CRUCIAL

TECHGUIDE

Nufarm

AUSTRALIAN THROUGH & THROUGH

KNOCKDOWN THE TOUGHEST WEEDS THROUGH THICK AND THIN.

Unrivalled intelligence.

We've cracked the code. Fully loaded triple salt, robust surfactant package and 600 load. It's first to market glyphosate technology; researched, designed, and formulated in Australia. It's for the innovators, the ground-breakers, the growers like you, with the vision to move first. Nufarm CRUCIAL is the all-in-one, the complete package, your blueprint for intelligent weed control. We've cut no corners, covered every angle and added cutting-edge detail, to make it easier for you.

Streamline your masterplan with Nufarm CRUCIAL, and discover the new benchmark against which success is measured.

Nufarm CRUCIAL®

DEVELOPMENT

Nufarm Australia's Single, Dual and Triple Salt development.

SINGLE SALT - 1980 - 90

Unique Formulations

DUAL SALT - 2000 - 13

Cutting-edge formulations

TRIPLE SALT - 2013 -

Lab testing begins on first triple salt experimental formulations

WORLDS FIRST TRIPLE SALT FORMULATION - 2019

Unrivalled Intelligence.

30+ Years in the making

100+ Field Trials... our largest EVER

200+ Protected Data Studies

Triple salts unique combination of
- Potassium
- Monomethylamine
- Mono-ammonium

Packaged with leading surfactants

Providing
- A liquid with a 600 g/L loading
- Fast plant uptake
- Proven and market leading compatibility

Allowing
- Fast brownout
- Short spray to sow timings
- Outstanding efficacy
- The widest registered uses OTT *

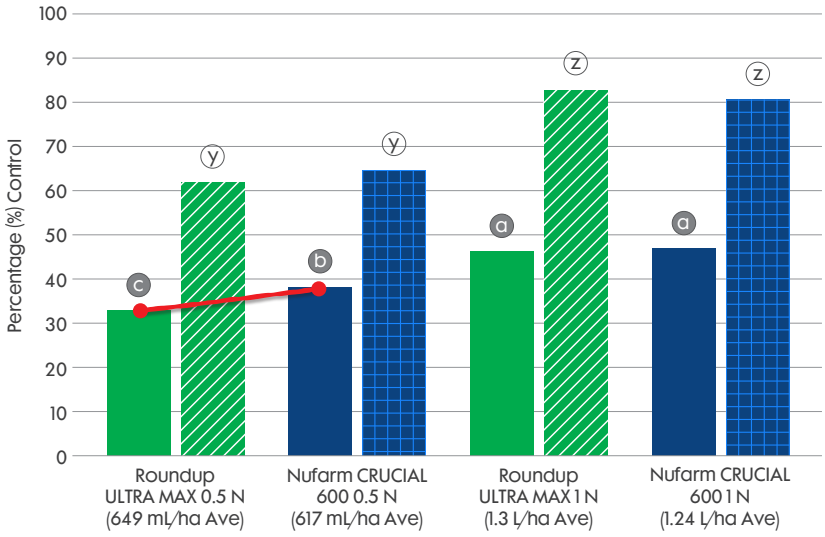
* OTT - Over The Top of glyphosate tolerant crops (subject to regulatory approvals)

EFFICACY

With 100 in-field trials, it's Nufarm's most extensive trial program ever. Combined with our most extensive laboratory compatibility testing ever, and you've got the proof that performance measures up to the hype.

BROADLEAF WEED CONTROL

Percentage (%) Average Broadleaf Weed Control – 10 trials (2016-2017)



Key

Ave. 10 DAA

Ave. 25 DAA

10 days = 1st Column

25 days = 2nd Column

(in each branded treatment)

The 0.5N or half rate treatments are used in glyphosate trial work to understand how formulations perform under extremely challenging conditions.

