate 570 g/L e.g. Roundup®, Ultra® MAX	0.795 to 0.95 L	(b) Note: Other glyphosate products containing different amounts of the active herbicide will require different rates: READ the LABEL.
well-grazed, actively growing	Just before to just after sowing but before rice emerges	paraquat + diquat 135 + 115 g/L e.g. Spray.Seed® 250	2.2 L (1.6 to 3.2 L)	(c) Allow up to 1 week for pasture re-greening. For clover dominant pastures add dicamba 0.5 L/ha. Up to 3.2 L/ha may be required for ungrazed pastures.
barnyard grass, <i>Echinochloa</i> spp.				
1 to 3-leaf	pre-sow to pre-emergence	paraquat 250 g/L e.g. Gramoxone® 250	0.8 to 1.6 L	(d) Ideally spray to knockdown barnyard grass seedlings before rice is sown or emerges. Spraying when rice has up to 50% coleoptile emergence may be justified to avoid large advanced grass seedlings at permanent water stage.
1 to 3-leaf	sowing to pre-emergence	paraquat + diquat 135 + 115 g/L e.g. Spray.Seed® 250	1.7 to 2.2 L	(e) Note: A permanent water stage application of a rice herbicide will still be necessary for the control of subsequent germinations of grass weeds.
1 to 4-leaf	seedling to early tillering	molinate 960 g/L Ordram® Note: Will also control silvertop grass if applied up to the 2-leaf stage.	3.75 L	(f) Apply to permanent water by aircraft.
0 to 3-leaf	pre-emergent to early tillering	thiobencarb 800 g/L Saturn® EC Note: Will also control dirty dora in the 0 to 2-leaf stage.	5 L	(g) Apply to drill or pasture sodsown rice onto moist or dry soil surface before the last flushing if permanent water can be applied within 11 days of spray application.
0 to 5-leaf	pre-emergent to early tillering	thiobencarb 800 g/L Saturn® EC plus propanil Stam®	5 L 7.5 L to 8.5 L	(h) Apply to drill or pasture sodsown rice onto moist or dry soil surface before the last flushing if permanent water can be applied within 11 days of spray application. Do not use this mix within 10 days of organophosphate insecticides. (h) Works by direct contact with weeds. Drain field thoroughly before application and flood within five days of application. Only spray under ideal conditions, preferably with temperatures above 25 °C.
0 to 5-leaf	emerging	cyhalofop butyl 285 g/L Barnstorm™ followed by Taipan®, Saturn®, Ordram®, Magister®	0.75 to 1 L/ha plus 1 L/ha Uptake® spraying oil	(i) For best results with Barnstorm™, water must be at least 1–2 cm deep in fields at spraying to ensure active growth of weeds. Start reflooding after two hours and fill the field as soon as possible to limit new weed germination and maximise weed control. DO NOT treat weeds if mud, cracks, or firm soil have appeared throughout fields before treatment, as poor control will result due to moisture stress. (i) At permanent flood, follow the label directions for Taipan®, Saturn®, Ordram® or Magister® as appropriate.
barnyard grass, <i>Echinochloa</i> spp.; silvertop grass, <i>Leptochloa fusca</i>				
up to 4-leaf	pre-sow	clomazone 480 g/L Magister® plus paraquat Gramoxone®	0.5 to 0.6 L 0.8 L	(j) Apply to dry soil after the first flush but before crop emergence. A second flush or rainfall is needed within five days to activate the Magister®. Permanent water needs to be applied within two weeks of application to minimise the likelihood of barnyard grass late germinations. Apply by ground using flat fan nozzles, which produce medium to coarse droplets to minimise off-target movement. After permanent water re-treat with an alternative product if required.
up to 4-leaf	after sowing to emerged rice	clomazone 480 g/L Magister® plus propanil Stam®	0.5 to 0.6 L 7.5 L	(k) Apply to dry soil to emerged rice 1–5 days between application and permanent water. Fully submerge barnyard grass with permanent water for three days before allowing flood levels to subside. Only suppression control for silvertop grass. Do not apply to Illabong. Apply by ground using flat fan nozzles, which produce medium to coarse droplets to minimise risk of off-target movement.
up to 2-leaf	up to 4-leaf	clomazone Magister®	0.6 L	(l) Apply as a drip at inundation to permanent water using a constant head siphon; to permanent water by fixed wing aircraft with a Bickley boom; by dripper (SCWIIRT) using a tractor or 4-wheel agbike. Water movement must cease for three days after application. Silvertop grass suppression only. Not on Illabong.
2 to 3-leaf up to 5-leaf	evenly germinated rice	propanil 480 g/L Stam®	7.5 to 8.5 L up to 12.5 L	(m) Propanil is a contact herbicide. Apply 12.5 L/ha for 4 to 5-leaf barnyard grass (See comments for aerial sowing).
up to 3-leaf barnyard grass, silvertop grass and sedges	after the first flush but before rice emergence	Tank mix: pendimethalin 440 g/L Stomp® 440 plus paraquat 250 g/L, Gramoxone® 250	3.4 L 0.8 L	(n) Apply after the first flushing and ensure the soil surface is sealed by the flushing or rainfall before application. Apply a second flush or permanent water after two days but not later than five days after applying Stomp® 440 EC. Use the higher rate when sodseeding into pasture for annual sedge control or more than 10 days is expected between treatment and permanent water. Do not apply to weakened rice.

