TERRAD'OR

TECHGUIDE

Nufarm

AUSTRALIAN THROUGH & THROUGH

CUT THROUGH BROADLEAF AND GRASS WEEDS FAST, WITH AN EXPERT SPIKE HERBICIDE.

Outstanding broadleaf weed and annual grass control with no residual activity. Your new knockdown spike herbicide solution.

Through having worked side by side with growers for over 100 years, Nufarm is Australian through and through. We know how to help you get the most from your land, especially when the threat of weeds appears. Make Nufarm's Terrad'or your number one go-to for fast and effective control of broadleaf weeds and true activity on grasses. Plus with no residual activity, and short plant-backs to key crops, maximum yield potential can be maintained.

Nufarm

Terrad'or®

A non-selective spike herbicide that offers outstanding control of broadleaf weeds, and increased speed of brownout of a range of broadleaf and grass weeds prior to establishment of crops.

CHEMISTRY

The newly discovered active ingredient in Nufarm's Terrad'or is tiafenacil which is a PPO inhibitor - protoporphyrinogen oxidase-inhibiting herbicide and is therefore classified as a group 14.

There are several herbicide families classified as PPO inhibitors, and tiafenacil is part of the Pyrimidindiones family which contains the newer generation of group 14.

Group 14	Inhibitors of protoporphyrinogen oxidase (PPOs)
Diphenylethers	oxyfluorfen (Striker, Goal)
Triazolinones	carfentrazone (Nail, Unity, Hammer, Affinity, Aptitude)
Phenylpyrazole	pyraflufen (Ecopar, Pyresta*)
N-phenylphthalimides	flumioxazin (Terrain, Valor)
Pyrimidindiones	butafenacil (B-Power), saflufenacil (Sharpen), **tiafenacil (Terrad'or)**

Group 14 differ in selectivity on the basis of dose rate and their own chemical nature and ability to penetrate plasma membranes of different plant species.

At commercial rates some will be active on only broadleaf weeds whilst others on both broadleaf and grass weeds. Group 14 have limited translocation in plants and are often referred to as contact herbicides.

Nufarm's Terrad'or is a standout as it **has ability to penetrate plasma membranes of a wide range of weeds**, and has **activity on both broadleaf and grass weed species**. Penetration of plasma membranes is assisted with most group 14 chemistry if an oil is used.

HOW GROUP 14 HERBICIDES WORK

Group 14 herbicides inhibit the enzyme protoporphyrinogen oxidase in the chlorophyll biosynthetic pathway. This stops chlorophyll formation in weeds and enables formation of highly reactive molecules that attack and destroy lipids and protein membranes. When this occurs, cells become leaky and cell organelles dry and disintegrate rapidly.

Destruction of cell membranes results in a rapid browning (necrosis) of plant tissue. Visual symptoms in the plant appear rapidly as a burning or bleaching of the green tissue and can occur in one to two hours on a bright, sunny day.

SPIKE ACTIVITY

Nufarm has trialled most of the Group 14 actives available in the Australian market, which allows us to summarise trial data to form a representative comparison chart of the strengths and weaknesses between the products on individual weed species. The chart below represents this.

Weed Control Broadleaf activity - commercial 'spike' rates. Comparison on approx equivalent spike rates							
Active	400 g/L Carfentrazone	**700 g/L tiafenacil**	240 g/L Oxyflurofen	25 g/L Pyraflufen-ethyl	500 g/kg Flumioxazin	120 g/L Butafenacil	700 g/kg Saflufenacil
Brand	Hammer	**Terrad'or**	Striker	Sledge	Terrain	Butafenacil	Sharpen
Plant Back	NIL	**Nil Cereals 1 Wk Canola**	NIl	NIL	1 hr	1 hr	1 hr to 16 wks
Rate range	15-45 mL/ha	**15-40 g/ha**	75 mL/ha	50-160 mL/ha	30 g/ha	46-130 mL/ha	17-34 g/kg
Buckwheat (*Polygonum* spp.)	**	****	*	*	*	****	***
Capeweed (*Arctotheca calendula*)	***	****	**	**	**	***	****
Double gee (*Emex australis*)	***	****	**	**	**	**	****
Fleabane (*Conyza bonariensis*)*	**	****	*	*	*	***	****
Marshmallow (*Malva parviflora*)	****	*****	**	**	**	***	****
Medic (*Medicago polymorpha*)	***	****	*	*	*	**	***
Sowthistle (*Sonchus* spp.)	****	*****	**	**	**	****	*****
Stork's-bill (*Erodium* spp.)	***	***	**	***	**	***	****
Sub clover (*Trifolium subterraneum*)	***	*****	*	*	*	**	***
Tares / Vetch (*Vicia* spp.)	**	****	*	*	*	***	***
Volunteer canola (*Brassica nupus*)	****	*****	**	**	***	****	****
Wild radish (*Raphanus* spp.)	***	*****	**	**	**	****	*****
Wild turnip (*Rapistrum* spp.)	***	*****	**	**	**	****	*****
Wireweed (*Polygonum heterophyllum*)	***	***	*	**	*	***	***
Annual ryegrass (*Lolium rigidum*)	*	***	*	*	*	*	**
Barley grass (*Hordeum* spp.)	*	****	*	*	*	*	**