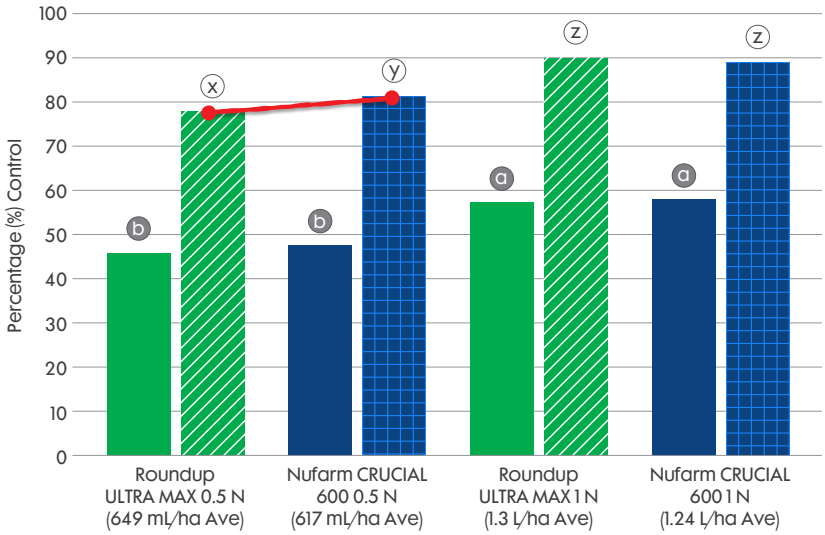
The results after 10 days at half rate, show that Nufarm CRUCIAL is a very reliable and robust formulation, under a wide range of conditions, performing very strongly compared to Roundup UltraMax.

WEEDS

- Fleabane *(Conyza bonariensis)*
- Erodium *(Erodium spp.)*
- Capeweed *(Arctotheca calendula)*
- Prickly Lettuce *(Lactuca serriola)*
- Wild buckwheat *(Fallopia convolvulus)*
- Wild radish *(Raphanus raphanistrum)*
- Turnip weed *(Rapistrum rugosum)*

GRASS WEED CONTROL

Percentage (%) Average Grass Weed Control – 10 trials (2016-2017)



Key

Ave. 10 DAA

Ave. 25 DAA

10 days = 1st Column

25 days = 2nd Column

(in each branded treatment)

The results after 25 days at half rate, again show that Nufarm CRUCIAL is a very reliable and robust formulation, under a wide range of conditions, performing very strongly compared to Roundup UltraMax.

The earlier assessment reflects rapid uptake, translocation and brownout; while the later assessment is representative of final control.

WEEDS

- Sterile oat *(Avena sterilis)*
- Rescuegrass *(Ceratochloa cathartica)*
- Ryegrass *(Lolium rigidum)*
- Barnyard grass *(Echinochloa colonum)*
- Wild oat *(Avena fatua)*
- Liverseed Grass *(Urochloa panicoides)*
- Crab Grass *(Eleusine indic)*

INDEPENDENT EXPERT OPINION

Glyphosate formulations all differ.

"The combination of glyphosate salts and surfactant systems have a dramatic effect on how a glyphosate formulation performs in the field.

Weed control differences between formulations can be observed when they are applied under less than ideal conditions, such as stressed weeds or weeds that are developing herbicide resistance"

