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FOR PROFITABLE, ADAPTIVE AND SUSTAINABLE PRIMARY INDUSTRIES

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Rice crop protection guide 2011

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A guide to the pesticides that are approved for the control of weeds and invertebrate pests in rice.

High-yielding profitable rice crops require good weed and pest control.

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 in using pesticides on rice crops are:

1. **effective use:** ricegrowers need to effectively control weeds and pests and minimise the development of herbicide resistance.
2. **safe use:** ricegrowers need to avoid unintended effects on humans, non-target crops and the environment.
3. **residues in drainage water:** ricegrowers need to avoid residues in drainage that may affect the environment. Residues can be greatly minimised by not draining rice water into drains within 21–28 days of pesticide application.

This Primefact 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. Tables 1–5 outline options for weed control; Tables 6–9 list treatments for insect, snail and aquatic earthworm control in rice.

This Primefact does not contain all the information necessary to safely and effectively use these pesticides in rice. Full details are contained on the label of each pesticide product and should be read in conjunction with this Primefact.

Pesticide selection and use

Pesticide selection and use is the responsibility of each grower. Growers must satisfy themselves that the pesticide they choose is the best one for the particular situation.

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, 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?

Plant-back guidelines

There have been several instances in the last few years where rice has been damaged by herbicides applied to a previous summer or winter crop. The increased incidence of damage was probably due to the drought and associated low irrigation allocations causing crops to be cut or abandoned prior to their maturity and the area then sown to rice.

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. Damage is known to have occurred with the Group C triazine herbicides (e.g. atrazine, simazine) and with Group B herbicides (e.g. Lusta®, Ally®, Logran® 750). Rice damage is also possible if the crop is sown too soon after using numerous other herbicides.

Group A Herbicides: 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 plant-back period has lapsed. An example of where it appears on the label is with Verdict®. It states cereal crops or grasses planted within twelve weeks of application may be damaged by the residual effects of Verdict® 520 herbicide, particularly on light and red soils.

Group B Herbicides: The persistence of residual Group B herbicides such as Logran® and Lusta® is dependent on various environmental conditions such as soil pH, temperature, soil moisture and organic matter content.

Group C Herbicides: In addition to the triazine herbicides other Group C herbicides also present potential rice plant-back issues. Diuron, for example, presents a risk as aerially sown rice is known to be extremely sensitive to it.

Specific rice plant-back guidelines are not available for most non-rice herbicides. Most plant-backs are made on the assumption that the herbicide is applied to a winter crop that reaches maturity in the season of application. The best available data, for some of the main winter crop herbicides which may impact on rice is given in Table 1, page 3.

Integrated weed management

Good weed control in rice involves integrated weed management: the combination of herbicides with other methods of weed control. The characteristics of the various weed species, the seed bank and the level of infestation determine the effects of various weed management practices on each particular weed.

Weed control can be part of many management practices including

- **Sowing methods** influence types and numbers of weeds. Ponding and draining associated with flushing for establishment of drill-sown rice reduce aquatic weed numbers and growth. Permanent water for aerial sowing inhibits barnyard grass growth.
- **Crop rotation:** rotating rice with winter crops helps reduce weed numbers.
- **Layout:** good layouts allow more even water depth and even weed germination which allows easier and more effective herbicide timing. Good water depth management practices before, during and after herbicide application assist in effective weed control.
- **Timely cultivations** before fill-up, 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 of barnyard grass after rice emergence is a possible option for reducing weed numbers.
- **Minimum cultivation** can help to reduce weed germinations.
- **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 avoid using equipment and headers in uncontaminated areas. For example,

Table 1. PLANT-BACK GUIDELINES

Herbicide Group	Active Constituent	Trade Name	Rate	Plant-back	Comments
GROUP B					
Sulfonylureas (SUs)	chlorsulfuron	Glean®	20 g/ha	12 months?	As soil pH increases rate of breakdown decreases. 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. Glean® is intended for use on land having a soil pH 8.5 or lower.
	metsulfuron	Ally®	7 g/ha	6 weeks	Recropping interval varies from 10 days to 14 months for a pH range of 5.6 to 8.5.
	triasulfuron	Logran®	35 g/ha	12 months	As pH increases the rate of breakdown decreases. Replanting can be up to 24 months or more depending on pH and rainfall.
Imidazolinones (Imis)	imazethapyr	Spinnaker®	70 g/ha	5 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 plus irrigation) from application to sowing at least 500 mm.
	MCPA imazapic imazapyr	Midas®	900 ml/ha	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	atrazine	Atrazine	2.5 L/ha	6 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.
		500	2.5–6.0 L/ha	18 months	

water plantain is prolific in the Eastern Murray Valley, with some infestations in the Western Murray Valley and only rare infestations in the Coleambally and Murrumbidgee Irrigation Areas. Murray Valley growers, therefore, should not take any equipment outside the Murray Valley. Similarly, Coleambally growers with alisma should avoid using equipment and headers outside the Coleambally Irrigation Area. Washing headers does not eliminate all seeds.

- **Rice pure seed scheme:** is operated by SunRice and Department of Primary Industries (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 build-up of new weed populations and entry and build-up of weeds in rice bays.
- **Green manuring and fodder conservation practices:** these practices allow weeds to be harvested before seed set, thus reducing weed seedbanks.
- **Rice hay:** may be an option for any 'out of control' weedy bays.
- **Allelopathy:** research investigations show some rice varieties can inhibit weed growth better than others.
- **Biocontrol:** the naturally occurring fungus *Rhynchosporium alismatis* has been investigated as a biocontrol agent for starfruit and alisma.