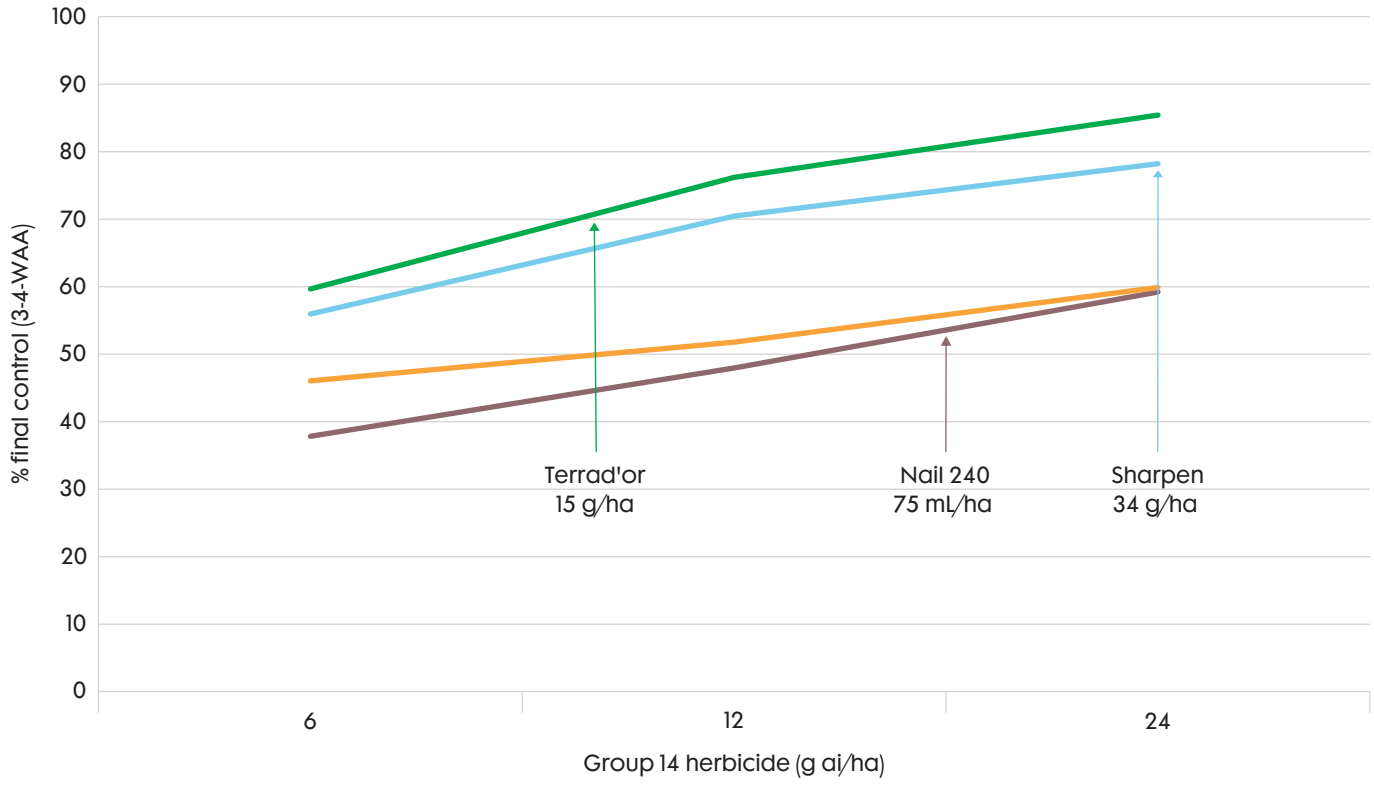
* Fleabane is a difficult weed to control, a 2 spray strategy should always be adopted, Most products above are not registered for the control.