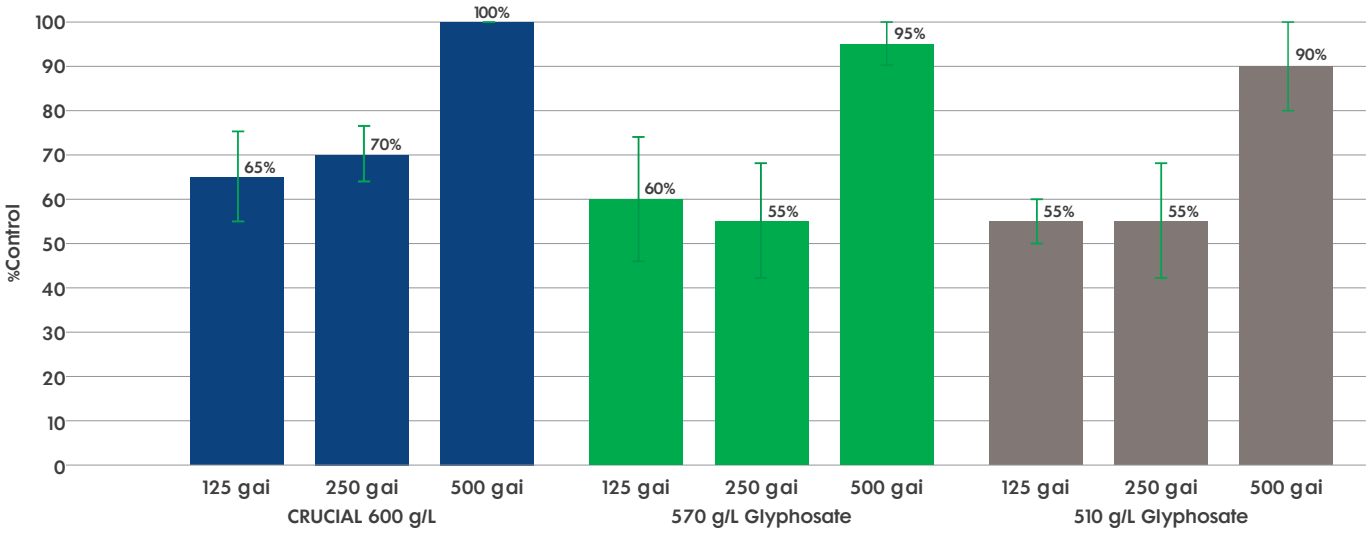
DR PETER BOUTSALIS

Dr Peter Boutsalis and Dr Sam Kleeman from Plant Science Consulting tested Nufarm's new CRUCIAL glyphosate product, and 4 other formulations, and compared the efficacy in controlling glyphosate resistant ryegrass.

"Nufarm CRUCIAL was more effective on the strong resistant ryegrass biotype" **Dr Peter Boutsalis**

NUFARM CRUCIAL EFFICACY

% Control Resistant Ryegrass (28 days after treatment)

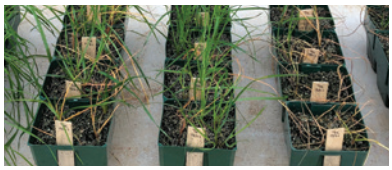


Untreated Control

Nufarm CRUCIAL
70% Control at 250 g ai

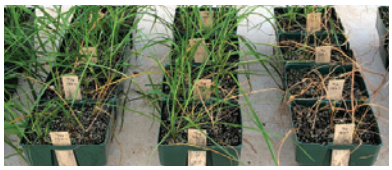
125 g ai 250 g ai 500 g ai

570g/L Glyphosate
55% Control at 250 g ai



125 g ai 250 g ai 500 g ai

510g/L Glyphosate
55% Control at 250 g ai



125 g ai 250 g ai 500 g ai

Level of glyphosate ai required to obtain an LD50 compared to CRUCIAL

	Ryegrass	Sowthistle	Barnyard grass
CRUCIAL	100%	100%	100%
Product A - 540 g/L glyphosate	124%	143%	163%
Product B - 570 g/L glyphosate	131%	150%	108%
Product C - 510 g/L glyphosate	151%	185%	202%
Product D - 540 g/L glyphosate	117%	138%	184%

Plant Science Consulting conducted a series of trials on weeds moderately resistant to glyphosate and they discovered a significant difference between glyphosate formulations on the mortality of ryegrass, sow thistle and barnyard grass.
Dr Boutsalis was able to calculate the level of glyphosate active required from the different formulations to obtain the glyphosate LD50 on these weeds. The LD50 is defined as the amount of herbicide required for 50% mortality of the population.

SPEED OF UPTAKE

Quick and effective. Nufarm CRUCIAL penetrates the leaf and translocates FAST... meaning FAST brownout, SHORT rainfastness, 1 HOUR spray-to-sow and the confidence of a great knockdown job – even with showers forecast or the seeder close behind.

UPTAKE AND TRANSLOCATION

A comparison of glyphosate formulations – Autoradiographs of treated ryegrass plants (24 hours after application)

weedmaster ARGO CRUCIAL

The Nufarm CRUCIAL treated ryegrass shows much more red in the root system, demonstrating faster penetration, translocation and accumulation of glyphosate into the root system when Nufarm CRUCIAL is used. Better translocation of glyphosate through the main leaf and tiller is also evident.