Guidelines for spraying pesticides onto rice crops

The application of pesticides to rice crops requires care and attention at all times. This particularly applies to aerial spraying.

1. **READ THE LABEL** and understand what it says.
2. Apply the correct rate of pesticide in the manner described on the label.
3. Wear protective clothing and use proper safety equipment (and supply it for employees) when handling and mixing pesticides, or marking for aircraft application. Using GPS marking systems in aerial spraying avoids hazards to markers.
4. Talk with your neighbours about your spray programs and potentially sensitive crops.
5. 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.
6. 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.

7. 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.
8. The rice pesticides used during the establishment of aerial sown rice, for example, molinate, Saturn®, Londax®, chlorpyrifos and trichlorfon, are applied to the water surface of the flooded field. Fine droplets to cover the leaf surface of the rice or weed plants are not needed in this situation. Coarse droplets are all that is required to carry the pesticides into the water, which will also ensure drift hazards are minimised. The Bickley boom, SCWIIRT (that is, 'soluble chemical water injection in rice technique') and helicopters provide techniques that minimise the drift hazards whilst maintaining effective pest control.

9. **Herbicides containing molinate** – There has been a significant change to the molinate label for 2011. The main change is that molinate is now required to be used through closed supply and delivery systems. Most aerial operators have the capability to apply molinate in accordance with the label requirements. Ground rig application is permissible provided the spray unit can operate a closed supply system and the operator is within a closed cab. Herbigation remains a permitted option however chemical will only be available in 200 L envirodrums and 1000 L shuttles.

10. Particular care is required in the use of MCPA to avoid drift to non-target crops or areas.

Herbicide resistance management for weed control in rice

The 2011 rice weed management strategies and programs outlined in this Primefact have been developed in conjunction with the Rice Crop Protection Group representing Department of Primary Industries, Bayer Crop Science, BASF Australia Ltd, Dow AgroSciences Australia Ltd, Crop Care Australasia Pty Ltd, DuPont (Australia) Ltd, FMC Chemicals Pty Ltd, Nufarm Ltd, Agropraisals Pty Ltd, Charles Sturt University, the RIRDC Rice R & D Committee and agribusiness in the MIA, CIA, and Murray Valley.

The key strategies for managing herbicide resistance and achieving effective weed control in rice for 2011 are:

- **Maximise the effectiveness** of the herbicides used by good management before, during and after application.

- **Use two herbicides**, that is, two different modes of action for each weed.
- **Rotate herbicides**, that is, where possible, use a herbicide with a different mode of action in the following rice crop.
- **Rotate sowing methods** between aerial and drill sowing as this allows the use of more modes of action and herbicide groups e.g. Stomp® Group D for drill sowing.
- **Consider knockdown herbicides** prior to sowing e.g. glyphosate or before rice emergence, e.g. paraquat + diquat for grass control. They help to reduce reliance on the more herbicide resistance prone Group A herbicides.

Maximise the effectiveness

Use each herbicide or herbicide program to maximise its effectiveness: that is, at the rates and in the manner described on the product label.

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. Each weed species and each herbicide used has its own specific requirements that must be integrated into the rice management system.

Use two herbicides with different modes of action for each weed.

Herbicides have different modes of action. The mode of action is the way they act in the plant to control the weed. Herbicides are classified into groups with similar modes of action. The Groups containing rice herbicides are:

- Group A Barnstorm®, Aura®
- Group B Londax®, Kendax® (bensulfuron methyl), Gulliver®
- Group C bentazone in Basagran® M60, Stam®
- Group D Stomp®
- Group H Taipan®, Viper® – Viper® is a commercial mix of clomazone (48 g/L, Magister®) and benzofenap (120 g/L, Taipan®)
- Group I MCPA, MCPA in Basagran® M60, dicamba
- Group J molinate, Ordram®, Saturn®
- Group L Spray-Seed®, Gramoxone® 250, Shirquat®
- Group M glyphosate
- Group Q Magister®, Viper®

Applying two herbicides with 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, as the second herbicide in all the currently available herbicide programs, either:

- MCPA, or
- Basagran® M60.

The rotation of herbicide groups is also the recommended practice for the control of **barnyard grasses**. Whilst there is no evidence of barnyard grass resistance to herbicides in Australian rice fields, resistance has occurred in Australia in other cropping systems. Barnyard grass populations resistant to a number of herbicides, including molinate and Saturn®, have been identified in California. The similarities of growing system, herbicides used and grass species make it essential for us to take action to avoid this situation in Australian rice crops.

Rotating rice with other crops or pastures, that is, avoiding rice-only rotations, will help prevent the development of resistant barnyard grass.

Which program?

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

1. intensity and spectrum of each weed, based on previous rice cropping and rotation
2. level of resistance to herbicides in each weed species observed or recorded in previous seasons
3. herbicide program used in the previous rice season
4. variety and establishment technique to be used.

Discuss these issues with your adviser.