*	No known activity	****	Excellent activity
**	Some activity	*****	Best choice
***	Good Activity		

One of the unique properties of Nufarm's Terrad'or is its higher activity per gram of active ingredient. This is easily summarised in the below graph.

The data from these 6 trials and across annual winter weed species that were present indicates that Nufarm's Terrad'or has the strongest activity.

Group 14 herbicides - Average Broadleaf Weed Control (6 trials / 10 weeds)



No glyphosate added
Bonza applied @ 0.5 % v/v with all treatments

Terrad'or
Butafenacil 120 g EC
Sharpen WG
Nail 240

Trial References: NUSN-13-306.01-H18, NUSN-13-306.01-H18, NUSA-13-306.01-H22, NSQ-13-306.01-H41, NUVC-13-306.01-H16, NUWA-13-3-H16

KEY WEEDS

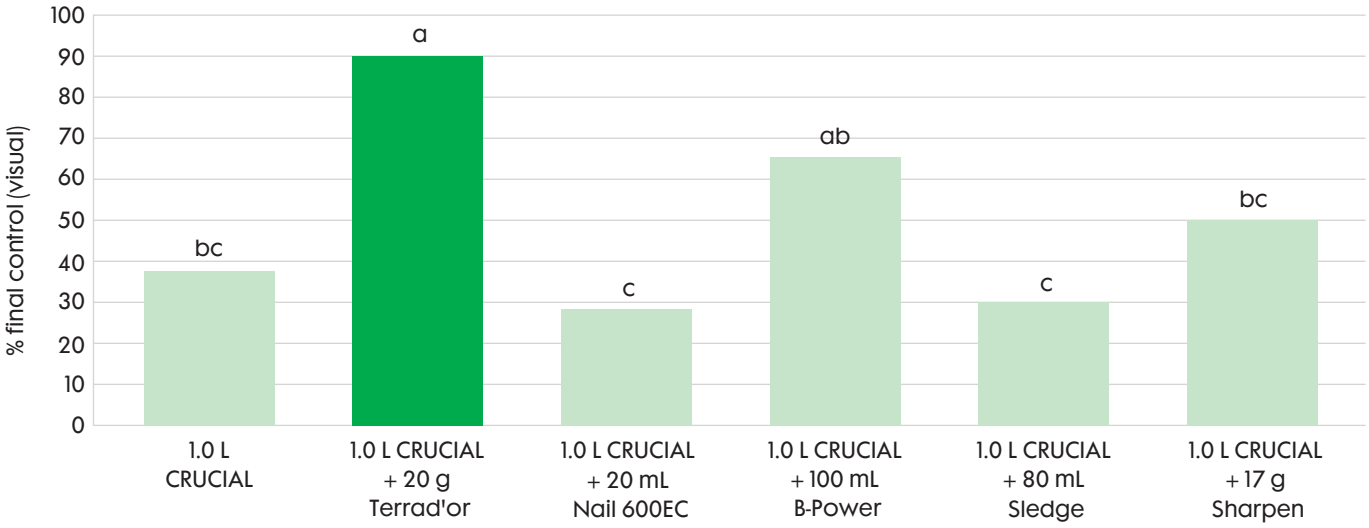
MARSHMALLOW CONTROL

One of the key weeds Group 14 chemistry is selected to assist control of is marshmallow. It is a particularly difficult weed to control especially when well established or when under stress. Nufarm has undertaken extensive trial work to understand the control of marshmallow and understands the difference in control between the different group 14 products.

The graph below represents a common situation, this site had marshmallow that was under stress and had also been grazed. The data shows that in these situations 100% control is very difficult to achieve, but it clearly highlights the difference between the strengths of the products.

Nufarm's Terrad'or controlled 90% of the population. That level of control, would allow a follow up with a sequential spray, cultivation or another management tool to enable full control.