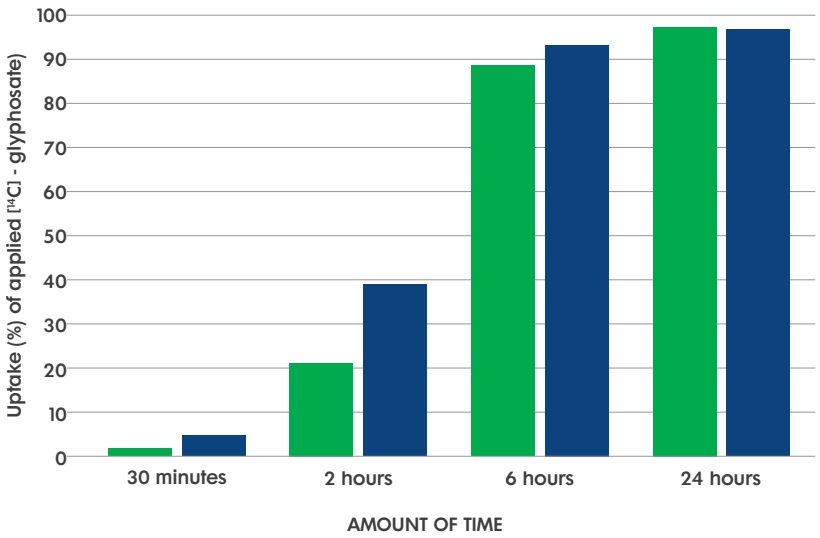
Faster uptake and translocation means more glyphosate translocated through the plant faster. This drives faster visual brownout, short rainfastness and short spray-to-sow periods.

Key

Concentration of glyphosate — LOW HIGH

UPTAKE OVER TIME

Glyphosate uptake from different formulations into treated ryegrass over time



Nufarm CRUCIAL demonstrated superior penetration, translocation and accumulation compared to Nufarm's weedmaster ARGO. These results are consistent with results seen in other field and glasshouse trials.

This fast uptake and translocation is critical for driving;

- fast visual brownout;
- rainfastness;
- spray-to-sow periods;
- and registrations such as pre-harvest, where it is important to shut down and kill weeds as fast as possible, to minimise the amount of viable seed weeds can set.

Key

weedmaster ARGO CRUCIAL

Rainfall occurring up to 1 hour of daylight after application may reduce effectiveness, heavy rainfall may wash the chemical off the foliage and a repeat treatment may be required.

FAST BROWNOUT

KIALLA EAST, VIC
EFFICACY AND BROWNOUT

RESULTS - DAY 02

Nufarm CRUCIAL

Roundup UltraMax

In an unreplicated glyphosate formulation demonstration at Kialla East, Victoria we tested the efficacy and brownout of Nufarm CRUCIAL against a number of other market-leading formulations. Conducted over 27 days at 1080 g ai/ha, Nufarm CRUCIAL demonstrated excellent performance.

RESULTS - DAY 15

Nufarm CRUCIAL

Roundup UltraMax

RESULTS - DAY 26

Nufarm CRUCIAL

Roundup UltraMax

VISCOSITY

It's all about speed...

Farmers want their operation to be as efficient as possible, so being able to suck or pour out of the drum as quickly as possible is a high priority. Even though Nufarm CRUCIAL has 600 g/L active and is stacked with a full surfactant package, it pours just as fast as Nufarm's weedmaster ARGO per litre.... and the 600 load saves time by allowing for more hectares per litre than other formulations.

CRUCIAL Liquid at -15°C

NUFARM CRUCIAL

Nufarm CRUCIAL has the widest ever label package of any glyphosate formulation, including in-crop over the top registrations.

FALLOW AND PRE-SOWING

- Consolidates all registered uses of glyphosate in this use period

WEED CONTROL TABLE

- Laid out in an easy to read format

FLEABANE CONTROL FOR FALLOW AND PRE-SOWING - MIXTURES WITH AMICIDE ADVANCE 700

- Unique Nufarm registration

CANOLA - ROUNDUP READY*

- Registered for use OTT in Roundup Ready Canola

PRE AND POST HARVEST USES, PASTURE TOPPING

- Consolidates all registered uses of glyphosate in this use period

OPTICAL SPOT SPRAY TECHNOLOGIES

- unique Nufarm registration to allow for rates in OSST equipment

POST SOW PRE-EMERGENT (PSPE) USES, SHIELDED SPRAYERS AND BAND SPRAYING

- Consolidates all registered uses of glyphosate in this use period

BRUSH AND WOODY WEEDS - MIXTURES WITH ASSOCIATE

- Consolidates all registered uses of glyphosate in this use period

UNWANTED TREE CONTROL

- Consolidates all registered uses of glyphosate in this use period

GENERAL WEED CONTROL - (HANDGUN, KNAPSACK, TREE AND VINE CROPS)

- Consolidates all registered uses of glyphosate in this use period (excludes aquatic uses)

Our new look label is indexed, making it easier to read and follow.

