RICE MANAGEMENT GUIDE

Bayer CropScience

INDEX

TAIPAN®

VIPER®

Saturn EC

DIPTEREX®

NEW IDEAS FOR RICE

Bayer CropScience brings to the Australian rice industry a strong range of complementary rice products. These include Taipan,® Saturn,® Viper,® and Dipterex.® Bayer CropScience is committed to researching and developing further innovative ideas for the Australian rice market in order to maximise yield potential and crop returns for rice growers.

The Bayer CropScience Rice Management Guide is designed to help achieve maximum product efficacy by providing additional information not included on the product labels.

TAIPAN®

Introduction

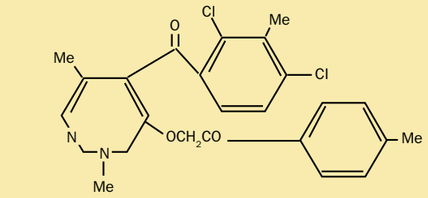
Taipan is a herbicide that introduced a new mode of action to the Australian rice market. Taipan also offers a unique option for early weed control in rice crops, with a comprehensive weed spectrum. These three features make Taipan a true alternative to other herbicides registered in the Australian rice market.

PRODUCT FORMULATION

Active ingredient

Trade name: Taipan Herbicide
Active constituent: 300 g/L benzofenap

Structural formula



Formulation type

Formulation: Suspension concentrate (SC)

Physical properties

Appearance:	Off-white viscous liquid
Odour:	Negligible
Flammability:	Non-flammable
Vapour pressure:	1.33 x 10^{-5} Pa (technical)
Specific gravity:	1.08 at 20°C
Combustibility:	Not applicable
Corrosiveness:	Non-corrosive
Miscibility:	Miscible with most water types.
Solubility in water:	Suspends
Stability:	Stable for a minimum of two years if stored in the unopened original container, in a suitable storage area out of direct sunlight and extreme temperatures.
Poison schedule:	S5
Hazchem code:	Not applicable
DG status:	Not considered a dangerous good for transport by road and rail.

TOXICOLOGICAL PROPERTIES

Active ingredient

Oral LD_{50} (rat):	>15,000 mg/kg
Dermal LD_{50} (rat):	>5,000 mg/kg
Inhalation LC_{50} (rat):	>1.93 mg/L air
Skin irritation:	Slight
Eye irritation (rabbit):	Slight
Skin sensitisation (Guinea pig):	Weak

BIOLOGICAL PROPERTIES

Mode of action

Activity

Benzofenap, the active ingredient of Taipan, has a non-hormonal herbicidal activity. Benzofenap inhibits carotenoid biosynthesis and photosynthesis at photosystem II. This is the process that produces the green pigmentation in plants, which enables absorption of sunlight for energy to drive photosynthesis. This mode of action places benzofenap in Group F (inhibitors of carotenoid biosynthesis). The only other herbicides in Group F are diflufenican, amitrole, norflurazon and clomazone.

Uptake and translocation

Benzofenap binds to the soil of a flooded rice bay and is absorbed primarily through roots of target weeds, but also through leaves and stems. Once inside the plant, benzofenap undergoes rapid degradation to metabolites which cause the herbicidal action.

Symptoms

The first visible symptoms appear 5–7 days after application, when target weeds become bleached or yellowed.

Resistant weeds warning

GROUP **F** HERBICIDE

Taipan is a member of the pyrazole group of herbicides and acts by inhibiting carotenoid biosynthesis. For weed resistance management, Taipan is a Group F herbicide.

Resistance management

Resistance to Group B herbicides has been detected in populations of dirty dora, starfruit and arrowhead. Group B herbicides are ALS (acetolactate synthase) inhibitors. Sulfonylureas like bensulfuron belong to this herbicide group.

Taipan belongs to the Group F herbicides (inhibitors of carotenoid biosynthesis). Group F herbicides have not been used previously in Australian rice crops for the control of aquatic broadleaf weeds, so Taipan offers rice growers a valuable alternative to Group B herbicides for the control of dirty dora, arrowhead and starfruit. Taipan also provides growers with the opportunity to be proactive in the establishment and implementation of suitable and successful resistance management strategies.

However it is important to use Taipan prudently. Growers are urged not to use Taipan in the same bay in consecutive rice crops. This will help to ensure the longevity of the product by reducing the likelihood of weeds developing resistance to Taipan.

Further to this, the application of a herbicide that provides a second mode of action is strongly recommended as part of a sound resistance management program. For this reason growers are urged to consider an MCPA application following the application of Taipan. This MCPA follow-up application is recommended whether or not, at the time of spraying, weed escapes have reached an economic threshold.

Herbicide rotations and/or the application of a herbicide that provides a second mode of action are only part of a comprehensive resistance management strategy. Growers are urged to consult “Ricecheck” recommendations for a full list of options available as part of an effective strategy.

BEHAVIOUR IN THE ENVIRONMENT

Extensive toxicological studies have shown that benzofenap, the active ingredient of Taipan, is of low risk to humans and the environment.

In crops

The behaviour of benzofenap in plants (uptake, transportation, metabolism and degradation) was studied with radioactively labelled active ingredient in the laboratory, and to some extent also in the field on various weeds and crop plants. Benzofenap decomposes rapidly in plants and is detoxified by the formation of a water-soluble compound. In *Poaceae* species such as rice, carotenoid biosynthesis is not significantly inhibited even by high concentrations of the active ingredient. This accounts for the selectivity of benzofenap in rice.

In water

Degradation studies have shown that benzofenap is quickly transferred from water to soil, where it is bound tightly. The main degradation pathway in water is via photolysis, with a half-life of 7 days. The low volatility is likely to prevent evaporation into the atmosphere. In summary, there is low risk of accumulation of benzofenap in water residues.

In animals

Benzofenap has been shown to have little effect on aquatic organisms (fish, freshwater midge, freshwater snail). Terrestrial organisms such as birds and mammals (mallard duck, quail, rats, dogs) are also at low risk. In addition, studies have shown that benzofenap does not transfer to meat or milk, even at feeding levels much higher than would be found in grain or straw.

In soil

Benzofenap is bound tightly to soil, and is more rapidly degraded under flooded (anaerobic) conditions than in dry conditions. Hydrolysis is followed by final degradation to CO_2.

EFFECTS ON FLORA AND FAUNA

Micro-organisms and earthworms

Benzofenap is non-toxic to earthworms and does not interfere with soil microbiological processes at recommended product use rates.

Fish

Benzofenap is moderately toxic to fish.

Birds

Toxicological studies (acute and dietary) have indicated that benzofenap has low toxicity to birds.

RESIDUE PROFILE

Breakdown in plants follows the same pathway as in soils and animals. No detectable residues are found in either rice grain or straw. In addition, trials studying the effect of benzofenap applied to water-seeded rice on the subsequent establishment and growth of wheat, barley, canola and subterranean clover showed no carryover phytotoxic effects.

Withholding period

Harvest – No withholding period is required when used as directed.
Grazing – Do not graze within seven weeks after application.

DIRECTIONS FOR USE

Crop	Weeds	Rate (ha)	Note
Rice (Qld, NSW and Vic)	Controlled: Arrowhead Seedlings of: Alisma, starfruit, water plantain	2.0 L	Heavy spring rainfall may promote weed germination. These weeds should be controlled prior to Taipan application.
	Suppressed: Dirty dora		

Note: Always refer to the full label before applying Taipan.

APPLICATION

Aerial application

Taipan may be applied by air (min. 30 L water/ha) using the coarsest droplet size.

Alternatively apply through solid-stream nozzles, i.e. a Bickley boom with the following set-up:

- Two nozzles mounted on droppers, one either side with droppers positioned just outside the first boom hanger (28–35% of wingspan).
- Dropper length approximately 40–60 cm or lower below the trailing edge of the wing.
- Solid-stream nozzles with the bore sufficient to apply desired volume at a pressure of 240 to 310 kPa (35 to 45 psi).
- Nozzles orientated rearwards and parallel to the airstream.
- Check valves (Spraying Systems Diaphragm 12328, ¾ inch) located behind nozzle to eliminate "trailing" after shut-off.

For Bickley boom application, spray at a maximum wheel height of 2 m above the water surface and at a maximum swath width of 25 m. Ensure a minimum water depth of 10 cm on the high side of bays prior to treatment. A minimum application volume of 20 L/ha is recommended for Bickley boom application (except in mixture with molinate, when a minimum 30 L water/ha is recommended).

Before applying Taipan to contoured bays, evaluate the layout of the bays to be treated and select the optimum flight pattern to ensure all bays receive the recommended rate of Taipan.

SCWIIRT application

Taipan can be dripped directly into the bay by a SCWIIRT (Soluble Concentrate Water Injection In Rice Technique) system on a tractor, 4-wheel motor bike or helicopter, using a minimum water volume of 5 L/ha.

Taipan is formulated as a suspension concentrate. Suspension concentrates are not suitable for herbigation.

Timing

For optimum efficacy on target weeds, Taipan has to be applied early, i.e. within 10 days of commencement of flooding. A later application, beyond ten days after the commencement of flooding, will result in reduced efficacy. The early application timing of Taipan makes it possible to control weeds when they are very young and before they start competing with young rice seedlings. Growers who are unable to fill bays within 10 days of commencement of flooding should refrain from using Taipan because product performance may be compromised.

An early application of Taipan is possible because of Taipan's excellent selectivity to germinating or very young rice plants. There is no need to wait for rice crops to reach a certain growth stage in order to minimise crop effects.

Mixing

To ensure even mixing, half-fill the spray tank with clean water and add the required amount of product. Taipan should always be pre-mixed before adding additional products. Agitate thoroughly, then add the remainder of the water. Agitate again before spraying commences. Reseal part-used product container immediately after use.