Aerial sown herbicide programs (see Table 2)

There are eight basic herbicide programs for aerial sown rice in 2011 based on the main aquatic weed herbicide used, that is, Taipan® or 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 molinate (J) or Magister® (Q)
- Program 2 Taipan® (H) with Standard Saturn® (J)
- Program 3 Taipan® (H) with molinate primer (J) and Standard Saturn® (J)
- Program 4 Taipan® (H) pre-mixed with Magister® (Q) (Viper®)
- Program 5 bensulfuron methyl (B) with molinate (J) or Magister® (Q)
- Program 6 bensulfuron methyl (B) with Standard Saturn® (J)
- Program 7 bensulfuron methyl (B) with molinate primer (J) and Standard Saturn® (J)
- Program 8 bensulfuron methyl (B) with Split Saturn® (J)

Table 2. WEED CONTROL 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	2.5 L	Apply to permanent water during application by metering from a drum with a constant head syphon. Apply to permanent water by aircraft , from completion of initial flooding to as soon as possible after sowing.
1 to 4-leaf	pre-emergent to early tillering	Ordram® Molinate 960	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>				
weed-free (prior to germination)	before flooding and sowing: dry soil application	thiobencarb 800 g/L Saturn® EC	3.75 to 5 L*	Apply by boom to dry soil surface – avoid overlapping. For best results, supply water separately to each bay. Maintain water coverage after flooding. * Note: For use with the Amaroo variety only. Bays should be rolled to break down clods prior to application. Do not use where water is muddy.
barnyard grass , 0 to 3-leaf	Early post-sowing 1 to 2-leaf	thiobencarb 800 g/L Saturn® EC	3.75 L	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.
dirty dora , 0 to 2-leaf				
no weeds present	just prior to sowing	Split Saturn® thiobencarb 800 g/L Saturn® EC	1 to 1.5 L <i>followed by</i>	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.
barnyard grass , 0 to 3-leaf	1 to 2-leaf		2.75 L	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.
dirty dora , 0 to 2-leaf				
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	Apply to newly flooded bays before weed germination. Apply by SCWIIRT by tractor or 4-wheel bike, helicopter 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	Follow Taipan® label directions.
barnyard grass , 0 to 3-leaf	post-sowing	thiobencarb 800 g/L Saturn® or	2.75 to 3.75 L	Follow Saturn® label directions.
		molinate 960 g/L Ordram®	2.5 to 3.7 L	Follow Ordram® label directions.

Table 2. WEED CONTROL IN AERIAL-SOWN RICE (continued)

Weed stage	Rice stage	Herbicide	Rate/ha	Application: comments
barnyard grass, <i>Echinochloa</i> spp.; silvertop grass, <i>Leptochloa fusca</i>				
barnyard grass: pre-emergence to 4-leaf	pre-sow to 2-leaf	clomazone 480 g/L Magister®	0.4 to 0.6 L	Ensure seedbed is free of germinated grasses prior to flooding. Apply by fixed wing aircraft or helicopter fitted with a Bickley boom or by dripper (SCWIIRT method) using a tractor or 4-wheel agbike to permanent water. When using the Bickley boom, always add 41-A drift retardant for Magister® and Viper®.
silvertop grass: up to 2-leaf growth can be suppressed		Viper® controls the weeds as listed for each component chemical (see page 5).	0.5 to 0.6 L	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	evenly germinated rice	propanil 480 g/L	7.5 to 8.5 L	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 of 25° to 26°C.
4 to 5-leaf		Stam®	12.5 L	
barnyard grass, <i>Echinochloa</i> spp.; silvertop grass, <i>Leptochloa fusca</i>				
3 to 5-leaf	1–2 leaf to late tillering	cyhalofop 285 g/L Barnstorm®	0.75 to 1 L plus 1 L/ha Uptake® Spraying Oil	Apply by fixed wing aircraft 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.
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®	Use 1.5 L/ha to treat larger weeds. Apply by aircraft 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>				
(3-leaf onwards) 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	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.

Table 2. WEED CONTROL IN AERIAL-SOWN RICE (continued)

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				
small, up to 3-leaf	2-leaf up to mid-tillering	bensulfuron methyl 600 g/kg Londax® DF Kendax® 600WG	50 to 85 g	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.
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	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: <ul style="list-style-type: none"> • will only suppress dirty dora • 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	MCPA needs to contact the leaves. Prior to 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	MCPA needs to contact the leaves. Lower water levels to expose all weeds and soil surface prior to 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 0.57 L	Dicamba needs to contact the leaves. Prior to application, lower water levels to expose the weed leaves to direct contact with the spray.
algae , green slime				
not apparent to developing on soil	sowing to early tillering	copper chelates Coptrol® copper ethanolamine complexes Cupricide®	2 to 5 L	Rate of application depends on depth of water and level of algal infestation. See product leaflet. Note: There is no registration or permit for the use of copper sulfate against algae in rice crops so its use cannot be recommended.

For a complete guide to each program refer to Table 4a and 4b.

Note: All programs should ideally include MCPA or Basagran® M60 to provide two modes of action on each of the aquatic weeds. Aura® (dim) and Barnstorm® (fop) are other options for a post-emergent grass weed control treatment using another mode of action (Group A).

Drill sown herbicide programs (See Table 3)

There are four drill sown herbicide programs for 2011. The first three are based on the main grass weed herbicide used, that is, molinate (Ordram®, Molinate 960). 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)
- Program 2 Gramoxone® (L) followed by Ordram® (J)
- Program 3 Gramoxone® (L) followed by Magister® (Q) followed by Ordram® (J)
- Program 4 Tank mixture of Gramoxone® (L) with $\frac{2}{3}$ rate Magister® (Q) and $\frac{2}{3}$ rate Stomp® (D) all applied post sowing to pre-rice emergence.

Weed control for delayed ponding

Program 4 is the preferred option for weed control when practicing delayed permanent water.

The weed control strategies are:

Crop rotation

Choose paddocks with a history of low barnyard and silvertop grass weed infestations, to minimise competition with rice and herbicide use.

If paddocks are known to have high barnyard and/or silvertop grass infestations use normal drill or aerial sowing plus early permanent water systems.

Pre-sowing

Wherever possible use a preplant knockdown glyphosate treatment to control the 1st weed germination. This is cheap, will reduce barnyard/silvertop grass populations and selection pressure for resistance on rice herbicides.