CANOLA - HYBRIDS WITH THE OPTIMUM GLY® HERBICIDE TOLERANCE TRAIT

- A Nufarm unique registration for OPTIMUM GLY (R) herbicide tolerant canola

CANOLA - TRUFLEX* WITH ROUNDUP READY* TECHNOLOGY

- Registration for use across the new Truflex trait

COTTON - ROUNDUP READY FLEX*

- Registration for use across the Roundup Ready Flex trait in cotton

Fig 1. Nufarm CRUCIAL

COMPATIBILITY

Simply outstanding...

The Nufarm CRUCIAL formulation features outstanding compatibility, with a very wide range of tank-mix partners.... scientifically PROVEN by the most extensive compatibility testing ever conducted by the Nufarm labs. That means LESS hassle, LESS stress and MORE confidence.

EXTENSIVELY TRIALLED - 2018-19

The compatibility lab trial below is just a small sample of the huge number of trials undertaken. Nufarm CRUCIAL demonstrated outstanding compatibility compared to other market-leading high-load glyphosate products.

NUFARM HQ, VIC LAB TRIAL 2019

540 SINGLE K-SALT GLYPHOSATE
(1.5 L/ha)
+
COMMONLY USED 625 2,4-D
(1.34 L/ha)

VS.

Nufarm CRUCIAL
(1.35 L/ha)
+
Nufarm Amicide ADVANCE 700 Selective Herbicide
(1.2 L/ha)

VS.

ROUNDUP ULTRAMAX K-SALT GLYPHOSATE
(1.43 L/ha)
+
COMMONLY USED 625 2,4-D
(1.34 L/ha)

15 MINUTES

As you can see, after only 15 minutes there is significant crystallisation in the 540 single k-salt glyphosate and 625 2,4-D mix.

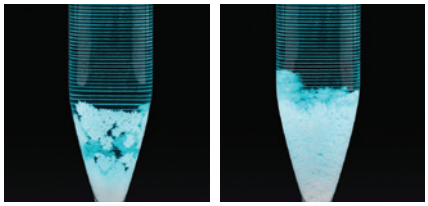
15 MINUTES

The Nufarm CRUCIAL and Amicide Advance 700 mix, remains clear with no crystallisation, and clearly shows Nufarm CRUCIAL'S outstanding compatibility, even in hard water. Fast forward 24 hours and the superior compatibility of Nufarm CRUCIAL and Amicide Advance 700 is evident, with no change since agitation.

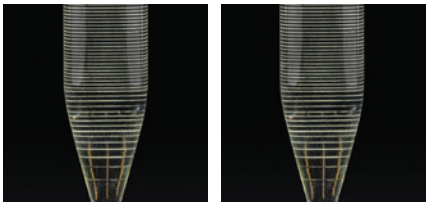
15 MINUTES

Like the 540 single K-salt glyphosate on the left, Roundup Ultramax and the 625 2,4-D also show significant crystallisation after just 15 minutes. This highlights the commonality between 540 and 570 single K-salt glyphosate formulations and their big weakness, compatibility.

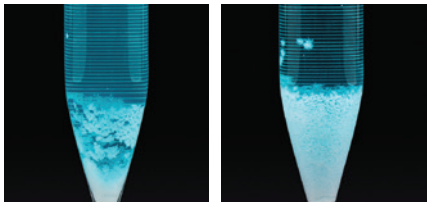
1 HOUR | 24 HOURS



1 HOUR | 24 HOURS



1 HOUR | 24 HOURS



Nufarm CRUCIAL compatibility testing results

- Products are listed in order of mixing
- All tested at 50L water per ha
- All water is hard water (3WHO - 1000ppm)

Products by name	Rate		Result
Boxer Gold®	2.5	L/ha	✓
CRUCIAL	1.3	L/ha	
Sakura®	118	g/ha	✓
CRUCIAL	1.3	L/ha	
Triflur X®	3.0	L/ha	✓
CRUCIAL	1.3	L/ha	
Avadex Xtra®	3.2	L/ha	✓✓
CRUCIAL	1.3	L/ha	
Balance®	100	gm/ha	✓
CRUCIAL	1.3	L/ha	
2,4-D Ester 680	800	mL/ha	✓
CRUCIAL	1.3	L/ha	
Rustler®	1	L/ha	✓
CRUCIAL	1.3	L/ha	
CRUCIAL	1.3	L/ha	✓✓
Kamba® 750	160	mL/ha	
Bromoxynil 200	1.5	L/ha	✓✓
CRUCIAL	1.3	L/ha	
Picloram 2,4-D	1.0	L/ha	✓✓
CRUCIAL	1.3	L/ha	
CRUCIAL	1.3	L/ha	✓✓
Amicide Advance® 700	1.2	L/ha	