COMPATIBILITY

When applied by aircraft including by Bickley boom, Taipan is compatible with molinate for the control of grassweeds – especially barnyard grass provided a minimum 30 L water/ha is used. In mixtures with Taipan, molinate should be used at label rates and according to label recommendations. Taipan and molinate should be applied from separate spray tanks in SCWIIRT applications because of their incompatibility at low spray volumes.

Taipan may also be tank-mixed with clomazone 480 EC to control barnyard grass, but only when applied by SCWIIRT from motorbike or helicopter (minimum water volume of 5 L/ha) or Bickley boom.

Tank-mixes of Taipan and Saturn (as a split Saturn treatment) at sowing have been found to cause unacceptable crop effects, and therefore cannot be recommended. However, a sequential application of Taipan at sowing followed by Saturn (at the secondary root stage) has been shown to provide an excellent weed control option for rice growers. This program is currently covered under the label guidelines, and has been broadly adopted.

Chlorpyrifos can be tank-mixed with Taipan for aerial or SCWIIRT applications to control bloodworm.

Water stability

Benzofenap can be unstable in strongly alkaline conditions (i.e. pH ≥9). The rate of breakdown in water is dependent upon pH, light, microbial content, oxygen and suspended particles.

Wetting agents

Taipan does not require the addition of a wetting agent.

WATER MANAGEMENT

After good application timing, appropriate water management is one of the most important requirements for obtaining optimum results from the application of Taipan. Strict adherence to seven key water management guidelines is essential when using Taipan:

1. Growers must be able to fill bays rapidly.

This enables application of Taipan at the correct timing (i.e. within 10 days of the start of flooding).

2. All water movement must cease for at least 12 hours prior to the application of Taipan.

Water depth at application should be sufficient to maintain coverage of the soil until additional water can be added after the 5-day lock-up.

3. Bays must be locked up for at least 5 days after the application of Taipan.

This allows Taipan to disperse properly and attach to the soil in readiness for uptake. Following the lock-up period, bays may be topped up for normal water management. Water levels can also be lowered at the critical 1–3 leaf stage of rice crops to ensure optimum establishment.

4. Water inlets must be sealed tightly, particularly in top bays.

Water movement may compromise the performance of Taipan.

5. Bays must have water coverage at all times.

If soil is exposed at any time, a reduction in the efficacy of Taipan can be expected.

6. Taipan should not be applied to cold or muddy water.

Cold and/or muddy water may also reduce efficacy.

7. Topping up bays.

After initial lock-up, the topping up of bays should be done at a rate to minimise soil disturbance and disruption of the herbicide chemical layer.

Water movement

A trial conducted at Leeton during the 1998 rice season clearly showed the importance of avoiding water movement for the recommended period of five days following a Taipan application. The table below shows that weed seedling counts were significantly higher where there was water movement within 24 hours of Taipan application than where water was held for five days.

Mean seedling numbers/m² in treatments with 5 and 1-day lock-up.

Weed (assessment time)	Bay 1 (5-day lock-up)	Bay 2 (1-day lock-up)
Dirty dora (34 DAT)	2.60	23.77
Starfruit (34 DAT)	3.27	102.92

EFFICACY

A series of 28 small plot and 36 commercial scale trials initiated on behalf of Bayer CropScience and the Rice Research and Development Committee determined application rates and timing for the adequate control of target weeds, including arrowhead, seedling alisma, seedling water plantain, seedling starfruit and dirty dora. Taipan does not provide control of barnyard grass (*Echinochloa* spp.), silver top grass (*Leptochloa fascicularis*), spikerush (*Eleocharis sphacelata*) or cumbungi (*Typha* spp.).

Efficacy: Dirty dora

Dirty dora (*Cyperus difformis*) is an annual sedge, closely related to other *Cyperus* spp., nut grass and umbrella sedge. Dirty dora is widely distributed throughout all rice-growing regions, with widespread ALS-resistant populations now documented.

The efficacy of Taipan at 2 L/ha on dirty dora is generally less consistent than on the other aquatic weeds. Control generally varies between 70 and 100%. An increase in the application rate of Taipan beyond 2 L/ha does not significantly contribute to an increase in activity. Because of this variable control, Taipan is registered for suppression only of dirty dora. Rice crops with good, even germination that are growing vigorously will help to out-compete surviving dirty dora plants. Rice crops should be monitored for dirty dora infestation 35 days after Taipan treatment. However, Taipan still provides an alternative mode of action on ALS-resistant dirty dora, which makes it a valuable resistance management tool.

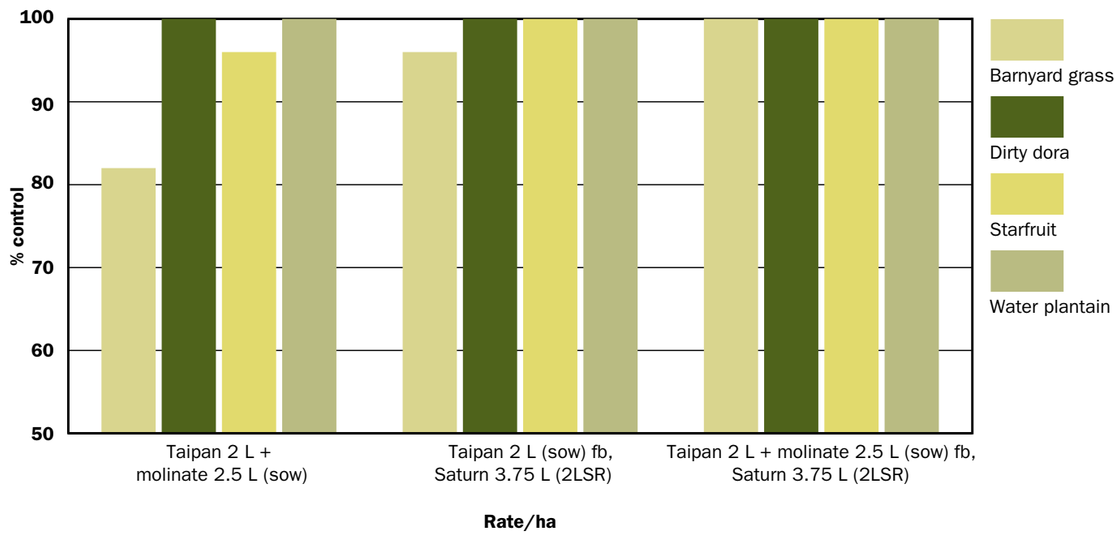
A program with molinate (3.75 L applied in a tank-mix at sowing) or Saturn (3.75 L applied at the secondary root stage) will provide a more robust effect on dirty dora and barnyard grass. This is demonstrated in Graph 2 on the next page, where a sowing application of Taipan (2.0 L) followed by post-emergent application of Saturn (3.75 L) or Taipan (2.0 L) + molinate (3.75 L) provided slightly better control of dirty dora than that achieved by Taipan alone (2.0 L).

Efficacy: Barnyard grass

Taipan does have some activity on barnyard grass (*Echinochloa* spp.), however results are variable and unreliable, and often not commercially acceptable. For this reason, Taipan is not recommended for the control of barnyard grass.

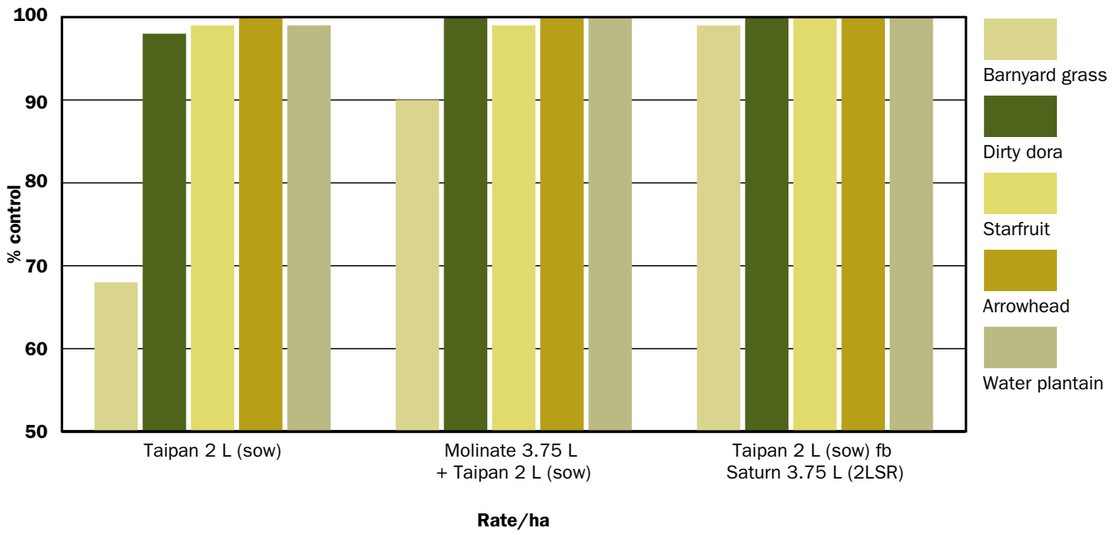
Trials conducted in 1999 have confirmed however that a combined program of Taipan (2 L) + molinate (2.5 L) at sowing followed by Saturn (3.75 L) applied at the secondary root stage provides robust control of a range of weeds, including barnyard grass (see Graph 1). This program is particularly useful where grassweeds have germinated at sowing (during fill-up).

GRAPH 1: % control of various rice weeds with Taipan, with the addition of molinate or Saturn.



This data is sourced from one replicated trial (H39-99). LSR=Leaf stage rice.

GRAPH 2: % control of various rice weeds with Taipan, molinate and Saturn combinations.