Marshmallow* % Control (27DAA)



*Marshmallow was stressed and heavily grazed

Trial Reference: NUVC-20-21340500-H20 #1

Terrad'or @ 20 g/ha

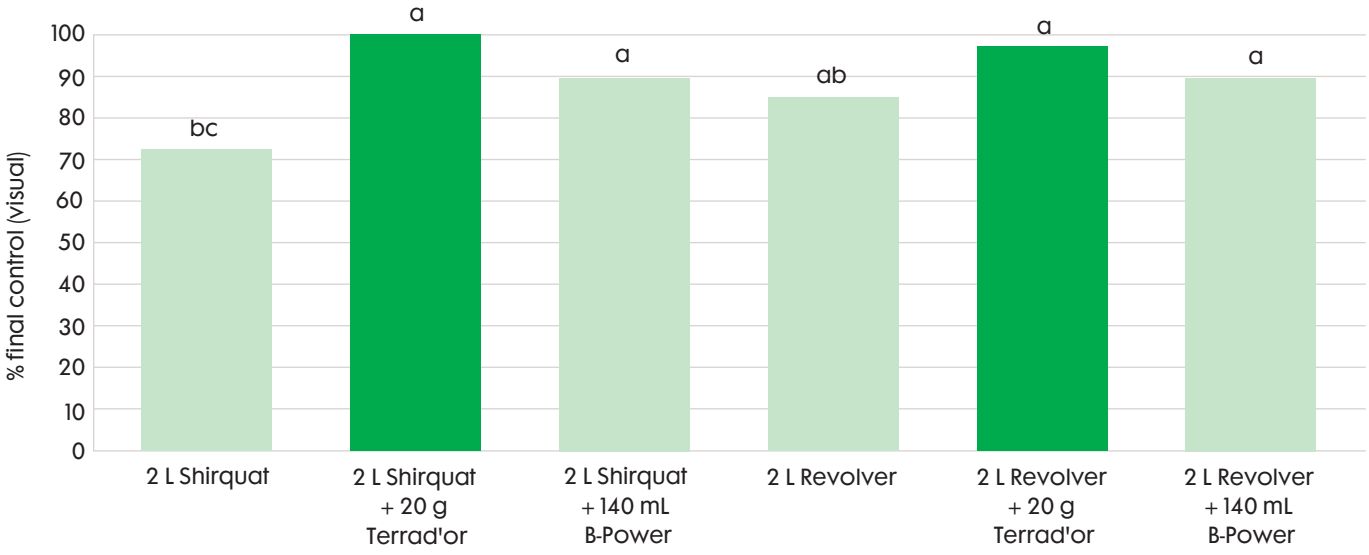
B-Power @ 100 mL/ha

Hammer 400 @ 30 mL/ha

With the increasing concern of glyphosate resistance, adoption of alternative chemistry is increasing. The main alternatives being used are Paraquat based products. Nufarm's Terrad'or is an excellent tank mix option with all non-selective herbicides (Paraquat, Glufosinate, Amitrole etc), and compliments well with these by increasing the final control of many broadleaf weed species, while also offering extra activity on grass weeds that may be present.

The graph below shows the increase in control of marshmallow when Nufarm's Terrad'or is tank mixed with Nufarm's Shirquat (Paraquat) and Revolver (Paraquat & Diquat)

Marshmallow* % Control (22DAA)