Weed stage	Rice stage	Herbicide	Rate/ha	Application: comments
Up to 3-leaf	after the first flush but before rice emerges	Tank mix: clomazone Magister® plus pendimethalin Stomp® 440 plus paraquat 250 g/L Gramoxone® 250	0.4 L 3.4 L 0.8 L	(o) Apply after the first flushing and ensure the soil surface is sealed by the flushing or rainfall before application. Not on Illabong. Preferred option for drill sown rice
	after first flush but rice has emerged	Tank mix: clomazone Magister® plus pendimethalin Stomp® 440 plus propanil Stam®	0.4 L 3.4 L 3.75L	(s) Apply after the first flushing and ensure the soil surface is sealed by the flushing or rainfall before application. Not on Illabong. Option for early weed control when rice has emerged before herbicide application. This lower rate of Stam® is on the Stomp® label and can only be used with mixing with Stomp®.
barnyard grass, <i>Echinochloa</i> spp.; silvertop grass, <i>Leptochloa fusca</i>				
3 to 5-leaf	1 to 2-leaf to late tillering	cyhalofop 285 g/L Barnstorm™	0.75 to 1 L plus 1 L/ha Uptake spraying oil	(p) Apply after flooding by fixed wing aircraft, helicopter or boom sprayer to partially drained fields ensuring there is still 1 to 2 cm water depth to ensure active growth and at least 75% of weed foliage is exposed to the spray. Works by direct contact with weeds. Re-flood after two hours and fill as soon as possible to limit germination of new weeds. If it is applied pre-flood, it is recommended the bays are flushed immediately before and after Barnstorm™ application to ensure weeds are not stressed at the time of application. Results may be more variable when not applied in permanent water.
1 to 2 tillers			1 L plus 1 L/ha Uptake spraying oil	
3 to 4 tillers (barnyard grass only)	1.5 L plus 1 L/ha Uptake® spraying oil			
2-leaf to 6 tiller	3-leaf minimum	profoxydim 200 g/L Aura®	375 mL plus 1 L/100 L Supercharge®	(q) Apply by aircraft, helicopter or ground boom to partially drained bays containing 1–2 cm water onto actively growing weeds with sufficient foliage exposed for adequate coverage. Re-flood after 2 hours and fill as soon as possible to limit germination of new weeds and maximise weed control. Avoid treating dense weed populations and preferably apply Aura® after a foundation herbicide effective on the target weed. If Aura® is applied pre-flood, it is important to ensure weeds are not dry stressed before application which could reduce the level of weed control. After application apply sufficient water to cover.
Past 5 leaf	1–2 leaf minimum	molinate 960 g/L Ordram®	up to 5.2 L/hr	(s) Salvage control of barnyard grass: After rice emergence and where the barnyard grass is past the 5-leaf stage and up to the early tillering stage, useful suppression or partial control may be achieved by increasing the rate of barnyard grass herbicide. Good water coverage of weed growth after spray application will assist weed suppression. For Ordram®: Increase rates up to 5.2 L/ha. Avoid spray overlap as some crop injury may occur.
docks, <i>Rumex</i> spp.				
small to large plants	seedling to early tillering	dicamba 500 g/L	0.4 to 0.56 L	(r) Dicamba needs to contact the leaves. Apply before permanent water. Can be applied after permanent water if water is lowered to expose dock plants.