This data is sourced from one replicated trial (H04-98). LSR=Leaf stage rice. Fb=Followed by

Efficacy: Arrowhead

Arrowhead (*Sagittaria montevidensis*) is found with high incidence in the Coleambally irrigation area (CIA) and Murrumbidgee irrigation area (MIA), where ALS (e.g. bensulfuron) resistant populations have been recorded. Arrowhead is a competitive plant that colonises aquatic environments quickly once introduced. Taipan (2.0 L/ha) has a high level of activity on arrowhead, providing season-long control and an alternative mode of action to that of ALS inhibitors.

Efficacy: Starfruit

Starfruit (*Damasonium minus*) is one of the most important broadleaf aquatic weeds in rice, with ALS-resistant populations now recorded in most areas. Starfruit generally germinates in response to continuous flooding. Taipan (2.0 L/ha) has been shown to effectively control seedling starfruit for up to 28 days after application. More mature plants will not be controlled effectively. Water management is critical to achieving effective control of starfruit.

Efficacy: Alisma

Alisma (*Alisma lanceolatum*) is found in most rice-growing areas, although it tends to be concentrated in the CIA and parts of the Eastern Murray valley (EMV) and MIA. Taipan (2.0 L/ha) provides excellent control of seedling alisma, but will not effectively control more mature plants that germinate from existing corms. Previously, MCPA was the only herbicide available for suppression of alisma.

Efficacy: Water plantain

Water plantain (*Alisma plantago aquatica*) populations tend to be more of a problem in the Murray valley (MV), where MCPA was again the only herbicide option prior to Taipan (although providing only suppression). Taipan (2.0 L) provides excellent control of seedling water plantain.

CROP SAFETY

Taipan has been shown to be safe for most commercially available varieties of rice, including long grain, medium grain and fragrant varieties. The varieties included in the trial work included Amaroo, Langi, Namaga, Millin, Kyeema, Jarrah, Doongara, Illabong, Koshihikari and Opus.

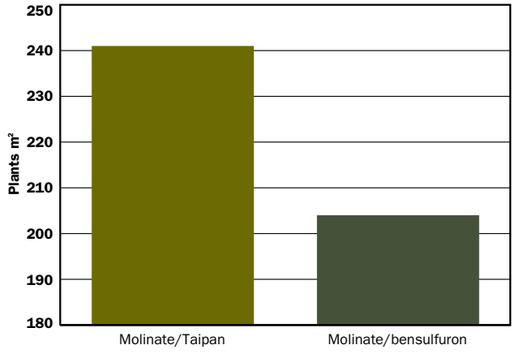
Crop establishment

Extensive trials have demonstrated that Taipan applications enhance rice crop establishment. Graph 3 summarises the average plant population from 8 trials, which demonstrated that rice plant numbers in bays treated with Taipan + molinate were 18% higher than plant numbers in bays treated with the industry standard (molinate + bensulfuron).

Yield

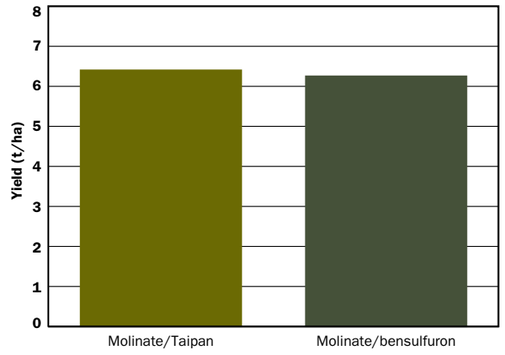
Taipan has exhibited yield advantages over standard treatments in both small bay replicated and commercial trials (as shown in graphs 4 and 5). Yield responses are generally related to early effective weed control, better crop tolerance and control of ALS-resistant weed populations.

GRAPH 3: Rice plant establishment with Taipan vs bensulfuron (no./m²)



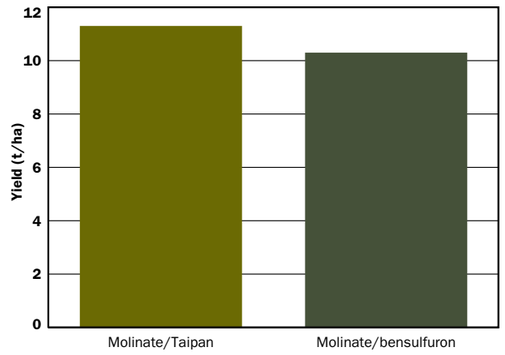
Average 8 trials 1998/99 season, counts 14–38 DAT.

GRAPH 4: Average grain yield of molinate/Taipan small plot replicated trials.



Average 10 small plot replicated trials.

GRAPH 5: Average grain yield of molinate/Taipan commercial trials.



Average 9 commercial trials.

GETTING THE BEST OUT OF TAIPAN

Do:

- ✔ Fill bays rapidly (within 10 days of the start of flooding).
- ✔ Stop all water movement for at least 12 hours before Taipan application.
- ✔ Apply Taipan within 10 days of the start of flooding.
- ✔ Apply Taipan by air (minimum 30 L/ha water) or by SCWIIRT rig on a tractor, 4-wheel motorbike or helicopter (minimum 5 L/ha water), or by Bickley boom (minimum 20 L/ha).
- ✔ If required, mix Taipan with recommended label rates of molinate (aerial application) or with recommended label rates of clomazone 480 EC (SCWIIRT application or Bickley boom) for barnyard grass control.
- ✔ Mix Taipan with chlorpyrifos for bloodworm control if seed treatment with Cosmos® has not been carried out.
- ✔ Lock up bays for a minimum of 5 days after Taipan application.
- ✔ Seal water inlets tightly to prevent water movement, especially in top bays.
- ✔ Top-up bays for regular water management after the lock-up period (minimum 5 days).
- ✔ Maintain water coverage of the soil surface at all times.
- ✔ Apply an MCPA follow-up spray whether weed escapes are present at the time of spraying or not.

Don't:

- ✘ Use Taipan if bays cannot be filled within 10 days of the start of flooding.
- ✘ Use Taipan at rates lower than 2 L/ha.
- ✘ Use Taipan for the control of barnyard grass, silvertop, spikerush or cumbungi.
- ✘ Herbigate or drip Taipan.
- ✘ Mix Taipan with molinate in SCWIIRT applications.
- ✘ Mix Taipan with Saturn.
- ✘ Apply Taipan to cold or muddy water.
- ✘ Plant crops other than wheat, barley, canola, sub-clover and rice after Taipan application.
- ✘ Use Taipan in the same bay in consecutive rice crops.

VIPER®

Introduction

Viper is a recent innovation in rice herbicides, combining the strengths of benzofenap and clomazone in one easy-to-use product.

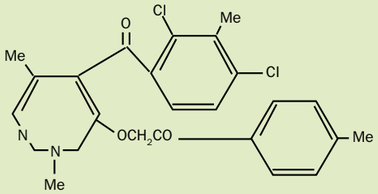
PRODUCT FORMULATION

Active ingredient

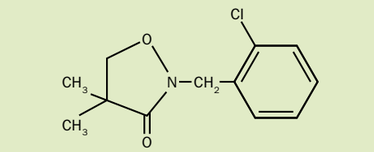
Trade name:	Viper Herbicide
Active constituent 1:	120 g/L benzofenap
Active constituent 2:	48 g/L clomazone

Structural formula

Benzofenap



Clomazone



Formulation type

Formulation:	Emulsifiable concentrate (EC)

Physical properties

Appearance:	Clear amber liquid
Odour:	Distinctive ketone odour
Flammability:	Non-flammable
Vapour pressure:	0.4 hPa at 20°C
Density:	1.06 g/mL at 20°C
Combustibility:	Combustible liquid Class C1
Corrosiveness:	Not corrosive to stainless steel and coated steels. Corrosive to ordinary steel.
Miscibility:	Miscible with most water types
Solubility:	Forms an emulsion
Stability:	Stable for a minimum of two years if stored in the unopened original container, in a suitable storage area out of direct sunlight and extreme temperatures.
Poison schedule:	S6
Hazchem code:	Not applicable
DG status:	Not considered a dangerous good for transport by road and rail.

TOXICOLOGICAL PROPERTIES

Tests have been performed with BENZOFENAP TECHNICAL on a number of different animal species using various routes of administration. Results obtained include the following:

Active ingredient (benzofenap)

Oral LD_{50} (rat):	>15,000 mg/kg
Dermal LD_{50} (rat):	>5,000 mg/kg
Inhalation LC_{50} (rat):	>1.93 mg/L air
Skin irritation:	Slight
Eye irritation (rabbit):	Slight
Skin sensitisation (Guinea pig):	Weak

Tests have been performed with CLOMAZONE TECHNICAL on a number of different animal species using various routes of administration. Results obtained include the following:

Active ingredient (clomazone)

Oral LD_{50} (rat):	1369 mg/kg
Dermal LD_{50} (rabbit):	>2000 mg/kg
Inhalation LC_{50} (rat):	4.85 mg/L air
Skin irritation (rabbit):	Minimally irritated
Eye irritation (rabbit):	Practically non-irritating

BIOLOGICAL PROPERTIES

Mode of action

Viper is a combination of benzofenap and clomazone, each of which has its own distinctive mode of action.

Benzofenap and clomazone – activity

Benzofenap and clomazone, the active ingredients in Viper, have non-hormonal herbicidal activity. Benzofenap and clomazone inhibit carotenoid biosynthesis and photosynthesis at photosystem II. This is the process that produces the green pigmentation in plants, which enables absorption of sunlight for energy to drive photosynthesis. This mode of action places benzofenap and clomazone in Group F (inhibitors of carotenoid biosynthesis).

Benzofenap – uptake and translocation

Benzofenap binds to the soil of a flooded rice bay and is absorbed primarily through roots of target weeds, but also through leaves and stems. Once inside the plant, benzofenap undergoes rapid degradation to metabolites which causes the herbicidal action.