Paraquat is registered for 1–3 leaf barnyard grass control just before sowing rice.

Direct drilling rice (no soil cultivation) will reduce weed germinations. A problem with this sowing method is that if stubble is burnt beforehand and ash is left on the soil surface it will tie up herbicides. Stomp® and Saturn® are particularly sensitive to ash tie-up.

Post sow to pre-rice emergence

There are three herbicide options – paraquat, Magister® and Stomp®.

Paraquat 250 g/L (e.g. Gramoxone® 250)

Paraquat is registered for control of 1–3 leaf barnyard grass prior to sowing rice to the pre-emergence rice stage. Experience shows rice at up to 50% coleoptile emergence can be sprayed if needed.

Clomazone 480 g/L (e.g. Magister®)

This is probably the best option for early grass control.

Advantages

Magister® has low volatility (in contrast to molinate), has good residual activity, is not phytotoxic to rice seed on the soil surface and can be mixed with paraquat if grasses are emerged.

Disadvantages

Magister® is weak on silvertop grass and can cause transient rice bleaching if applied post-sowing.

Use

For barnyard and/or silvertop grass control, drill rice, flush and spray prior to crop emergence. Apply 0.5–0.6 L/ha Magister® to dry soil after the first flush but prior to crop emergence. If weeds have started emerging, add 0.8 L/ha paraquat (250 g/L) to the Magister®. If there is no follow-up rainfall to activate Magister®, apply a second flush to activate the Magister®. This should give 2–3 weeks of weed control.

Pendimethalin 330 g/L and 440 g/L (e.g. Stomp® 330 or 440 EC)

Advantages

It gives good residual control, has low volatility and water solubility (resides where it is applied), can be mixed with paraquat for emerged grasses and controls sedges.

Disadvantages

Weed control is poorer if there is surface organic matter and it is phytotoxic to any shallow rice seed not covered by soil.

Use

For barnyard grass, silvertop grass and sedge control. Drill rice, flush and apply 3–4.5 L/ha of 330 g/L Stomp® or 2.25–3.4 L/ha of 440 g/L Stomp®. The soil must be sealed by the flushing or by rain to prevent cracks. If weeds have started emerging, then mix 0.8 L/ha paraquat (250 g/L) with the Stomp®. If there is no follow-up rainfall to activate Stomp®, apply a second flush 2–5 days after spraying to activate the chemical. This should give 2–3 weeks of weed control.

Table 3. WEED CONTROL IN DRILL-SOWN RICE

Prepared seedbed, pasture sodseed, stubble sodseed

Weed stage	Rice stage	Herbicide	Rate/ha	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 for example, Roundup® CT Glyphosate 450	0.8 to 1 L	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 360 g/L for example, Roundup® Glyphosate 360	1 to 1.3 L	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 for example, Spray Seed® 250	2.2 L (1.6 to 3.2 L)	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 for example, Gramoxone® 250	0.8 to 1.6 L	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	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® Molinate 960	3.75 L	Apply to: • dry bays prior to permanent water or prior to the last flushing • to permanent water by aircraft • to permanent water during application by metering from a drum, with a constant head siphon. Note: Will also control silvertop grass if applied up to the 2-leaf stage.
0 to 3-leaf 0 to 5-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	Apply to drill or pasture sodsown rice onto moist or dry soil surface prior to the last flushing if permanent water can be applied within 11 days of spray application.
0 to 5-leaf	pre-emergent to early tillering	Saturn® EC plus propanil Stam®	5 L 3.75 to 7.5 L	Apply to drill or pasture sodsown rice onto moist or dry soil surface prior to 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. 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 of 25° to 26°C.
0 to 5-leaf	emerging	cyhalofop 285 g/L Barnstorm® followed by Taipan®/Saturn®/Molinate/Magister®	0.75 to 1 L/ha plus 1 L/ha Uptake® Spraying Oil	When Barnstorm® is applied pre-flood, it is recommended the bays are flushed immediately prior to 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. At permanent flood, follow the label directions for Taipain®, Saturn®, Molinate 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 Shirquat®	0.5 to 0.6 L 0.8 L	Apply to dry soil after the first flush but prior to crop emergence. A second flush or rainfall is needed within 5 days to activate the Magister®. Permanent water needs to be applied within 2 weeks of application to minimise likelihood of late germinations of barnyard grass. 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.

Note: For control of green algae slime, dirty dora, starfruit or alisma infestations after permanent water has been applied, see 'Weed control in aerial-sown rice'.

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®** or **Molinate** 960: Increase rates up to 5.2 L/ha. Avoid spray overlap as some crop injury may occur.

Table 3. WEED CONTROL IN DRILL-SOWN RICE (continued)
Prepared seedbed, pasture sodseed, stubble sodseed

Weed stage	Rice stage	Herbicide	Rate/ha	Comments
barnyard grass, <i>Echinochloa</i> spp.; silvertop grass, <i>Leptochloa fusca</i>				
up to 4-leaf	after sowing to emerged rice	clomazone 480 g/L Magister® plus propanil Stam®	0.5 to 0.6 L 3.75 to 7.5 L	Apply to dry soil to emerged rice 1 to 5 days between application and permanent water. Fully submerge barnyard grass with permanent water for 3 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	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 3 days after application. Silvertop 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	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 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 or 200 g/L e.g. Paraquat 200	2.25 L or 3.4 L 0.8 L or 1 L	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 2 days but not later than 5 days after application of Stomp 330 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.
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 2.5 L 0.8 L	Apply after the first flushing and ensure the soil surface is sealed by the flushing or rainfall before application. Not on Illabong.
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	Apply after flooding by fixed wing aircraft 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 2 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 prior to 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	Use 1.5 L/ha to treat larger weeds.
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®	Apply by aircraft 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.
docks, <i>Rumex</i> spp.				
small to large plants	seedling to early tillering	dicamba 500 g/L	1 to 1.4 L	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 4a. HERBICIDE RESISTANCE MANAGEMENT PROGRAMS: TAIPAN® BASED PROGRAMS