Trial reference: NUSA-20-21340500-H01

TRIAL PHOTOS

8 DAA SHIRQUAT + TERRAD'OR

UTC

Shirquat @ 2 L/ha

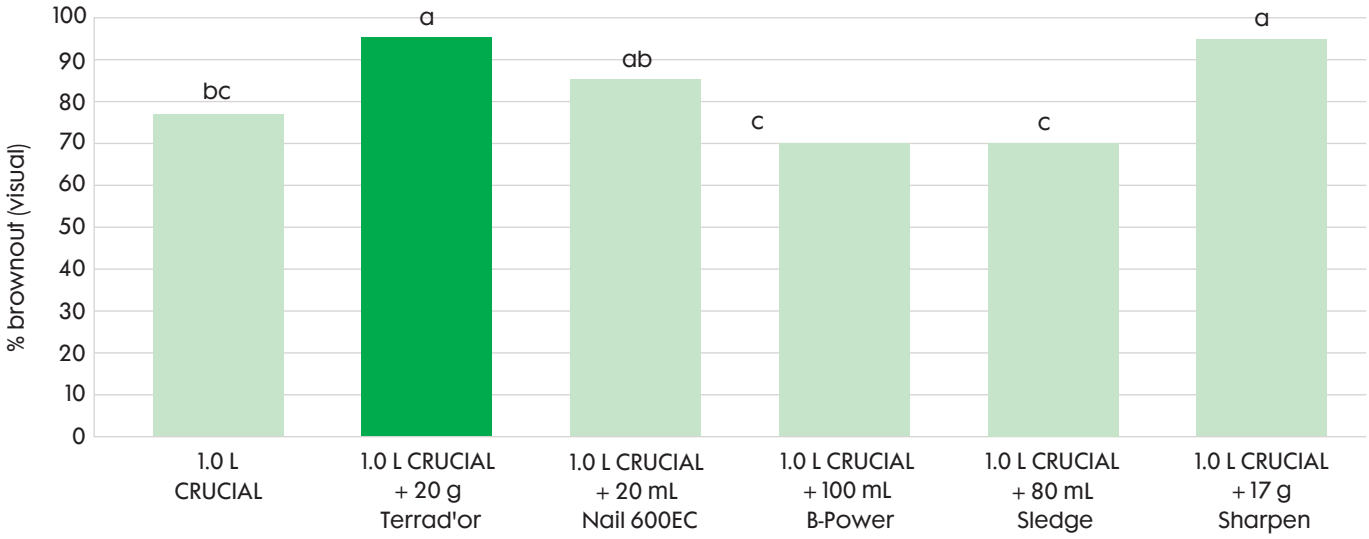
Shirquat @ 2 L/ha + 140 mL/ha B-Power

Shirquat @ 2 L/ha + Terrad'or @ 20 g/ha

VOLUNTEER PULSE & PASTURE LEGUME CONTROL

Getting effective control of pasture legumes and volunteer pulses during Autumn knockdown is difficult, the choices that are available often are not very effective or have significant plantback restrictions. Nufarm's Terrad'or is a great choice, with excellent efficacy on both clover, medic, and vetch species. Its very short plantback also enables it to be used close to sowing.

Clover % Brownout at 14 DAA

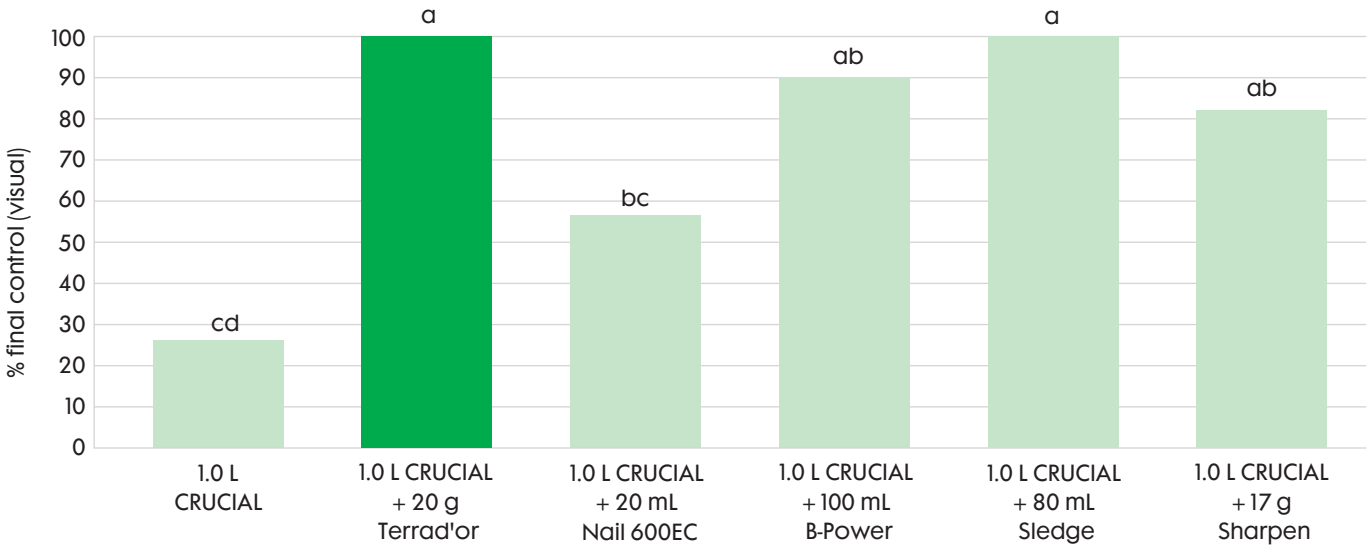


Trial Reference: NUVC-20-21340500-H19 #1

ERODIUM – STORKSBILL CONTROL

Often growers and advisors select the Group 14 spike chemistry to try and control erodium, because using straight glyphosate products is not effective. This weed often germinates in late summer, and is well established by the time the paddock is ready for autumn knockdown, which can also make the Group 14 chemistry less effective. As erodium becomes established the leaf cuticle thickens and develops a shiny surface which makes penetration more difficult. Nufarm's Terrad'or in conjunction with Nufarm's Banjo can penetrate this leaf cuticle more effectively than some other Group 14 chemistry. This is demonstrated in the trial results below.