Clomazone – uptake and translocation

Clomazone is absorbed by plants through the roots from the soil and by shoots. It is then translocated in the xylem and diffuses within leaves. It does not move downward in plants or from leaf to leaf.

Symptoms

The first visible symptoms appear within 5–7 days when the target weeds become bleached or yellow.

Resistant Weeds Warning

GROUP **F** HERBICIDE

Viper is a member of the Pyrazole and Isoxazolidinone groups of herbicides and acts by inhibiting carotenoid biosynthesis. For weed resistance management, Viper is a Group F herbicide.

Resistance management

Resistance to Group B herbicides has been detected in populations of dirty dora, starfruit and arrowhead. Group B herbicides are ALS (Acetolactate synthase) inhibitors. Sulfonylureas like bensulfuron belong to this group.

Viper belongs to the Group F herbicides (inhibitors of carotenoid biosynthesis). Viper offers rice growers a valuable alternative to Group B herbicides for the control of arrowhead and starfruit and the suppression of dirty dora. Viper also provides growers with the opportunity to be proactive in the establishment and implementation of suitable and successful resistance management strategies.

However it is important to use Viper prudently. Growers are urged not to use Viper in the same bay in consecutive rice crops. This will help to ensure the longevity of the product by reducing the likelihood of weeds developing resistance to Viper.

Further to this, the application of a herbicide that provides a second mode of action is strongly recommended as part of a sound resistance management program. For this reason growers are urged to consider an MCPA application following the application of Viper. This MCPA follow-up application is recommended whether or not, at the time of spraying, weed escapes have reached an economic threshold.

Herbicide rotations and/or the application of a herbicide that provides a second mode of action are only part of a comprehensive resistance management strategy. Growers are urged to consult “Ricecheck” recommendations for a full list of options available as part of an effective strategy.

BEHAVIOUR IN THE ENVIRONMENT

Toxicological studies have shown that benzofenap and clomazone, the active ingredients of Viper, are of low risk to humans and the environment.

In crops

Benzofenap: The behaviour of benzofenap in plants (uptake, transportation, metabolism and degradation) was studied with radioactively labelled active ingredient in the laboratory, and to some extent also in the field on various weeds and crop plants. Benzofenap decomposes rapidly in plants and is detoxified by the formation of a water-soluble compound. In *Poaceae* species such as rice, carotenoid biosynthesis is not significantly inhibited even by high concentrations of the active ingredient. This accounts for the selectivity of benzofenap in rice.

In water

Benzofenap: Degradation studies have shown that benzofenap is quickly transferred from water to soil, where it is bound tightly. The main degradation pathway in water is via photolysis, with a half-life of 7 days. The low volatility is likely to prevent evaporation into the atmosphere. In summary, there is low risk of accumulation of benzofenap in water residues.

Clomazone: Highly soluble in water but has a moderate tendency to adsorb to soil particles. Clomazone is also subject to photodegradation in water.

In soil

Benzofenap: Binds tightly to soil, and is more rapidly degraded under flooded (anaerobic) conditions than in dry conditions. Hydrolysis is followed by final degradation to CO_2.

Clomazone: Microbial degradation of clomazone is promoted by high soil moisture, warm temperature, and by increasing pH. Degradation is faster in sandy loam soils when compared to clay loams. The half-life of clomazone ranges from 28 to 84 days depending on the soil type and the organic matter content.

In animals

Benzofenap: Benzofenap has been shown to have little effect on aquatic organisms (fish, freshwater midge, freshwater snail). Terrestrial organisms such as birds and mammals (mallard duck, quail, rats, dogs) are also at low risk. In addition, studies have shown that benzofenap does not transfer to meat or milk, even at feeding levels much higher than would be found in grain or straw.

EFFECTS ON FLORA AND FAUNA

Micro-organisms and earthworms

Viper is relatively non-toxic to earthworms and does not interfere with soil microbiological processes at recommended product use rates.

Fish

Viper is moderately toxic to fish.

Birds

Toxicological studies (acute and dietary) have indicated that Viper has a low toxicity to birds.

Off target whitening

Viper can cause whitening of certain species of trees, shrubs, ornamental, agronomic crops, vines and fruits and vegetables either by spray drift or by volatilisation following product dilution. The effects may last a few weeks and plants usually grow out of it with no long term effect. This phenomenon is unlikely to occur following application into permanent water in rice. However, drift could occur following aerial application through the Bickley boom. The Viper label includes a number of recommendations to minimise the likelihood of this whitening occurring.

RESIDUE PROFILE

Withholding period

No withholding period is required when used as directed.

DO NOT cut or graze for stock food for 3 months after application.

Crop Rotation

Treated areas may be replanted to wheat, barley, sub-clover or canola six months after application of Viper.

There is no minimum recropping interval required for subsequent rice crops. However, if rice is replanted in the same season as a failed rice crop, do not retreat the area with Viper or other herbicides containing benzofenap or clomazone.

DIRECTIONS FOR USE

Crop	Weeds controlled	Rate (ha)	Note
Rice Aerial-sown or Dry broadcast sown (followed by permanent water).	Alisma*, arrowhead, starfruit, water plantain*, barnyard grass (up to 3-leaf).	5.0 L	* Seedlings only – plants vegetatively propagated from previous plant residues will not be controlled.
	Alisma*, arrowhead, starfruit, water plantain*, barnyard grass (up to 4-leaf).	5.0 L + 100 mL Magister® Herbicide	

Crop	Weeds suppressed	Rate (ha)	Note
Rice Aerial-sown or Dry broadcast sown (followed by permanent water).	Dirty dora, silver top grass# (up to 1-leaf).	5.0 L	# Where high silver top grass populations are expected, apply the Viper and Magister mixture as recommended.
	Dirty dora, silver top grass (up to 2-leaf).	5.0 L + 100 mL Magister® Herbicide	

Note: Always refer to the full label before applying Viper.

APPLICATION

Inappropriate application techniques can result in visible damage to sensitive off-target species. Viper must only be applied direct to the water surface of permanently flooded bays by SCWIIRT application via a properly equipped ground sprayer, helicopter or by fixed-wing aircraft through a Bickley boom.

Ground/helicopter application

Product may be applied undiluted, or diluted with sufficient water to achieve an application volume of at least 10 L/ha. SCWIIRT equipment should be set up so that nozzles are positioned no more than 50 cm from the water surface and pressure is maintained at or below 200 kPa (30 PSI or 2 bar). A maximum distance of 30 m is recommended between runs.

Fixed-wing aircraft (Bickley boom) application

For application by fixed-wing aircraft, Viper must only be applied through a Bickley boom with the following set-up:

- Two nozzles mounted on droppers, one either side with droppers positioned just outside the first boom hanger (28–35% of wingspan)
- Dropper length approximately 40-60 cm or lower below the trailing edge of the wing
- Solid-stream nozzles with bore sufficient to apply desired volume at a pressure of 240 to 310 kPa (35 to 45 psi)
- Nozzles orientated rearwards and parallel to the airstream.
- Check valves (Spraying Systems diaphragm type 12328, ¾ inch) located behind nozzle to eliminate “trailing” after shut-off.

Spray at a maximum wheel height of 2 m above the water surface and at a maximum swath width of 25 m. Ensure a minimum water depth of 10 cm on the high side of bays prior to treatment.

A minimum application volume of 20 L/ha is recommended. Dilute the required amount of Viper in clean water to achieve a spray volume of 20 L/ha. Add 41-A® drift retardant at the rate of 60 g per 100 L of spray mixture.

Before applying Viper to contoured bays, evaluate the layout of the bays to be treated and select the optimum flight pattern to ensure all bays receive the recommended rate of Viper.

COMPATIBILITY

Viper is compatible with the insecticide chlorpyrifos and with the herbicide Magister (maximum application rate 100 mL/ha). The products should be mixed undiluted, or diluted with sufficient water to achieve an application volume of 10 L/ha, except for application by Bickley boom, where a total application volume of 20 L/ha is necessary.

WATER MANAGEMENT

Ensure bays are locked-up for at least 5 days after application. Water depth at application should be sufficient to maintain water coverage during the lock-up period. A minimum water depth of 10 cm is recommended when applying Viper by Bickley boom.

After the lock-up period bays may be topped up as necessary for normal water management. Poor water management leading to exposed mud may result in reduced weed control.

DO NOT drain rice water into regional drains within 28 days after Viper application or as defined by the local irrigation authority, whichever is the greater time period.

After good application timing, appropriate water management is one of the most important requirements for obtaining optimum results from the application of Viper. Strict adherence to seven key water management guidelines is essential when using Viper:

1. Growers must be able to fill bays rapidly.

This enables application of Viper at the correct timing (i.e. within 10 days of the start of flooding).

2. All water movement must cease for at least 12 hours prior to the application of Viper.

Water depth at application should be sufficient to maintain coverage of the soil until additional water can be added after the 5-day lock-up.

3. Bays must be locked up for at least 5 days after the application of Viper.

This allows Viper to disperse properly and attach to the soil in readiness for uptake. Following the lock-up period, bays may be topped up for normal water management. Water levels can also be lowered at the critical 1–3 leaf stage of rice crops to ensure optimum establishment.

4. Water inlets must be sealed tightly, particularly in top bays.

Water movement may compromise the performance of Viper.

5. Bays must have water coverage at all times.

If soil is exposed at any time, a reduction in the efficacy of Viper can be expected.

6. Viper should not be applied to cold or muddy water.

Cold and/or muddy water may also reduce efficacy.