Table 11. Recommended chemical programs for drill sown rice – costs

Herbicide resistance management program	Chemical	Rate L/ha or g/ha	\$/L or \$/g	\$/ha	Fixed wing aerial application \$/ha	Total program cost \$/ha
Program 1						
Pre rice emergence	Gramoxone®	0.80	7.00	6		
Before last flush	Saturn®	5.00	28.00	140		
Only spray if temperature is above 25 °C	Stam®	7.50	33.00	248		
Apply to permanent water by aircraft	Ordram®	3.75	34.00	128	21	542
Program 2: for paddocks with good grass weed						
Pre rice emergence	Gramoxone®	0.80	7.00	6		
Apply to permanent water by aircraft	Ordram®	3.75	34.00	128	21	154
Program 3						
Pre rice emergence	Gramoxone®	0.80	7.00	6		
	Magister®	0.50	72.00	36		
Apply to permanent water by aircraft	Ordram®	3.75	34.00	128	21	190
Program 4: recommended program for drill sown rice						
Pre rice emergence	Gramoxone®	0.80	7.00	6		
	Magister®	0.50	72.00	36		
	Stomp®	3.40	11.00	37		89
Program 5: Post rice emerging						
Only spray if temperature is above 25 °C	Stam®	3.75	33.00	124		
This lower rate of Stam® can only be used if mixed with Stomp®	Magister®	0.5	72.00	36		
	Stomp®	2.25	11.00	25		185
All programs may need a backup spray, costs:						
Backup spray using secondary mode of action	Barnstorm™	1.5	93.00	140	21	plus 160
	Aura®	0.375	373.00	140	21	or 160

Note: Indicative costs only. Prices are average retail (excluding GST), from resellers in the Murrumbidgee and Murray Valley, as at 1 July 2018. They are to be used as guide only. Prices will vary depending on location, availability and quantity purchased.

Table 12. Timing of herbicide applications for resistance management programs for drill sown rice

Program	Number of modes of action per weed				
	DD	SF	AH	A,WP	BYG
<p>Consult labels of individual products for details of rates, application and weeds controlled.</p>					
<p>Program 1: Gramoxone®, Saturn® plus Stam® followed by Ordram®</p> <ul style="list-style-type: none"> Spray Gramoxone® to knockdown barnyard grass seedlings before rice is sown or after the first flush before rice emergence. Apply Saturn®EC to rice before last flush. Best if permanent water can be applied within 11 days of spray application. Stam®. Only spray under ideal conditions, preferably with temperatures above 25°C. Do apply within 10 days of organophosphate insecticides. Apply Ordram® to permanent water by aircraft using closed supply and delivery systems. Water movement into and between bays should stop 2 hours before application of Ordram® and for three days after application. Ordram® will control silvertop grass up to the 2 leaf stage. 	✓			✓	✓✓✓
<p>Program 2: Gramoxone® with Ordram®</p> <ul style="list-style-type: none"> This program is designed for paddocks with good grass weed control before the rice crop. Gramoxone® and Ordram® comments as above. 				✓	✓✓
<p>Program 3: Gramoxone® tank mixed with Magister® followed by Ordram®</p> <ul style="list-style-type: none"> Apply Gramoxone® and Magister® after first flush before crop emergence. A flush is needed within 5 days of application to activate the Magister®. Permanent water needs to be applied within 2–3 weeks of application to minimise the likelihood of late germinations of barnyard grass. Magister® will only suppress silvertop grass and can cause transient bleaching of rice. Prevent water movement for at least three days after treatment with Magister®. Do not apply Magister® to rice variety Illabong. Gramoxone® and Ordram® comments as above. 				?✓	✓✓✓
<p>Program 4: Gramoxone® plus Magister® and Stomp® followed by Barnstorm™ or Aura®</p> <ul style="list-style-type: none"> Apply Gramoxone®, Magister® and Stomp® after first flush before crop emergence and ensure soil surface is sealed by flushing or rainfall before application. Gramoxone® and Magister® comments as above. Barnstorm™ or Aura® might be needed to clean up escapes and provide another herbicide mode of action for all grass weeds. 	✓	✓✓		✓	✓✓✓✓
<p>Program 5: Stam® plus Magister® and Stomp® followed by Barnstorm™ or Aura®</p> <ul style="list-style-type: none"> Apply Stam®, Magister® and Stomp® after first flush when crop has emerged and ensure soil surface is sealed by flushing or rainfall before application. Stam® and Magister® comments as above. Barnstorm™ or Aura® might be needed to clean up escapes and provide another herbicide mode of action for all grass weeds. <p>Stam® @ 3.75 L with Magister® @ 0.4 L plus Stomp® @ 3.4 L</p> <p>When rice emergence occurs before herbicide application. Barnstorm™ 0.75 to 1 L or Aura® 0.375 L</p> <p>Post flooding</p>	✓	✓✓		✓	✓✓✓✓