Program LS = leaf stage TR = tillered rice Consult labels of individual products for details of rates, application and weeds controlled.	safe for medium grains	safe for long grains	Modes of action per weed					Rice Growth Stages											
			DD	SF	AH	AWP	BYG	filling up	seed	coleoptile	1-leaf	2-leaf	3 to 4-leaf	1st tiller	early tiller	mid tillering	panicle initiation		
Program 1: Taipan® with molinate 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 or Basagran® M60 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	?✓	✓	✓✓	✓✓	✓✓	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 LS to late tillered rice						Gulliver® 40 g with 1.6-2.7 MCPA 250 @ 4-5 LS to 3 tiller		
								plus molinate 2.5 to 3.75 L @ pre- to post-sowing Apply molinate when barnyard grass is at the 0-4 leaf stage. Avoid application at sowing. or Magister® 0.4 to 0.6 L @ pre-sow to 2 LS rice Apply Magister® when barnyard grass is at the 0-3 leaf stage.										Basagran® M60 2 to 2.5 L @ 1 to 2 TR or MCPA 2.7 L @ 3 TR For Basagran® M60 or MCPA, lower water level and apply to weed foliage.	
Program 2: Taipan® with Standard Saturn® • Taipan®, MCPA, Basagran® M60, Barnstorm®, Aura®: Comments as above. • Saturn®: Apply when dirty dora is in the 0-2 LS, and barnyard grass is 0-3 LS. Rice must have secondary (fibrous) roots.	yes	yes	?✓✓	✓✓	✓✓✓	✓✓	✓✓	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 LS to late tillered rice						Gulliver® 40 g with 1.6-2.7 MCPA 250 @ 4-5 LS to 3 tiller		
																		Saturn® 3.75 L @ secondary (fibrous) root rice stage Apply when dirty dora is 0-2 LS, and barnyard grass is 0-3 LS.	Basagran® M60 2 to 2.5 L @ 1 to 2 TR or MCPA 2.7 L @ 3 TR
Program 3: Taipan® with Standard Saturn® and molinate primer • A robust program where weed pressures are high. • Molinate: Apply to newly flooded weed-free fields before rice sowing. • Taipan®, Saturn®, MCPA, Basagran® M60, Barnstorm®, Aura®: Comments as above.	yes	no	?✓✓	✓✓	✓✓	✓✓	✓✓	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 LS to late tillered rice						Gulliver® 40 g with 1.6-2.7 MCPA 250 @ 4-5 LS to 3 tiller		
								plus molinate 1 to 1.5 L @ pre-sow Apply to weed-free, newly flooded fields before sowing.										Saturn® 3.75 L @ secondary (fibrous) root rice stage Apply when dirty dora is 0-2 LS, and barnyard grass is 0-3 LS.	Basagran® M60 2 to 2.5 L @ 1 to 2 TR or MCPA 2.7 L @ 3 TR
Program 4: Viper® (Taipan® pre-mixed with Magister®) • Taipan®, MCPA, Basagran® M60, Barnstorm®, Aura®: Comments as above. • Add 100 mL/ha Magister® to Viper® application for high silvertop populations and 3-4 LS barnyard grass.	yes	yes	?✓	✓✓	✓✓	✓✓	✓✓	Viper® 5 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 LS to late tillered rice						Gulliver® 40 g with 1.6-2.7 MCPA 250 @ 4-5 LS to 3 tiller		
																		Basagran® M60 2 to 2.5 L @ 1 to 2 TR or MCPA 2.7 L @ 3 TR	

KEY LS = leaf stage TR = tillered rice ✓ 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 may only suppress the weed or may 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 4b. HERBICIDE RESISTANCE MANAGEMENT PROGRAMS: BENSULFURON METHYL BASED, All rates in the table are per hectare.