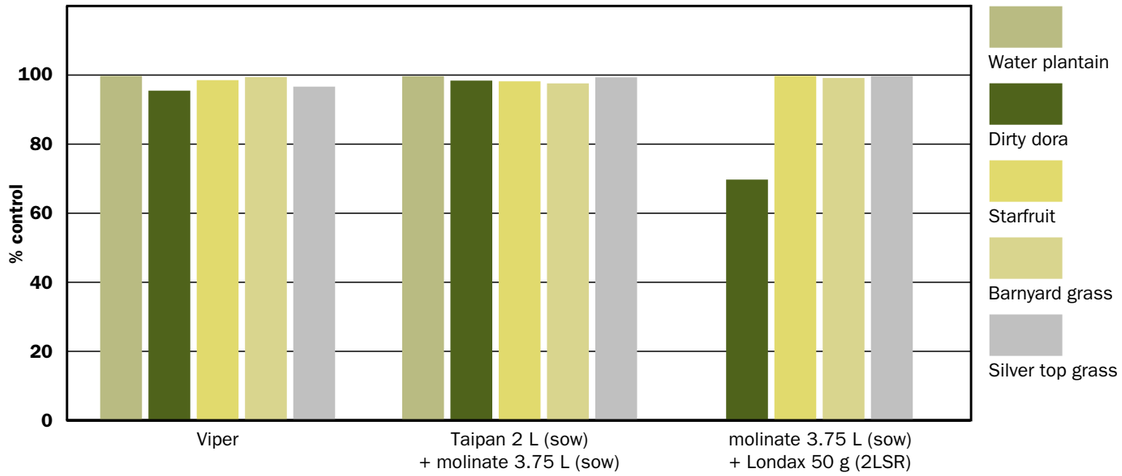
7. Topping up bays.

After initial lock-up, the topping up of bays should be done at a rate to minimise soil disturbance and disruption of the herbicide chemical layer.

EFFICACY

Viper provides robust, residual activity on a range of important aquatic weeds in rice, including barnyard grass, arrowhead, starfruit, alisma, water plantain, and suppression of silver top grass and dirty dora.

GRAPH 6: Control of various rice weeds by Viper.



Trial no: H67-98, H33-99, H34-99, H35-99, H59-99, H20-00, H23-00 LSR=Leaf stage rice. Note: Suspected ALS-tolerant species present within some trials.

Efficacy: Barnyard grass

Viper has activity on barnyard grass (*Echinochloa* spp.), however it is important to note that Viper will only control barnyard grass up to the 3-leaf stage. Larger barnyard grass (up to 4-leaf) can be controlled with the addition of Magister.

Efficacy: Arrowhead

Arrowhead (*Sagittaria montevidensis*) is found with high incidence in the Coleambally irrigation area (CIA) and Murrumbidgee irrigation area (MIA), where ALS (e.g. bensulfuron) resistant populations have been recorded. Arrowhead is a competitive plant that colonises aquatic environments quickly once introduced. Viper is particularly active on arrowhead, however it is necessary to ensure the seedbed is free of germinated weeds prior to flooding.

Efficacy: Starfruit

Starfruit (*Damasonium minus*) is one of the most damaging broadleaf aquatic weeds in rice, with ALS-resistant populations now recorded in most areas. Starfruit generally germinates in response to continuous flooding. Viper provides consistent control of starfruit that is equivalent to Taipan or molinate followed by Londax® . Residual control of starfruit can be expected for up to 28 days.

Efficacy: Alisma

Alisma *(Alisma lanceolatum)* is found in most rice-growing areas, although it tends to be concentrated in the CIA and parts of the Eastern Murray valley (EMV) and MIA. Viper provides robust control of alisma, however it is important to note that plants vegetatively propagated from previous plant residues will not be controlled.

Efficacy: Water plantain

Water plantain (*Alisma plantago aquatica*) populations tend to be more of a problem in the Murray valley (MV), where MCPA was the only herbicide to use prior to Viper (although providing only suppression). Viper provides control of water plantain and is particularly important in a resistance management program. Again it is important to note that plants vegetatively propagated from previous plant residues will not be controlled.

Efficacy: Dirty dora

Dirty dora (*Cyperus difformis*) is an annual sedge, closely related to other *Cyperus* spp., nut grass and umbrella sedge. Dirty dora is widely distributed throughout all rice-growing regions, with widespread ALS-resistant populations now documented. Viper provides suppression of dirty dora. It is important to ensure good crop establishment as the crop competition will assist in dirty dora control.

Efficacy: Silver top

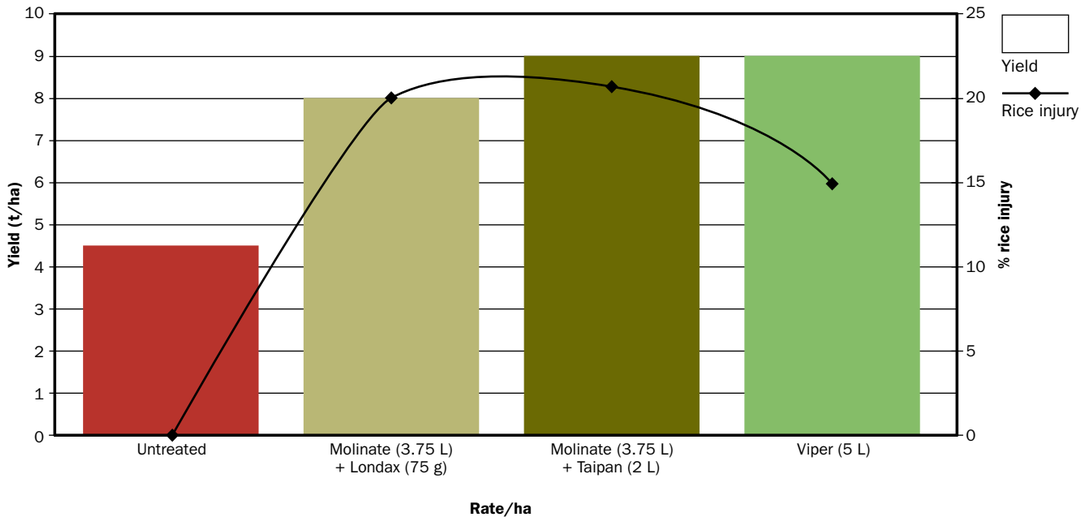
Viper has activity on silver top grass (*Diplachne fusca*), however it is important to note that Viper will only suppress silver top grass up to the 1-leaf stage. Larger silver top grass (up to 2-leaf) can be suppressed with the addition of Magister.

CROP SAFETY

Viper is relatively soft on rice, enabling excellent crop establishment and providing the best chance to achieve maximum possible yield potential (and crop returns). It is generally accepted that Viper's crop safety can be attributed to:

- Early application timing
- The absence of root growth inhibition (i.e. root pruning), which can often be associated with bensulfuron application, and
- The absence of deep water during later seedling growth (i.e. 2–3 leaf), which is routinely required for post-emergent herbicide application. Deep and/or muddy water at this growth stage can combine with dispersive soils to reduce light (and heat) absorption, which may in turn amplify the growth inhibition cold stress causes in rice plants.

GRAPH 7: Relationship between rice crop injury, weed control and yield.



Average 3 trials: H20–00, H23–00 and H27–00. All sites confirmed ALS-susceptible.

Saturn® EC

Introduction

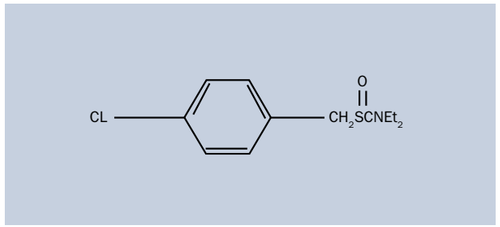
Launched in 1981, Saturn's alternative mode of action has taken on increased importance in recent years as widespread resistance to bensulfuron has been documented in a number of key weed species. As a consequence of the development of this resistance, many growers have adopted a herbicide strategy which includes Saturn in their program for the control of dirty dora and barnyard grass.

PRODUCT FORMULATION

Active ingredient

Trade name: Saturn EC Herbicide
Active constituent: 800 g/L thiobencarb
Chemical name: S-4 chlorobenzyl diethylthiocarbamate

Structural formula



Formulation type

Formulation: Emulsifiable concentrate

Physical properties

Appearance: Light yellow liquid
Odour: Aromatic solvent odour
Specific gravity: 1.10
Combustibility: Combustible liquid, class C1
Corrosiveness: Non-corrosive
Miscibility: Miscible in most water types
Solubility in water: Forms an emulsion
pH: 6.0–8.0
Stability: Stable for a minimum of two years if stored in the unopened original container, in a suitable storage area out of direct sunlight and extreme temperatures.
Poison schedule: S5
Hazchem code: Not applicable
DG status: Not considered a dangerous good for transport by road and rail.

TOXICOLOGICAL PROPERTIES

Active ingredient

Oral LD_{50} (rat): 1033–1130 mg/kg
Dermal LD_{50} (rat): >2000 g/kg
Inhalation LC_{50} (rat): 43 mg/L air (1 hr)
Skin irritation: Irritant
Eye irritation (rabbit): Irritant

BIOLOGICAL PROPERTIES

Mode of action

Activity

Saturn is a selective herbicide that is absorbed by the roots and foliage of the plant. Saturn, a thiocarbamate herbicide, is a member of the Group E herbicides which have inhibition of mitosis mode of action.

Uptake and translocation

The active ingredient in Saturn, thiobencarb, is taken up by the roots and transported to the growing points of the leaf bases, stems and roots.

Symptoms

When Saturn is applied pre-emergence, the weeds can develop up to the coleoptile to 1-leaf stage before they quickly yellow and die. After a post-emergence application, barnyard grass becomes pale yellow in colour, deteriorates rapidly, collapses onto the soil and dies. Dirty dora becomes darker in colour, stunted in growth and dies.

Resistant weeds warning

GROUP **E** HERBICIDE

Saturn is a member of the thiocarbamate group of herbicides. Saturn is a herbicide which inhibits mitosis. For weed resistance management, Saturn is a Group E herbicide.