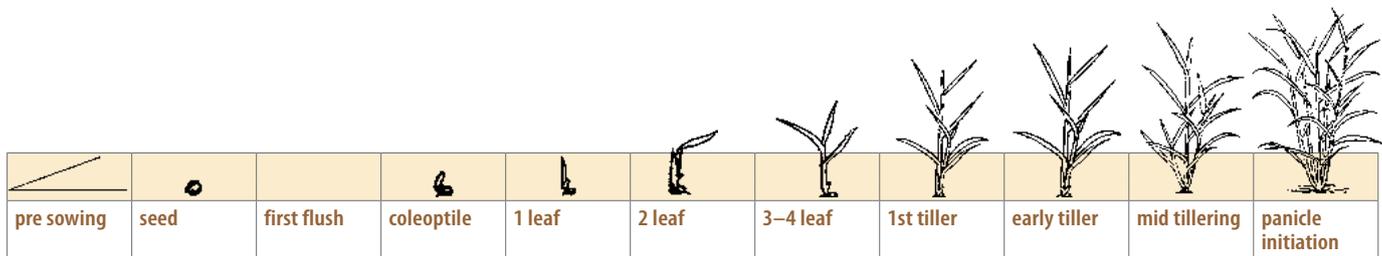
KEY ✓ – each mode of action per species is one tick ✓✓ – at least 2 ticks is desirable for sound resistance management of grass weeds.

? A mode of action where the herbicide used may only suppress the weed or may not carry a label claim for control of that weed species.

Notes: All of the drill sown programs may need a second herbicide action for cleanups or escapes after permanent water. Barnstorm™ or Aura® are ideal for grass escapes or cleanups.

Some drill sown crops may have a germination of broadleaf weeds before canopy closure and may need to be cleaned up by using one of the broadleaf weed control options for rice: Taipan®, MCPA or Basagran® M60

DD – dirty dora, SF – starfruit, AH – arrowhead, A – alisma, WP – water plantain, BYG – barnyard grass



pre sowing	seed	first flush	coleoptile	1 leaf	2 leaf	3-4 leaf	1st tiller	early tiller	mid tillering	panicle initiation
Gramoxone® 0.8-1.6 L, pre sowing or before rice emergence			Saturn®EC @ 5 L plus Stam® @ 7.5-8.5 L applied to barnyard grass at 0-5 leaf stage				Ordram® 3.75 L @ permanent water			
Gramoxone® @ 0.8-1.6 L, pre sowing or before rice emergence							Ordram® 3.75 L @ permanent water			
Gramoxone® @ 0.8 L with Magister® @ 0.6 L post sowing before rice emergence							Ordram® 3.75 L @ permanent water			
Gramoxone® @ 0.8 L with Magister® @ 0.4 L plus Stomp® @ 3.4 L post sowing before rice emergence							Barnstorm™ 0.75-1 L or Aura® 0.375 L post flooding			
				Stam® @ 3.75 L, Magister® @ 0.4 L and Stomp® @ 3.4 L post sowing post rice emergence.			Barnstorm™ 0.75-1 L or Aura® 0.375 L			

Drill sown programs

Insect, snail and aquatic earthworm control

Bloodworms – *Chironomus tepperi* and other species

There are many different bloodworm species present in rice fields, and not all of them feed on rice. Identifying which species is present is not possible without specialised equipment, and this makes it impractical to provide density-based population thresholds to indicate when bloodworm treatment is required.