Products by name	Rate		Result
CRUCIAL (refer label)	1.3	L/ha	×
Butisan®	1.8	L/ha	
Sentry®	50	gm/ha	✓✓
CRUCIAL	1.3	L/ha	
Associate®	8	gm/ha	✓✓
CRUCIAL	1.3	L/ha	
CRUCIAL	1.3	L/ha	✓✓
2,4-D Amine 475	1.7	L/ha	
Nufarm Liase	2.0	%V/V	✓✓
CRUCIAL	1.3	L/ha	
Sakura	0.2	Kg/ha	
Avadex Xtra	3.2	L/ha	✓✓
CRUCIAL	1.3	L/ha	
Oxyfluorfen 240	150	mL/ha	
CRUCIAL	1.3	L/ha	✓✓
Collide® 700	0.1	%	
Terrad'or	40	g/ha	
CRUCIAL	1.3	L/ha	✓✓
Banjo®	1	%	
Carfentrazone 600	32	mL/ha	
CRUCIAL	1.3	L/ha	✓✓
Banjo	0.5	%	

Products by name	Rate		Result
Terrain 500	700	gm/ha	✓
CRUCIAL	1.3	L/ha	
Banjo	0.5	%	

Key

✓✓ **Compatible with constant agitation**
- Tank mix good

✓ **Compatible with constant agitation**
- Tank mix may fail at high loads
- May have issues on standing (no agitation)

× **Not Compatible**
- Tank mixes badly
- Settles
- Breaks emulsions

Due to variability in the compatibility and quality of WG/WDG herbicide formulations commonly used in Australia, Nufarm recommends undertaking a compatibility test prior to mixing high application rates of WG/WDG herbicide formulations with Nufarm CRUCIAL. This testing should be undertaken with all products planned to be tank mixed. Most compatibility issues arise in mixes of 3 or more products. Nufarm does not support compatibility with brands other than those documented on the label and other marketing material.

Do not use primary filters finer than 50 mesh or inline filters finer than 80 mesh. Filters should be checked and cleaned after each tank load.

Nufarm CRUCIAL®

SAFETY AND STEWARDSHIP OF GLYSOPHATE

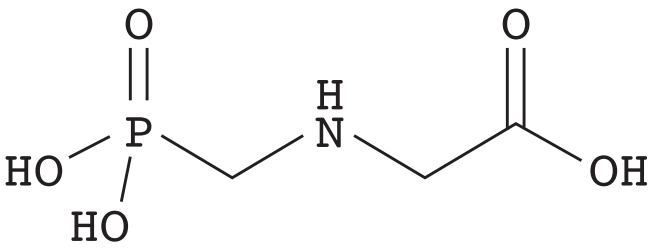
Who regulates glyphosate and how do they decide if it's safe?

Before any agricultural chemical product can be manufactured or sold it must be assessed and registered by the relevant regulator. Regulatory bodies in major agricultural markets are independent government bodies and product assessments are based on extensive review of scientific data.

Regulatory assessments typically include studies of residue, toxicology, eco-toxicology, environmental effects, product chemistry and efficacy studies. Regulators consider both published and unpublished scientific studies in determining whether a product is safe for use.

Based on their assessment, regulators decide whether to register the product, specify the conditions under which it is permitted for use, and prescribe specific safety precautions and warnings to be included on the product label.

Once a product has been registered for use, regulators have the right to reconsider the approval or registration at any time. Reconsideration may be initiated when new research or evidence raises concerns about the use or safety of the product.



Glyphosate molecular structure

The current regulatory view of the safety of glyphosate.

Independent regulators in every major agricultural market in the world have assessed the risks of glyphosate to humans and the environment. Without exception, these regulators have determined that glyphosate is safe to use in accordance with label directions.

Each of the regulatory agencies listed on the top right reviewed the registration of glyphosate following its classification by IARC as a probable carcinogen in 2015.

"The weight-of-evidence suggests there is no carcinogenic risk related to the use of glyphosate."

THE EUROPEAN FOOD SAFETY AUTHORITY (2015)

"The available scientific evidence did not meet the criteria to classify glyphosate as a carcinogen, as a mutagen or as toxic for reproduction."