Resistance management

To manage weed resistance, growers should adopt a herbicide resistance management program. Such a program would include products from different chemical groups that use different modes of action for control. The rice industry is presently experiencing an increase in the occurrence of confirmed resistance of dirty dora to Londax® (600 g/kg bensulfuron), a member of the ALS inhibitors (Group B). Saturn provides an alternative mode of action on dirty dora and is an important part of any resistance management strategy.

BEHAVIOUR IN THE ENVIRONMENT

In crops

Saturn will damage non-target crops such as sorghum, ryegrass, oats, cucurbits and onions.

In water

Saturn is considered stable in acidic and moderately alkaline media. Half-life in water is 2–3 days. Saturn is primarily broken down by microbial activity, providing rapid degradation in the soil. It is not readily leached because it is strongly bound to soil particles, which minimises the loss from volatilisation and photodegradation.

In soil

Saturn is tightly bound to soil particles. The half-life of Saturn in soil varies from between 2 and 3 weeks under aerobic conditions, to between 6 and 8 months under anaerobic conditions.

EFFECTS ON FLORA AND FAUNA

Fish

Thiobencarb is relatively toxic to fish, with an LC_{50} for carp at 3.6 mg/L. Streams should not be contaminated with Saturn.

Bees

Saturn is considered to be of low toxicity to honey bees.

Birds

Studies have been conducted to establish the acute oral toxicity of thiobencarb, subacute oral toxicity, and its effects on the reproductive capacity of various wild avian species. The acute oral LD_{50} for mallard ducks is >10,000 mg/kg and >7800 mg/kg for bobwhite quail.

RESIDUE PROFILE

Residues

Breakdown in plants follows the same path as in soils and animals.

Withholding period

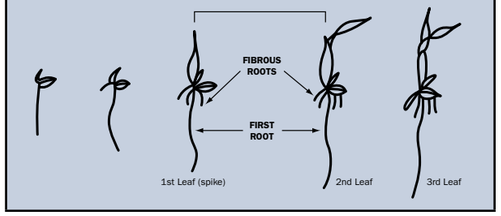
Not required when used as directed.

APPLICATION

Application timing

Post-emergent applications of Saturn should be made when the majority of rice seedlings have reached the secondary (fibrous) root stage and are attached to the soil. Applications of Saturn prior to this stage can cause crop damage. At this stage the rice seedling is normally at the 1 to 2-leaf stage.

Rice seedling development at post-sowing stage



Aerial-sown rice

In aerial-sown rice, Saturn can either be applied as a standard (single) post-emergent treatment (at the secondary root stage of rice), as a sequential treatment (at sowing and again at the secondary root stage), or as a dry-soil application prior to flooding.

(A) Aerial sown rice – Flooded bay – Single application

Crop	Weeds	Rate (ha)
Rice (aerial-sown into flooded bay) (NSW and Vic)	Barnyard grass (*Echinochloa* spp.), dirty dora (*Cyperus difformis*)	3.75 L

Note: Always refer to the full label before applying Saturn.

Restraints

DO NOT use Saturn where muddy water can be expected.

Application

Aerial application

Apply Saturn to flooded bays. Use flat-fan nozzles or AU 5000 rotary atomisers delivering a minimum of 20 to 40 L spray volume/ha with droplet size of 200 to 350 µm to ensure thorough, even distribution of Saturn.

Alternatively, apply through solid-stream nozzles, i.e. a Bickley boom with the following set-up:

- Two nozzles mounted on droppers, one either side with droppers positioned just outside the first boom hanger (28–35%) wingspan.
- Dropper length approximately 40–60 cm or lower below the trailing edge of the wing.
- Solid-stream nozzles with bore sufficient to apply desired volume at a pressure of 240 to 310 kPa (35 to 45 psi).
- Nozzles orientated rearwards and parallel to the airstream.
- Check valves (Spraying Systems diaphragm type 12328, ¾ inch) located behind nozzle to eliminate “trailing” after shut-off.

For Bickley boom application, spray at a maximum wheel height of 2 m above the water surface and at a maximum swathe width of 25 m. Ensure a minimum water depth of 10 cm on the high side of bays prior to treatment. A minimum application volume of 20 L/ha is the recommended rate. Before applying Saturn to contoured bays evaluate the layout of the bays to be treated and select the optimum flight pattern to ensure all bays receive the recommended rate of Saturn.

Thoroughly mix the required amount of Saturn with a similar quantity of water before adding the remainder of water to the spray tank while agitating. Re-agitate if the mixture is allowed to stand before use.

DO NOT over-spray headlands.

SCWIIRT application

Soluble Chemical Water Injection In Rice Technique (SCWIIRT) involves metering herbicide concentrates directly into flooded fields and relying on aqueous dispersion of the chemical across the field. Four-wheel drive vehicles or helicopters are adapted to meter chemical diluted in a small quantity of water into flooded bays. In this use situation Saturn is best applied in a SCWIIRT system with a total application volume of 6.5 L/ha. Thoroughly mix the required amount of Saturn with the majority of the water before adding the remainder of the water to the spray tank while agitating. Re-agitate if the mixture is allowed to stand before use.

General instructions

Flood the area to be sown quickly, and sow within 7 days of the start of filling flat bays. Sow pre-germinated rice seed (not dry rice seed) in the normal way, maintaining full water coverage on high sides of bay. Apply Saturn only when the fibrous (secondary) roots of the rice seedling are developing and are attached to the soil surface. At this point the rice seedling is normally in the 1 to 2-leaf stage. This stage normally occurs between 7 and 20 days after sowing, depending upon temperature conditions. DO NOT apply to rice prior to the development of fibrous roots or to floating rice, as crop damage may occur.

Water management

Water movement should cease 6 to 12 hours before application and water should be held for a minimum of 3 days. Three days after spray application, bays may be topped up as normal water management requires.

(B) Aerial-sown rice – Flooded bay – Split application

Crop	Weeds	Rate (ha)
Rice (aerial-sown into flooded bay) (NSW and Vic) excluding long grain and Paragon varieties	Barnyard grass (*Echinochloa* spp.), dirty dora (*Cyperus difformis*)	Application 1 (pre-sowing): 1.0–1.5 L Application 2 (post-sowing): 2.75 L
Rice (aerial-sown into flooded bay) (NSW and Vic) Langi and Paragon varieties only*	Barnyard grass (*Echinochloa* spp.), dirty dora (*Cyperus difformis*) Note: Only suitable where low anticipated weed pressure	Application 1 (pre-sowing): 1.0 L Application 2 (post-sowing): 2.75 L

Note: Always refer to the full label before applying Saturn.

Restraints

DO NOT use Saturn where muddy water can be expected.

DO NOT use Saturn if contours of bays exceed 10 cm (4 inches).

Application

Aerial application

Apply Saturn to newly flooded bays.

Use flat-fan nozzles or AU 5000 rotary atomisers delivering 20 to 40 L spray volume/ha with droplet size of 200 to 350 µm to ensure thorough, even distribution of Saturn.

Alternatively, apply through solid-stream nozzles, i.e. a Bickley boom with the following set-up:

- Two nozzles mounted on droppers, one either side with droppers positioned just outside the first boom hanger (28–35%) wingspan.
- Dropper length approximately 40–60 cm or lower below the trailing edge of the wing.
- Solid-stream nozzles with bore sufficient to apply desired volume at a pressure of 240 to 310 kPa (35 to 45 psi).
- Nozzles orientated rearwards and parallel to the airstream.
- Check valves (Spraying Systems diaphragm type 12328, ¾ inch) located behind nozzle to eliminate "trailing" after shut-off.

For Bickley boom application, spray at a maximum wheel height of 2 m above the water surface and at a maximum swath width of 25 m. Ensure a minimum water depth of 10 cm on the high side of bays prior to treatment. A minimum application volume of 20 L/ha is the recommended rate. Before applying Saturn to contoured bays evaluate the layout of the bays to be treated and select the optimum flight pattern to ensure all bays receive the recommended rate of Saturn.

Thoroughly mix the required amount of Saturn with a similar quantity of water before adding the remainder of the water to the spray tank while agitating. Re-agitate if the mixture is allowed to stand before use.

DO NOT over-spray headlands.

SCWIIRT application

Soluble Chemical Water Injection In Rice Technique (SCWIIRT) involves metering herbicide concentrates directly into flooded fields and relying on aqueous dispersion of the chemical across the field. Four-wheel drive vehicles or helicopters are adapted to meter chemical diluted in a small quantity of water into flooded bays. In this use situation Saturn is best applied in a SCWIIRT system with a total application volume of 5 L/ha. Thoroughly mix the required amount of Saturn with the majority of water before adding the remainder of water to the spray tank while agitating. Re-agitate if the mixture is allowed to stand before use.

Application 1 (Pre-sowing): Apply by air or by SCWIIRT to newly flooded bays prior to the germination of weeds. Apply within 7 days of the start of filling, and 6 to 12 hours after all water movement has ceased. Sow pre-germinated rice 1 to 3 days after treatment.

Use the higher 1.5 L/ha rate where dirty dora plants have already germinated (<1 leaf), there are high populations (for example >200 plants/m^2), or it is suspected bensulfuron-resistant dirty dora plants are prevalent.

Note: Application to bays in which weed germination has occurred may result in unsatisfactory weed control.

Application 2 (Post-sowing): Apply Saturn by air or by SCWIIRT to flooded bays as soon as possible after the rice seedlings develop fibrous (secondary) roots and they attach to the soil surface.

Apply Saturn when barnyard grass is at the 0 to 3-leaf stage and dirty dora is at the 0 to 2-leaf stage.

DO NOT apply to rice prior to the development of fibrous roots or to floating rice, as crop damage may occur.