PROGRAM	safe for medium grains	safe for long grains	Modes of action per weed																
			DD	SF	AH	AWP	BYG	filling up	seed	coleoptile	1-leaf	2-leaf	3 to 4-leaf	4 to 5-leaf	1st tiller	early tiller	mid tillering	panicle initiation	
<p>Program 5: bensulfuron methyl with molinate or Magister®</p> <ul style="list-style-type: none"> 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 2 or 3 crops on the same field. 3.75 L of molinate 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	✓✓	✓✓	✓✓	??	✓✓	Molinate 2.5 to 3.75 L @ pre to post sowing. Apply molinate when barnyard grass is at 0–4 LS. Avoid application at sowing. or Magister® 0.4–0.6 L @ pre-sow to 2 LS rice. Apply Magister® when barnyard grass is at 0–3 LS.					Gulliver® 40 g with 1.6–2.7 MCPA 250 @ 4–5 LS to 3 tiller Basagran® M60 2 to 2.5 L @ 1 to 2 TR or MCPA 2.7 L @ 3 TR For both Basagran® M60 and MCPA, lower water level and apply to weed foliage.						
<p>Program 6: bensulfuron methyl (B) with Standard Saturn®</p> <ul style="list-style-type: none"> Bensulfuron: comments as above. Narrow window of Saturn® application is the main limitation. Tank mixtures of bensulfuron methyl plus Saturn® may reduce barnyard grass control with Saturn®. For long grains, ensure Saturn® is applied before and separately to bensulfuron methyl, to avoid damage. MCPA, Basagran® M60, Gulliver® plus MCPA provide a second herbicide action where aquatic weeds other than dirty dora are present. Lower water level and apply to weed foliage. Barnstorm® and Aura®: comments as above. 	Yes	Yes	✓✓✓	✓✓	✓✓	✓?	✓✓	Barnstorm® 0.75 to 1.5 L @ 1–2 LS to late tillered rice Saturn® 3.75 L @ secondary (fibrous) root rice stage Apply when dirty dora is 0–2 LS, and barnyard grass is 0–3 LS.					Aura® 0.375 L @ 3 LS to late tillered rice Londax® / Kendax® 50 to 85 g @ 2 LS rice (apply as above) Gulliver® 40 g with 1.6–2.7 MCPA 250 @ 4–5 LS to 3 tiller Basagran® M60 2 to 2.5 L @ 1 to 2 TR or MCPA 2.7 L @ 3 TR						
<p>Program 7: bensulfuron methyl with Standard Saturn® and molinate primer</p> <ul style="list-style-type: none"> This program is for high weed pressures. Bensulfuron: comments as above. If applied alone the low pre-treatment molinate rate will not control weeds, just suppress them temporarily. Can injure long grain varieties excessively. MCPA, Basagran® M60, Gulliver® plus MCPA, Barnstorm® and Aura®: comments as above. 	Yes	No	✓✓✓	✓✓	✓✓	✓?	✓✓	Molinate 1 to 1.5 L @ pre-sow Apply to weed-free, newly flooded fields before sowing.					Barnstorm® 0.75 to 1.5 L @ 1–2 LS to late tillered rice Saturn® 3.75 L @ secondary (fibrous) root rice stage (apply as above) Londax® / Kendax® 50 to 85 g @ 2 LS rice (apply as above). Gulliver® 40 g with 1.6–2.7 MCPA 250 @ 4–5 LS to 3 tiller Basagran® M60 2 to 2.5 L @ 1 to 2 TR or MCPA 2.7 L @ 3 TR						
<p>Program 8: bensulfuron methyl with Split Saturn®</p> <ul style="list-style-type: none"> Bensulfuron: 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 prior to flooding. MCPA, Basagran® M60, Barnstorm® and Aura®: comments as above. 	Yes	No	✓✓✓	✓✓	✓✓	✓?	✓✓	Saturn® 1 to 1.5 L @ pre-sow Apply to weed-free, newly flooded fields before sowing.					Barnstorm® 0.75 to 1.5 L @ 1–2 LS to late tillered rice Saturn® 3.75 L @ secondary (fibrous) root rice stage (apply as above) Londax® / Kendax® 50 to 85 g @ 2 LS rice (apply as above). Gulliver® 40 g with 1.6–2.7 MCPA 250 C @ 4–5 LS to 3 tiller Basagran® M60 2 to 2.5 L @ 1 to 2 TR or MCPA 2.7 L @ 3 TR						

Herbicide Tank Mixtures – Paraquat, Clomazone & Pendimethalin

Advantages

Research has shown that a tank mix of all three herbicides is a robust weed control program particularly suited to direct drilled rice and drill sowing where delayed permanent water is intended. The mix provides both knockdown and residual grass weed control

Disadvantages

The pendimethalin (e.g. Stomp® 440) is phytotoxic to any shallow rice seed not covered by soil. It also means any re-sowing can only be by drill below the herbicide treated soil.

Use

For barnyard grass, silvertop grass and sedge control. Drill rice, flush and apply tank mix of 0.8 L/ha Gramoxone®, 0.4 L/ha Magister® and 2.5 L/ha Stomp® 440.

Early post emergence

For subsequent germinations of barnyard and/or silvertop grass after Magister® or Stomp® treatment, there are three options with propanil and Barnstorm® for smaller barnyard and silvertop grass and Aura® for bigger grasses. None of these three herbicides offer residual control of subsequent grass weed germinations.

Propanil 480 g/L (e.g. Stam®)

This is a contact grass herbicide. Effectiveness for weed control is dependent on temperature. Best control is achieved at temperatures > 25°C. It is a Group C chemical for herbicide resistance which is a different mode-of-action to Barnstorm® or Aura®, both of which are Group A herbicides. Propanil is also effective against some sedge and broadleaf weeds.

Do not apply propanil within 7 days of an organophosphate insecticide (e.g. chlorpyrifos) otherwise severe crop damage may occur.

Use

For 2–5 leaf barnyard grass, apply 7.5–12.5 L/ha Stam® when rice is evenly germinated.

Cyhalofop 285 g/L (e.g. Barnstorm®)

This is a systemic grass herbicide. It needs good soil moisture to ensure grasses are actively growing for best results. If soil moisture is poor, weed control results will be poor. For best results apply Barnstorm® straight after a flush or good rain, when the soil is wet. Do not tankmix with broadleaf herbicides due to antagonism. Addition of Uptake® Spraying Oil is essential.

Use

For 3–5 leaf up to 1–2 tiller barnyard and silvertop grass when rice is from 1–2 leaf to late tillering stage.

Profoxydim 200 g/L (e.g. Aura®)

This is a systemic grass herbicide. It needs good soil moisture to ensure grasses are actively growing for best results. If soil moisture is poor, weed control will be poor. For best results apply Aura® straight after a flush or good rain, when the soil is wet. Addition of Supercharge® spray oil is essential.