THE EUROPEAN CHEMICALS AGENCY (2017)

"Glyphosate does not pose a cancer risk to humans when used in accordance with the label instructions."

THE AUSTRALIAN PESTICIDES AND VETERINARY MEDICINES AUTHORITY (2016)

"Glyphosate is unlikely to be genotoxic or carcinogenic."

THE NEW ZEALAND ENVIRONMENTAL PROTECTION AUTHORITY (2016)

"The overall weight of evidence indicates that glyphosate is unlikely to pose a human cancer risk."

HEALTH CANADA'S PEST MANAGEMENT REGULATORY AGENCY (2015)

"EPA continues to find that there are no risks to public health when glyphosate is used in accordance with its current label and that glyphosate is not a carcinogen."

THE UNITED STATES ENVIRONMENTAL PROTECTION AUTHORITY (2019)

"Based on studies currently available on glyphosate, there is evidence suggesting absence of carcinogenicity in humans."

THE BRAZILIAN HEALTH REGULATORY AGENCY ANVISA (2019)

Stewardship of glyphosate

Nufarm is committed to ensure that its activities present a high level of protection for the health and safety of its employees, customers, the public and the environment.

This is lived through one of Nufarm's four core values:
Responsibility:

We are accountable for our decisions and our actions. We recognise that trust is at the foundation of relationships and that acting ethically, safely and responsibly creates that trust.

It is important that anyone involved in any chemical handling activity with Nufarm products understands the formal documentation (APVMA Approved Product labels and Safety Data Sheets) that Nufarm provides with the product. This applies to product handling where activities include the storage, transport, handling and/or application of glyphosate.

For our growers, we defer to accredited training programs on the safe use of products.

These courses are delivered by Registered Training Organisations under the Australian Qualification Framework and are typically recognised under State and Territory legislation. We also support industry driven programs such as those designed to mitigate the risk of spray drift, delivered under Nufarm's Spraywise stewardship program as well as other providers.

Growers are legally required to follow all product label requirements, including safety directions established by the APVMA and additional statements required under relevant Work Health and Safety (WHS) laws. All Nufarm labels direct growers to Safety Data Sheets provided for each product which are available on our website.

Nufarm's chemical handling approach for every product encompasses:

- **Understanding product Safety Data Sheets and how to assess risk phrases and toxicology information;**
- **Review of the alternative routes of exposure for typical agricultural chemicals;**
- **Review and use of appropriate controls, Personal Protective Equipment and spill response measures;**
- **Understanding First Aid requirements for typical agricultural chemicals.**

Glyphosate and surfactants 101.

RULE 1.

Different salts of glyphosate have different inherent characteristics, as does each surfactant package.

RULE 2.

The performance of a formulation is always a function of the salt overlayed with a partner surfactant or surfactants.

RULE 3.

Getting one or a few attributes from a formulation is really quite simple;however, getting many attributes in a single formulation is extremely difficult.

Nufarm CRUCIAL. Your all-in-one formulation.

It's always been the same old story – you can get each feature in a certain formulation, but never all the features in the one formulation. That is, until Nufarm CRUCIAL.

Fig 1. Nufarm CRUCIAL

CHARACTERISTICS

- Revolutionary world first triple salt technology glyphosate
- Formulated using:
  - Potassium (K)
  - Monoammonium (NH)
  - Monomethylamine (MMA)
- Triple salt and perfectly matched robust surfactant package takes Nufarm CRUCIAL to a new unrivalled benchmark
- More glyphosate per litre
- 600 load
- Market-leading compatibility
- Widest ever label package of any glyphosate formulation, including in-crop over the top registrations.
- Outstanding efficacy
- Fast brownout
- Easy-to-use liquid formulation
- Viscosity equal to Nufarm's weedmaster ARGO
- Most advanced glyphosate technology ever!

The information and recommendations set out in this brochure are no substitute for professional or expert advice and are based on tests and data believed to be reliable at the time of publication. Results may vary, as the use and application of the products is beyond our control and may be subject to climatic, geographical or biological variables, and/or developed resistance. To the maximum extent permitted by law, Nufarm Australia Limited disclaims all warranties of any kind, whether express or implied, including but not limited to any warranty that the information is up-to-date, complete, true, legally compliant, accurate, non-misleading or suitable.

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Please refer to respective product labels for registered uses in specific crops.

For more information, contact your local Nufarm Business Development Manager

nufarm.com.au/product/crucial

Nufarm CRUCIAL®

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