General instructions

When using the split application technique, it is essential that both applications are carried out. The 1st (pre-sowing) application is onto newly flooded bays and suppresses weed germination, allowing the rice to develop to the secondary root stage. Then the 2nd (post-sowing) application is required for the control of emerging weeds, completing the herbicide program. If one application is applied without the other, the technique will result in unsatisfactory weed control.

If certain conditions prevent the second application of Saturn from taking place at the correct stage, alternative products (e.g. molinate or Londax) should be used for post-emergence weed control.

Water management

Prior to the first application (pre-sowing), flood the area to be sown over a period not longer than 7 days. Water movement should cease 6 to 12 hours before application and water should be held for a minimum of 3 days. Three days after spray application, bays may be topped up as normal water management requires.

*Ensure full coverage of soil with enough water depth to enable distribution of product throughout the bay. Occasionally crop effects may be observed after the 3 day lock up period. Reducing the water level will assist crop recovery. Contact Bayer CropScience for further advice.

(C) Aerial-sown rice – Dry soil application

Crop	Weeds	Rate (ha)
Rice (aerial-sown into flooded bay – Amaroo variety only) (NSW and Vic)	Barnyard grass (*Echinochloa* spp.), dirty dora (*Cyperus difformis*)	3.75 to 5.0 L

Note: Always refer to the full label before applying Saturn.

Restraints

DO NOT use on bays that have not been rolled to break down soil clods prior to application.

DO NOT use on rice varieties other than Amaroo.

DO NOT use where muddy water can be expected.

Application

Ground-rig application

Saturn can be applied by ground rig before permanent water is applied. Apply at low pressures (to either a moist or dry soil surface), using ground sprayers with flat-fan nozzles delivering at least 50 L/ha with a droplet size of 200 to 350 µm. Overlapping with the boom should be avoided as crop injury may occur. Site preparation is important with dry-soil application. Saturn should only be used pre-flooding where bays have been adequately prepared and rolled to break down soil clods.

In addition, the site should be free of germinating weeds prior to application. Thoroughly mix the required amount of Saturn with a similar quantity of water before adding the full quantity to the spray tank while agitating.

Re-agitate if the mixture is allowed to stand before use.

General instructions

Saturn should only be used pre-flooding where bays have been adequately prepared and rolled to break down soil clods. Sow pre-germinated rice seed (not dry rice seed) into flooded bays maintaining water coverage on high sides of bays.

Water management

Flood bays as soon as possible after application and no later than 5 days after application or efficacy will be reduced. For best results, supply water separately to each bay from the supply channel, or align irrigation stops on one side of paddock and ensure toe furrows are clear. After completion of initial flooding following application, complete water coverage of bays must be maintained to ensure satisfactory weed control throughout the season. If water levels drop and expose the soil surface, weed control may be reduced.

(D) Combine and pasture sod-sown rice

Saturn should be applied when barnyard grass is at the 0 to 3-leaf stage and dirty dora is at the 0 to 2-leaf stage. In combine and pasture sod-sown rice, it is generally applied as a post-emergent spray by air or ground rig. Drip application is no longer recommended.

Crop	Weeds	State	Rate (ha)
Rice (combine and pasture sod-sown)	Barnyard grass (*Echinochloa* spp.), dirty dora (*Cyperus difformis*)	NSW, WA, Vic only	5.0 L
	Above mentioned species plus *Cyperus iria*	Qld only	
	Barnyard grass (*Echinochloa* spp.), dirty dora (*Cyperus difformis*)	NSW, WA, Vic only	3.8 L Saturn + 4.2 L of Ronacil® (360 g/L propanil)

Note: Always refer to the full label before applying Saturn.

Restraints

DO NOT apply Saturn to germinating or emerging rice (0 to 1.5-leaf stage) if ponding is likely to occur in low areas for more than 3 days.

DO NOT use Saturn where irrigation layouts do not permit complete water coverage of most weed growth.

DO NOT apply Saturn to rice sod-sown into burnt stubble.

DO NOT apply to rice in a weakened condition from causes such as soil salinity, wilting, overwatering or any other cause.

DO NOT use when barnyard grass is beyond the 3-leaf stage (5-leaf stage for mixture with Ronacil) or dirty dora is beyond 2-leaf.

Application

Saturn can be applied by air or by ground rig just before or soon after rice emergence, but before permanent water is applied. The rice crop should have been flushed at least once prior to application to ensure sealing of the soil surface. Where rice has established on rainfall moisture alone, sealing may not have occurred. Good drainage after flushing is essential.

Mixing

Thoroughly mix the required amount of Saturn, or Saturn plus Ronacil, with a similar quantity of water before adding the full quantity of water to the spray tank, while agitating. Re-agitate if the mixture is allowed to stand before use.

General instructions

Where rice is sod-sown into pasture, it is advisable to use livestock and/or a knockdown herbicide to control the pasture growth prior to sowing. If most of the barnyard grass is in the 5-leaf stage before rice emergence, and it is unlikely that permanent water will be applied within 10 to 11 days of treatment, the use of a knockdown herbicide is recommended. Apply Saturn or a Saturn + Ronacil mixture later, to control subsequent germination of weeds. Use of the mixture is especially recommended with slow-to-establish, short-strawed rice varieties.

All compatibility testing has been conducted with Saturn and Ronacil (propanil). If an alternative formulation of propanil is to be considered, consult your local rice agronomist.

Water management

Permanent water may be applied as soon as rice plants are at, or past, the 1.5-leaf stage.

DO NOT drain rice water into regional drains within the withholding period after Saturn application as defined by the NSW Environment Protection Authority (EPA) or the local irrigation authority.

(i) Rice not ready for permanent water

Flushing irrigations should follow spray application within 5 days in the case of Saturn and after 2 days but not later than 5 days in the case of Saturn plus Ronacil. Flushing water must be held for 2 days at a sufficient depth to completely submerge the majority of weed growth and then be drained from the bays. Repeat flushing as necessary to prevent crusting and drying of the soil surface. Apply permanent water not later than 10 to 11 days after the spray application.

(ii) Rice ready for permanent water

Permanent water should follow spray application within 5 days in the case of Saturn, and after not less than 2 days but not more than 5 days in the case of Saturn plus Ronacil. Permanent water should be maintained at a sufficient depth to completely submerge most weed growth.

Salvage control

Where the rice is ready for permanent water and barnyard grass is between 5-leaf and tillering, useful suppression and/or partial control may be achieved by higher rates of the Saturn/Ronacil mix (Saturn up to 5 L/ha plus Ronacil (360 g/L) up to 7 L/ha). This treatment may cause some transient leaf scorch of the rice.

Permanent water must be applied at least 2 days, but no more than 5 days, after application. Permanent water should be maintained at a depth sufficient to completely submerge the weed growth for 3 days after application. After this time normal water coverage should be maintained.

COMPATIBILITY

Saturn is compatible with Ronacil (propanil), chlorpyrifos and Londax (bensulfuron).

EFFICACY

Dirty dora

As an annual sedge, dirty dora is closely related to the other *Cyperus* spp., nut grass and umbrella sedge. It is widely distributed throughout all rice-growing regions, with widespread ALS-resistant populations now documented.

Saturn has been shown to have excellent efficacy on dirty dora, including ALS-resistant populations. Saturn provides a number of flexible application options with other rice herbicides, such as Taipan (in a program) and bensulfuron (as a tank-mix).

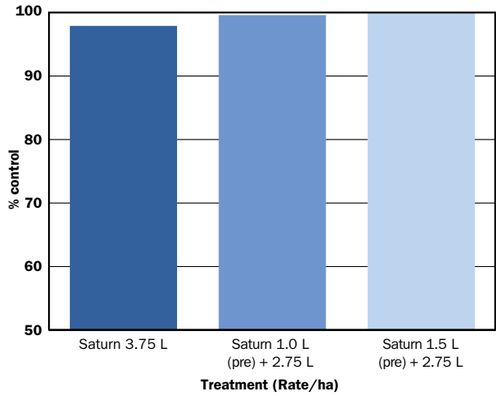
A standard (single) application of Saturn (with bensulfuron) can have a narrow application window. Saturn application timing needs to be accurate, otherwise poor efficacy and/or crop damage can occur. The split Saturn application method has been developed to improve timing flexibility, increasing the application window and improving the reliability of Saturn. This use is registered for medium grain varieties, and the long grain variety Langi, which tends to be less susceptible to Saturn damage than some other long grain varieties.

The 'split Saturn' technique involves two applications at separate timings. The first application at pre-sowing, pre-emergence is designed to suppress germination of dirty dora. This enables the second post-sowing, post-emergent treatment to be applied when the rice has established secondary roots and at the correct timing for the weeds.

A number of small plot replicated and commercial trials have been conducted in order to develop the split Saturn application technique in rice. The application of Saturn in a split program (including Londax) provided control of dirty dora which was at least equal to that provided by the current standard post-emergent application of Saturn (plus Londax) (Graph 8). In two of these trials, the control of dirty dora was increased using a split Saturn program compared to a standard post-emergent Saturn treatment.

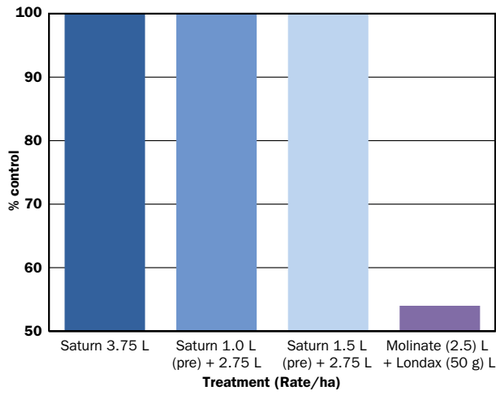
Where bensulfuron-resistant dirty dora was confirmed, excellent control was obtained with both the standard and split application treatments of Saturn when compared with the standard treatment of molinate plus Londax (Graph 9).