Bloodworms are the most consistent pest problem in aerially-sown rice crops. All aerially-sown crops should be treated for bloodworm at or immediately before sowing. Crops should be inspected regularly after treatment, and if there are signs of significant re-infestation **and** crop damage within 20 days of sowing, the affected crops should be re-treated by air. Crops are most vulnerable in the first 16 days after the bays are flooded, since *C. tepperi* larvae are at their highest density during this period.

Seed treatment with fipronil (Cosmos®, Emporium®) provides far better residual control than other registered seed treatments (maldison, trichlorfon), protecting plants for 9–14 days. If fipronil seed

treatment is not available, the only alternative initial treatments recommended by the NSW Department of Primary Industries are chlorpyrifos and alphacypermethrin, one of which should be applied by air (**not on seed**) the day **before** sowing. These treatments will both provide 7–12 days protection under normal conditions, and both chemicals are also recommended for use as follow-up treatments when required. Chlorpyrifos, alphacypermethrin and diazinon cannot be registered for use as seed treatments because of their high toxicity to birds and other wildlife. Any crops sown with maldison seed treatments are likely to require a follow-up application of chlorpyrifos or alphacypermethrin 5–7 days after sowing.

Bloodworms can cause significant damage in drill-sown crops, however, this is fairly uncommon as the plants generally have well-developed secondary root systems by the time permanent water is applied. Drill-sown rice should be inspected regularly after permanent water, and treated with chlorpyrifos or alphacypermethrin only if bloodworms are present in large numbers **and** plant root damage is evident.

Table 13. Chemicals for bloodworm control

Pesticide	Rate	Method of application		Notes
		to seed at sowing	by air to flooded bays	
fipronil 500 g/L, e.g. Cosmos®, Emporium®	20 mL/100 kg of seed or 25 mL/ha	Yes	No	Will provide 9–14 days residual control of target species.
alphacypermethrin 100 g/L, e.g. Dominex Duo®, Astound Duo®	100 mL/ha	No	Yes	Will provide 7–12 days residual control of target species.
alphacypermethrin 300 g/L, Alpha-Scud®	35 mL/ha	No	Yes	Will provide 7–12 days residual control of target species.
maldison 440 g/L, Fyfanon®	680 mL/ha	No	Yes	Will provide 5–7 days control.
maldison 500 g/L, Fyfanon®	600 mL/ha	No	Yes	Will provide 5–7 days control.
maldison 1000 g/L, Fyfanon®	300 mL/ha	Yes	Yes	Will provide 5–7 days control.
maldison 1150 g/L, Hy-mal®	260 mL/ha	Yes	Yes	Will provide 5–7 days control.
chlorpyrifos 500 g/L, e.g. Lorsban®, Strike-out®	60 or 150 mL/ha	No	Yes	Use maximum rate where water is more than 15 cm deep or amount of decaying plant material is high. Will provide 7–12 days residual control of target species.
trichlorfon 500 g/L, e.g. Dipterex®, Lepidex®	600 – 850 mL/ha	Yes (625 mL/ha)	Yes	Use higher rate where water is more than 8 cm deep or where the amount of decaying plant material is high.
diazinon 800 g/L, e.g. Diazol®, Diazinon	75 – 150 mL/ha	No	Yes	The maximum rate will be required for satisfactory control in most situations.

The advice in 'Notes' is based on NSW DPI research. Shaded cells are our recommended treatments.