Use

For 2–6 tiller barnyard and silvertop grass when rice has a minimum of 3 leaves.

To date we have little experience in tank mixing Group A post-emergence grass herbicides (Barnstorm® and Aura®) with residual herbicides. Stam® is labelled for mixtures with both Stomp® and Magister® where crop and weed emergence has occurred.

Rotate herbicides

Use a different herbicide with a different mode of action in the subsequent rice crop.

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.

In the control of aquatic weeds, this means rotating from a Londax® program to a Taipan® program from one crop to the next in the same field. Where dirty dora is the dominant weed, consider rotating Saturn® for control as an alternate mode-of-action option.

The following Table 5 shows the mode of action for rice chemicals and the rating for herbicide resistance risk.

Herbicide resistance

Barnstorm® and Aura® are both group A mode-of-action herbicides and are listed as High Risk by

Table 5. MODE OF ACTION GROUPS FOR RICE CHEMICALS (AS AT 14 SEPTEMBER 2010)

	Chemical Family	Active Constituent (first Trade name)
HIGH RISK	GROUP A	Cyhalofop (Barnstorm®) Profoxydim (Aura®)
	Group B	Azimsulfuron (Gulliver®) Bensulfuron (Londax®)
MODERATE RISK	Group C	Propanil (Stam®) Bentazone (Basagran®)
	Group D	Pendimethalin (Stomp®)
	Group H	Benzofenap (Taipan®, Viper®)
	Group I	MCPA, Basagran® M60 Dicamba (Banvel®)
	Group J	Molinate (Ordram®) Thiobencarb (Saturn®)
	Group L	Diquat (Sprayseed®) Paraquat (Gramoxone®)
	Group M	Glyphosate (Roundup®)
Group Q	Clomazone (Magister®, Viper®)	

Source: Crop Life Australia Limited

Crop Life Australia for development of herbicide resistance. Therefore it is essential that grass weed control does not rely on these herbicides. They should only be used together with an Integrated Weed Management strategy, which uses herbicides with other modes-of-action together with other non-herbicidal management techniques.

In all instances, refer to the product labels prior to applying any of the above mentioned products and consult your agronomist if in any doubt regarding their suitability for your individual crop circumstances.

Insect, snail and earthworm control

Registration information listed here is based on NSW product registrations listed in the July 2011 edition of the Infopest™ Pest Management Information System. This information should be used as a guide only – **always read product labels to ensure that the proposed use conforms with a registered use pattern.**

No responsibility can be accepted by either the Department of Primary Industries or the Queensland Department of Employment, Economic Development and Innovation (the developers of Infopest®) for the accuracy or completeness of the registration details listed. 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.

Bloodworms – *Chironomus tepperi* and other species

All aerially sown rice crops should be treated for bloodworm at or 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 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.

Table 6. CHEMICAL CONTROL FOR BLOODWORM (Shaded cells indicate recommended treatments.)

Pesticide	Rate	Method of application		Notes
		to seed at sowing	by air to flooded bays	
fipronil 500 g/L Cosmos®	20 mL/100 kg of seed or 25 mL/ha	Yes	No	This treatment will provide 9 to 14 days residual control of target species.
alpha cypermethrin 100 g/L Alpha cypermethrin, Astound Duo®, Alpha-Cyp Duo®, Alpha Duo®, Dominex Duo®, Fastac Duo®, Alpha-Scud Elite®	100 mL/ha	No	Yes	This treatment will provide 7 to 12 days residual control of target species.
maldison 440 g/L Fyfanon®440 EW	680 mL/ha	No	Yes	This treatment will provide 5 to 7 days control.
maldison 500 g/L Maldison 500	600 mL/ha	No	Yes	This treatment will provide 5 to 7 days control.
maldison 1000 g/L Fyfanon®	300 mL/ha	Yes	Yes	This treatment will provide 5 to 7 days control.
maldison 1150 g/L Hy-mal®	260 mL/ha	Yes	Yes	This treatment will provide 5 to 7 days control.
chlorpyrifos 500 g/L Chemicide®, Chlorpos®, Chlorpyrifos, Chop®, Cyren® Fortune®, Generifos®, Kensban®, Lorsban®, Pidgeon's Pest Controller®, Strike-out®	60–150 mL/ha	No	Yes	Use maximum rate where water is more than 15 cm deep or amount of decaying plant material is high. 80–100 mL/ha is recommended under normal conditions. Will provide 7 to 12 days residual control of target species.
trichlorfon 500 g/L 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 Diazinon, Diazol®	75–150 mL/ha	No	Yes	The maximum rate will be required for satisfactory control in most situations.

Source: The advice in 'Notes' is based on DPI NSW research.

Seed treatment with fipronil (Cosmos®) provides far better residual control than other registered seed treatments (maldison, trichlorfon), protecting plants for 9 to 14 days. If fipronil seed treatment is not available, the only alternative treatment regime recommended by the Department of Primary Industries is to apply chlorpyrifos or alpha cypermethrin by air (**not on seed**) the day **before** sowing. This will provide 7 to 12 days protection under normal conditions. Chlorpyrifos, alpha cypermethrin and diazinon cannot be used as seed treatments because of their high toxicity to birds and other wildlife.

After initial treatment aerially sown crops should be inspected regularly to determine whether a subsequent application of either chlorpyrifos or alpha cypermethrin is necessary. Any crops sown with maldison seed treatments are likely to require a follow-up application of chlorpyrifos or alpha cypermethrin 5 to 7 days after sowing. Combine or sod-sown rice should be inspected regularly after permanent water is applied and treated with chlorpyrifos or alpha cypermethrin if bloodworms are present in large numbers **and** plant root damage is evident. There are many different bloodworm species present in rice fields, and not all of them feed on rice. Identifying which species are 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.