GRAPH 8: Comparison of standard and split Saturn treatments on dirty dora.



Average 7 trials (H29-94, H30-94, H31-94, H46-95, H47-95, H48-95, H49-95), assessed 55 DAS.

GRAPH 9: Comparison of standard and split Saturn treatments on ALS-resistant dirty dora.



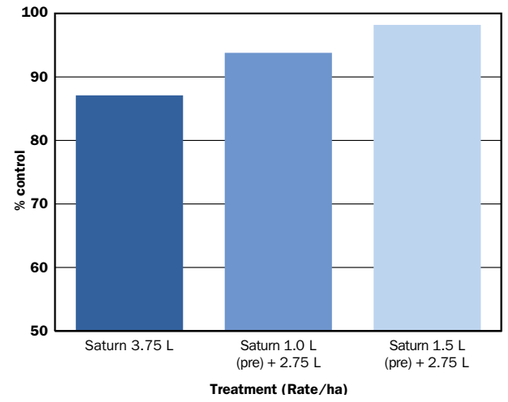
Trial H48-95, assessed 57 DAS.

Barnyard grass

Barnyard grass (*Echinochloa* spp.) is the most prevalent grassweed occurring in rice production, with four main species: awnless barnyard grass (*E. colona*), common barnyard grass (*E. crus-gali*), prickly barnyard grass (*E. microstachya*) and hairy millet (*E. oryzoides*). In some cases, particularly with spring rainfall, barnyard grass can emerge before rice seedlings, competing for light and nutrients and causing sample contamination at harvest.

Saturn provides excellent control of barnyard grass, although recent trials have indicated that the use of a split Saturn application method results in more robust control than a standard application. This relates to a wider application window (Graph 10).

GRAPH 10: Comparison of standard and split Saturn treatments for barnyard grass control.

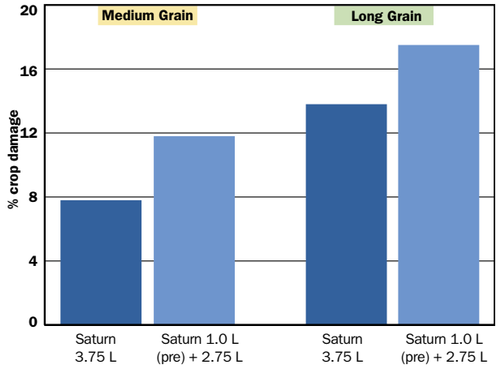


Average 6 trials (H29-94, H30-94, H31-94, H46-95, H47-95, H49-95), assessed 55 DAS.

CROP SAFETY

Saturn can be used on all varieties of rice (except when using a split Saturn application; then only medium grain varieties and Langi variety are sufficiently tolerant. Note that for Langi and Paragon varieties the first application must be no more than 1 L/ha). In general, split Saturn treatments cause comparable transient crop effects to standard Saturn applications. These effects are generally short-lived.

GRAPH 11: Comparison of Saturn and split Saturn treatments for crop tolerance.

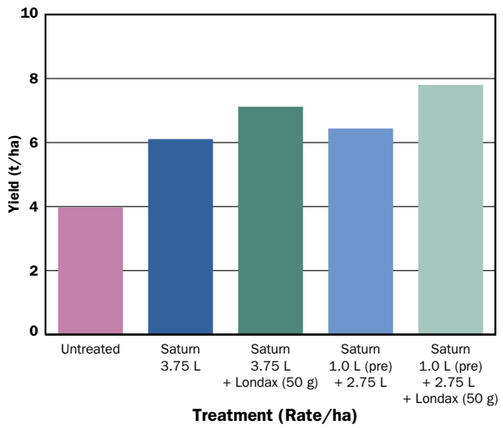


Average 3 trials (H29-94, H30-94, H47-95), assessed 22 DAS.

CROP YIELD

Yield data confirms that a split Saturn application tends to yield better than a standard Saturn application. The graph below shows that the addition of Londax to control weed species not controlled by Saturn resulted in added yield. In most cases this is related directly to removal of early weed competition following the pre-sowing application.

GRAPH 12: Comparison of standard Saturn and split Saturn treatments for crop yield.



Average 2 trials (H29-94, H31-94).

DIPTEREX®

Introduction

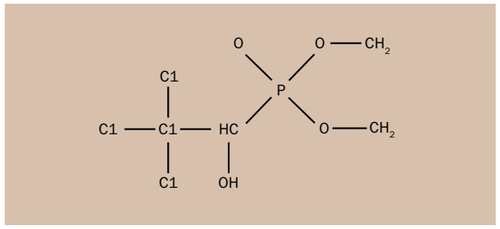
Dipterex is well established for effective and convenient control of both bloodworm and leaf miner in rice. It has excellent compatibility with other crop protection agents and can be used selectively if and when a significant threat from the target pests has emerged.

PRODUCT FORMULATION

Active ingredient

Trade name: Dipterex 500 SL Insecticide
Active constituent: 500 g/L trichlorfon

Structural formula



Formulation type

Formulation: Soluble concentrate (SL)

Physical properties

Appearance: Clear, colourless
Odour: Negligible
Vapour pressure: 2.1 x 10^{-6} hPa at 20°C
Density (kg/L): 1.21
Flashpoint: >35°C
Solubility in water: 12.3 g/100 mL of water at 20°C
15.4 g/100 mL of water at 25°C
24.3 g/100 mL of water at 35°C
Poison schedule: 6
Hazchem code: 3W
Dangerous good: Classified as a dangerous good for transport by road or rail

TOXICOLOGICAL PROPERTIES

Active ingredient

Oral LD_{50} (rat): 700 mg/kg
Dermal LD_{50} (rat): >2000 mg/kg
Skin irritation: Not a skin irritant
Eye irritation: None
Inhalation LC_{50} (rat): 1300 mg/m^3

BIOLOGICAL PROPERTIES

The outstanding properties of Dipterex are its very powerful insecticidal effect, its relatively low order of mammalian toxicity, plus the fact that it spares beneficial insects. Dipterex is an organophosphate which acts primarily as a stomach poison, and also has a very good contact poison action. It has a broad spectrum of activity, killing quickly and to a good depth.

As a result of its penetrating action, Dipterex kills not only pests feeding on plants but also those already present in the plant tissues, e.g. leaf miners. Its plant tolerance is generally good at the recommended concentrations.

DIRECTIONS FOR USE

Crop	Pest	Rate (ha)
Rice	Bloodworm	600–850 mL
	Leaf miner	850 mL

Note: Always refer to the full label before applying Dipterex.

APPLICATION

Rice-bloodworm control

Apply at sowing time or within 24 hours of sowing to flooded bays where the water depth is 150 mm or less. Use the higher rate when the water depth is greater than 150 mm or where high amounts of organic matter are present. Bays should be flooded at least 3 days prior to application to ensure maximum hatching of bloodworm. When the organic matter content of bays is unavoidably high, reduce the water level and monitor the results of spraying. Re-apply as indicated by the pest population.

Rice – Leaf miner

Apply at first sign of larvae activity.

Mixing

Add the required quantity of Dipterex to water in the spray vat while stirring or with agitators in motion. Use immediately after mixing. Re-seal part-used product container immediately after use.

INSECT IDENTIFICATION

Bloodworm *(Chironomous tepperi)*

Adult – Midge is mosquito-like, laying egg masses each 0.4 x 0.1 mm in a spiral ring. Survives 3–8 days.

Larvae – Grow over four moults, range from 0.1–18 mm, reddish brown in colour.

WEED IDENTIFICATION

Dirty dora *(Cyperus difformis)*

Seedling leaf – Bright green, triangular, hairless, growing from the base.

Seed – Very small (0.6 mm), green to brown.

Starfruit *(Damasonium minus)*

Seedling leaf – Bright green, fleshy, hairless, 3 to 5 pronounced veins on the leaf.

Seed – Small (1–2 mm) and black, contained in bright green star-shaped fruit.

Flower – White/pale pink.

Arrowhead *(Sagittaria montevidensis)*

Seedling leaf – Spear-shaped, bright green, hollow spongy petioles grow from the base.

Seed – Bright green (brown at maturity).

Flower – White.

Water plantain *(Alisma plantago aquatica)*

Seedling leaf – Wider leaf blades than alisma (7–10 cm), 7 prominent parallel veins, connected by numerous transverse veins, leaves attached to a large petiole up to 80 cm in length.

Seed – Can reproduce from seed or from corms.

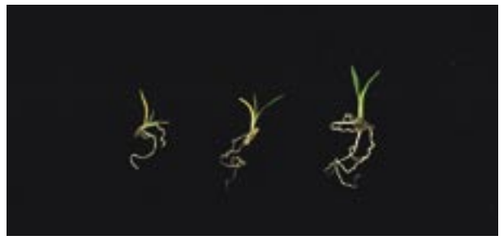
Flower – White/pale pink.

Barnyard grass *(Echinochloa spp.)*

Seedling leaf – Blue-green, erect or prostrate, no ligules or auricles.

Seed – Small (1.5 to 5 mm), straw-coloured.

Silver top grass
(Leptochloa fascicularis)



Seedling leaf – Dull blue-green, narrow and drooping, prominent ligules but no auricles, white mid vein.

Seed – Very small (0.5 mm), dark brown.

Alisma *(Alisma lanceolatum)*

Seedling leaf – Similar to starfruit in appearance when young, thin leaves.

Flower – Cream.

Cumbungi *(Typha spp.)*

Seedling – Green/blue-green leaves, perennial with rhizome base, cylindrical pithy stem.

Seed – Prolific seeder, also develops on rhizomes.

Source: Quality rice production in Australia.

NOTES:

CONTACTS

For more information on using Taipan, Viper, Saturn and Dipterex in your rice crop, contact your local rice specialist.

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