Aquatic earthworms – *Eukerria saltensis*

Aquatic earthworms are much longer than bloodworms (up to 70 mm, as opposed to 25 mm maximum for bloodworms) and unlike bloodworms, they lack distinct head capsules and have no appendages at the ends of their bodies (see Figure 19). It is important to be able to differentiate between bloodworms and aquatic earthworms, since aquatic earthworms will not be controlled by registered bloodworm treatments. In recent seasons there have been increasing reports of bloodworm control failures, and in some cases this has been due to the misidentification of aquatic earthworms as bloodworms.

Aquatic earthworms may be a severe problem in aerially-sown crops, particularly on heavy clay soils. There are no pesticides registered for their control, but there are several management options available that might reduce the severity of crop damage.

Pre-sowing. Landforming to reduce areas of deep water, coupled with good paddock drainage over winter. Avoid sowing rice into infested fields immediately following irrigated pastures which promote the development of high earthworm populations.

- **Sowing.** Flood and sow smaller areas separately to shorten fill-up times. This will give the worms less opportunity to destabilise the soil surface before sowing.
- **Post-sowing.** Drain fields for as long as possible if the water is dirty and/or dense algal growth is present. Water-run gypsum will help to clear the water on re-filling. If you are considering draining your crop, please remember that irrigation company guidelines applicable to your area **must** be followed to prevent off-site drainage contamination.



Figure 18. Partially cleared bloodworms showing their conspicuous head capsules and abdominal appendages (see insets). Live bloodworms are much redder in colour. Length c.a. 20 mm.



Figure 19. An aquatic earthworm. Note that there is no head capsule or abdominal appendages (see insets, which are preserved specimens).

Leafminers – *Hydrellia michelae*

Leafminers are the larvae of a small fly. The female fly lays eggs on the rice plant near the waterline, and the larvae burrow into the leaves, feeding, and ultimately pupating within the plant tissues. Affected leaves lie flat on the water, often developing pale areas around the point where the leafminer has been feeding (Figure 14 on page 22).

Larvae and pupae within the plant can usually be detected by feeling for irregularities in the leaves or examining suspect leaves in front of a strong light. Damage is more severe in deep water and during cold seasons, with plants generally being most susceptible during mid October to mid December. Thresholds listed below should be used as guidelines for determining if treatment is required.

Table 14. Damage thresholds for treating leafminer infestations

A registered pesticide should be applied when the percentage of infested plants meets or exceeds the guideline values listed.

Seedling density (plants/m ²)	% of plants infested
<80	Treat if >5%
80 to 120	Treat if >10%
>120	Treat if >20%

Further information on sampling fields to determine leafminer densities is available in Chapter 10 of *Production of quality rice in South Eastern Australia*.

Armyworms – *Leucania convecta*

Armyworms are the caterpillars of a noctuid moth, and might require chemical control from tillering through to harvest. Care must be taken to ensure that the correct withholding periods are observed before harvest to ensure no chemical residues are present in the grain. At present, the registered withholding periods for maldison, trichlorfon and chlorpyrifos are one, two and 10 days respectively. It is suggested, however, that growers voluntarily observe the

following minimum withholding periods in order to provide an even greater margin of safety:

- maldison eight days minimum between treatment and harvest
- trichlorfon 12 days minimum between treatment and harvest
- chlorpyrifos 25 days minimum between treatment and harvest.

Growers considering treating for armyworms within 20 days of harvest should consult their agronomist to ensure that the level of infestation justifies the treatment cost.

The synthetic pyrethroid alphacypermethrin (Dominex Duo[®], Astound Duo[®], and other trade names) is currently registered for armyworm control in rice. Alphacypermethrin products are registered for use against armyworms in drained crops only, and have seven-day withholding periods. The NSW Department of Primary Industries and SunRice recommend that growers **do not use alphacypermethrin products for armyworm control in rice**. This is due to concerns about residue contamination in crops destined for sensitive overseas markets.

The following treatment thresholds are based on data from overseas species and on the results of a survey of experienced NSW rice agronomists. Damage thresholds for *L. convecta* on Australian rice varieties have not yet been developed experimentally; these thresholds should be considered as a guide only.

Table 15. Damage thresholds for treating armyworm infestations.

A registered pesticide should be applied when armyworm populations meet or exceed threshold levels.