Other Insect Pests

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. 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 7. DAMAGE THRESHOLDS FOR TREATING LEAFMINER INFESTATIONS. Chemical treatment should only be used when the percentage of infested plants meets the guidelines listed.

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

Armyworms – *Leucania convecta*

Armyworms are the caterpillars of a noctuid moth, and occasionally require chemical control in the months leading up to harvest. Care must be taken to ensure that the correct withholding periods are observed prior to harvest in order to ensure no chemical residues are present on the crop. At present, the registered withholding periods for maldison, trichlorfon and chlorpyrifos are 1, 2 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	8 days minimum between treatment and harvest
trichlorfon	12 days minimum between treatment and harvest
chlorpyrifos	25 days minimum between treatment and harvest

These extended withholding periods should also be observed if growers need to use maldison or chlorpyrifos for plague locust control close to harvest (trichlorfon is not registered for locust control).

Growers considering treating for armyworm within 20 days of harvest should consult their agronomist to ensure that the level of infestation justifies the cost of treatment. Armyworm damage thresholds provided in earlier versions of this guide are now considered to have been overly conservative, and difficult to apply in practice. The following simplified thresholds are based on data from overseas species, as damage thresholds for *L.convecta* on Australian rice varieties have not yet been developed. They should be considered as a guide only.

Table 8. DAMAGE THRESHOLDS FOR TREATING ARMYWORM INFESTATIONS. Chemical treatment should only be used when armyworm populations meet guideline levels.

Crop stage	Treat if pest density exceeds:
Panicles not exposed	8 armyworm/m ²
Panicles exposed – more than 2 weeks to harvest	12 armyworm/m ²
Panicles exposed – less than 2 weeks to harvest	16 armyworm/m ²

The synthetic pyrethroid alpha cypermethrin (Trade Names: Alf®, Alpha®, Alpha-Cyp Duo®, Alpha-Cyper®, Alpha-cypermethrin, Alpha Duo®, Alpha Duop®, Alpha Forte®, Alpha-Scud Elite®, Alphasip Duo®, Astound Duo®, Buzzard®, Centaur®, Dictate®, Dictate Duo®, Dominex Duo®, Fastac Duo®, Ken-Tac®, Unialphacyper®, Unitox®) is currently registered for use against armyworm in rice. These products are registered against armyworm in drained crops only, and have 7 day withholding periods. The Department of Primary Industries

and SunRice recommend that growers **do not use alpha cypermethrin products for armyworm control in rice**. This is due to concerns about residue contamination in crops destined for sensitive overseas markets.

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 may 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. Mature locusts form large, highly mobile swarms that can cause widespread crop damage and may require chemical control.

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 to 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 crop rotations are in use – a single season's 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

Table 9. CHEMICAL CONTROL FOR LEAFMINER, LOCUST AND ARMYWORM
(Shaded cells indicate recommended treatments.)

Pest	Crop stage	Pesticide	Rate / ha	Notes
Leafminer <i>Hydrellia michelae</i>	seedlings above permanent water	trichlorfon 500 g/L Dipterex®, Lepidex®	850 mL	
Australian Plague Locust <i>Chortoicetes terminifera</i>	seedlings to harvest	chlorpyrifos 500 g/L Chemicide®, Chlorpos®, Chlorpyrifos, Chop®, Cyren®, Fortune®, Generifos®, Kensban®, Lorsban®, Pidgeon's Pest Controller®, Strike-out®	350 mL	Growers should consult the APVMA or DPI websites as other actives may be available under APVMA permit.
		maldison 440 g/L Fyfanon®	1400 or 1900 mL	
		maldison 500 g/L Maldison®	1200 or 1700 mL	
		maldison 1000 g/L Fyfanon®	600 or 850 mL	
		maldison 1150 g/L Hy-mal®	520 or 750 mL	
Armyworm <i>Leucania convecta</i>	generally flowering to harvest	trichlorfon 500 g/L Dipterex®, Lepidex®	1200 mL	
		maldison 440 g/L Fyfanon® 440 EW	1800 mL	
		maldison 500 g/L Maldison	1600 mL	
		maldison 1169 g/L Fyfanon® ULV	700 mL	
		chlorpyrifos 500 g/L Chemicide®, Chlorpos®, Chlorpyrifos, Chop®, Cyren®, Fortune®, Generifos®, Kensban®, Lorsban®, Pidgeon's Pest Controller®, Strike-out®	700–900 mL	Use higher rate if caterpillars are more than 15 mm in length.

infestations it is important that supply channels be kept as dry as possible between crops.

The previous APVMA permit that allowed the application of copper sulphate (bluestone) for snail control has expired and at the time of writing there were no products available for the chemical control of rice snails. The APVMA now requires copper sulphate to be formally registered, and a registration application is currently being developed. It is not currently known whether copper sulphate will be available for use against snails in the 2011/12 rice season, and if so, whether it will be fully registered or under permit. Resellers and aerial operators will be advised of the outcome as soon as it is known.

Aquatic earthworms – *Eukerria saltensis*

Aquatic earthworms are much longer than bloodworms (up to 70 mm, as opposed to 18 mm maximum for bloodworms) and, unlike bloodworms, lack a distinct head capsule. They may be a severe problem in aerially-sown crops, particularly on heavy clay soils. At present there are no chemicals available for their control. There are several management options available that may 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.

Further information on sampling fields to determine leafminer and armyworm densities is available in Chapter 10 of *Production of Quality Rice in South Eastern Australia*.

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