Crop stage	Treat if pest density exceeds:
Panicles not exposed	8 armyworm/m ²
Panicles exposed – more than 2 weeks to harvest	10 armyworm/m ²
Panicles exposed – less than 2 weeks to harvest	12 armyworm/m ²



Figure 20. Armyworm and armyworm damage. Photos: Rice extension

Sampling and assessing armyworm infestations

When armyworms are found, it is important to systematically assess infestations by sampling in diagonal transects across the bays before deciding whether treatment is warranted. Estimates of armyworm densities can be made by using a 'beat sheet' or sampling tray, and hitting or shaking the foliage to make the armyworm drop onto the sheet or tray where they can be counted. Alternatively, armyworms dislodged from the foliage can be counted whilst floating on the water surface. A wire frame either 0.5 m² or 1 m² can be easily made out of fencing wire and used to delimit an area for each sample. At least eight samples should be taken along each of two transects for each bay. No samples should be taken within 3 m of the crop edge, and no more than two samples should be closer than 8 m to the crop edge. The average count should be adjusted to an armyworms/m² value, and a decision whether or not to spray should be based on the threshold values provided. Further information is available in the NSW DPI Primefact [Armyworms in rice](#).

Australian plague locusts – *Chortoicetes terminifera*

Plague locust damage to rice crops has become increasingly common in recent years. Immature locusts without fully developed wings (hoppers) form bands that can invade combine or sod-sown crops between flushes. Immature locusts generally do not penetrate far into flooded rice fields, and are best controlled in dryland areas before they reach the crop.



Figure 21. Australian plague locust.

Mature locusts form large, highly mobile swarms that can cause widespread crop damage and could require chemical control. If growers need to use maldison or chlorpyrifos for plague locust control close to harvest, the extended withholding periods listed for armyworm control should also be adhered to. Trichlorfon is not registered for locust control in rice.

Snails – *Isidorella newcombi*

Snail infestations occur in most rice crops each season, however not all snail species will attack the crop. Infestations occurring after mid-late December are unlikely to cause significant damage regardless of the snail species involved. *Isidorella newcombi* is the most common snail species associated with crop damage. *Isidorella* is capable of surviving in dry soil by entering dormancy, leading to serious problems in fields sown to rice for a second consecutive year. The snails cannot survive the period between rice crops if summer crop rotations are used – a single summer fallow is enough to eliminate dormant populations provided the soil is not waterlogged.

Snails can remain dormant in dry channel banks as well as in fields, so if crop rotations are used to minimise snail infestations it is important that on-farm supply channels be kept as dry as possible between crops.

Copper sulphate (bluestone) is registered for rice snail control, however, growers need to be aware that the two registered brands of copper sulphate, Snailblitz® and Grochem®, have different maximum application rates (see Table 16 on page 34).

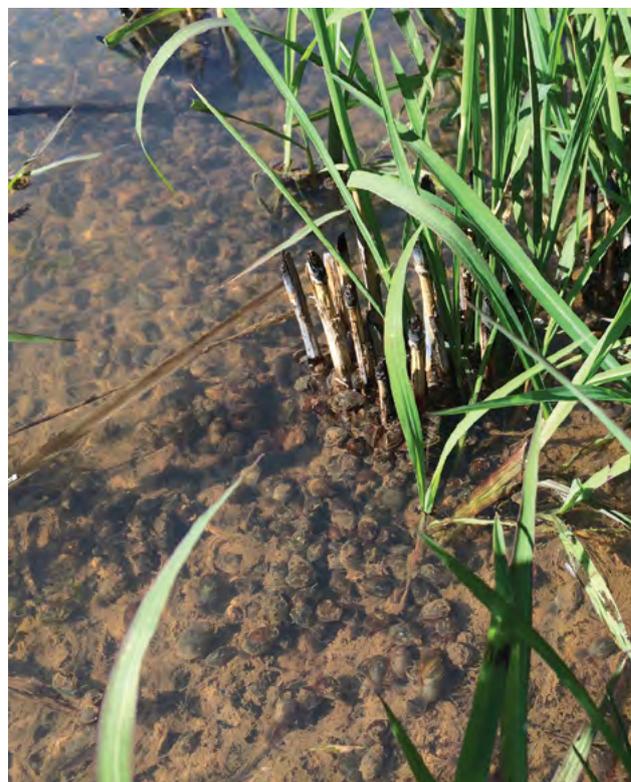


Figure 22. Snails in crop.
Photo: Rice extension

Table 16. Chemicals for leafminer, locust, snail and armyworm control

Pest	Crop stage	Pesticide	Rate per hectare	Notes
Leafminers – <i>Hydrellia michelae</i>	Seedlings above permanent water	trichlorfon 500 g/L, e.g. Dipterex®, Lepidex®	850 mL	
Australian plague locusts – <i>Chortoicetes terminifera</i>	Seedlings to harvest	chlorpyrifos 500 g/L, e.g. Lorsban®, Strike-out®	350 mL	Growers should consult resellers as other actives may be available under APVMA permit.
		maldison 440 g/L, Fyfanon®	1400 or 1900 mL	
		maldison 500 g/L, Fyfanon®	1200 or 1700 mL	
		maldison 1000 g/L, Fyfanon®	600 or 850 mL	
		maldison 1150 g/L, Hy-mal®	520 or 750 mL	
		maldison ¹ 1169 g/L, Fyfanon® ULV	700 mL	
Snails – <i>Isidorella newcombi</i>	Seedlings to late tillering	copper sulphate pentahydrate (bluestone) 250 g/kg copper, Snailblitz®, Grochem® copper sulphate molluscicide	6–12 kg (Snailblitz®) 6–10 kg (Grochem®)	Use higher rates for deep water and/or high organic matter levels.
Armyworms – <i>Leucania convecta</i>	Generally flowering to harvest	trichlorfon 500 g/L, e.g. Dipterex®, Lepidex®	1200 mL	
		maldison 440 g/L, Fyfanon®	1800 mL	
		maldison 1169 g/L, Fyfanon ULV®	700 mL	
		chlorpyrifos 500 g/L, e.g. Lorsban®, Strike-out®	700 or 900 mL	

¹ APVMA permit PER11843

Shaded cells are our recommended treatments.

Higher rates within the registered ranges are recommended for use in deeper water or where large amounts of organic matter are present. Whilst copper sulphate is effective against immature and adult snails, it has no significant effect on snail eggs, and as a consequence a second application may be required.

Chemical registrations listed here are NSW product registrations taken from the web edition of the Infopest® database (accessed 11 July 2018). This information should be used as a guide only – always read product labels to ensure that the proposed use conforms to a registered use pattern.

Other commercial products may also be registered for particular uses. Interstate growers in particular should check labels to ensure that product registrations mentioned here are valid in their own state.

For more information

The [Rice crop protection guide](#) is also available on the these websites:

<https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/summer-crops/rice-development-guides/rice-crop-protection-guide>

[Rice Extension webpage](#) at <https://riceextension.org.au>

The following publications are sources of more detailed information on weeds, pests and diseases in rice:

[Rice field guide to pests, diseases and weeds in southern NSW](#)

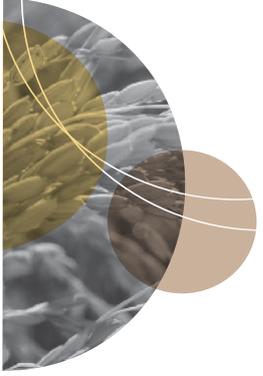
<https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/summer-crops/rice-development-guides/field-guide>

[Management of drill sown rice](#) – NSW DPI Factsheet www.dpi.nsw.gov.au/agriculture/broadacre/summer-crops/rice/drill-sown

[Armyworms in rice](#) – NSW DPI Primefact www.dpi.nsw.gov.au/agriculture/broadacre/pests-diseases/pests-diseases/armyworms

[Production of quality rice in south eastern Australia](#). RIRDC/NSW Agriculture <https://ret.sunrice.com.au/DocumentsAndForms/Production%20of%20Quality%20Rice%20in%20South%20Eastern%20Australia%20-%20Copy.pdf>

[Chemical labels](#) can be searched at: portal.apvma.gov.au/pubcris



Notes



Rice crop protection guide 2018–19

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Rice Extension funded by AgriFutures Australia

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