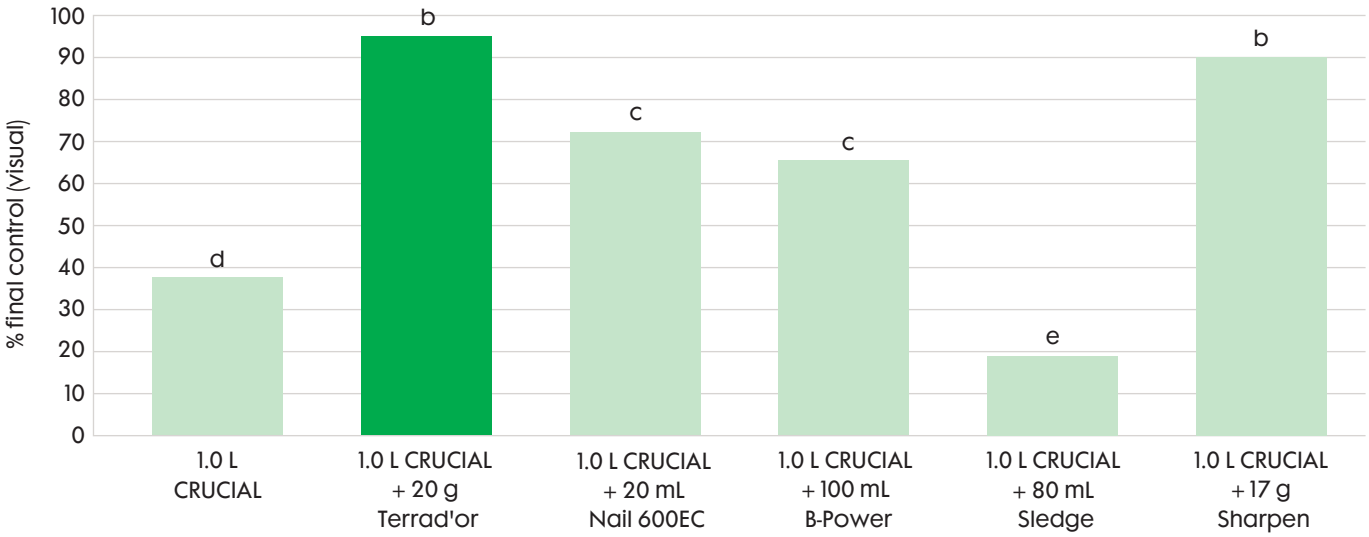
Erodium % Control (28DAA)



Trial Reference: NUVC-20-21340500-H19 #1

SHEPHERD'S PURSE CONTROL

Shepherd's Purse % Control (21DAA)



Trial Reference: NUSN-20-21340500-H30 #1

GRASS CONTROL

With glyphosate resistance becoming a wider problem especially with some key grass weeds such as Annual Ryegrass, herbicides with alternative modes of action should be considered. Group 14 actives with grass activity could be useful to help in the management of resistant weeds, if used wisely. There are no recorded cases of weeds resistant to Group 14 herbicides in Australia.

Nufarm has worked with a number of key researchers to understand the benefit that Nufarm's Terrad'or could have to help assist in the management of Annual Ryegrass resistance. Dr Peter Boutsalis and Dr Sam Kleeman from Plant Science Consulting undertook trials on known glyphosate resistant populations of Annual Ryegrass to understand if Nufarm's Terrad'or could assist in it's control. Roberto Busi has undertaken further work to understand the enhanced grass activity of Nufarm's Terrad'or.

From this work, along with extensive field work across Australia, we had enough data to be able to prove that, a tank mixture of Nufarm's Terrad'or 40 g/ha and Nufarm CRUCIAL provides higher levels of Annual Ryegrass control where populations have a low level of glyphosate resistance; compared to glyphosate standalone.

The true fit for Nufarm's Terrad'or as a glyphosate resistance management tool is in paddocks that have no known resistance, or that have a very low level of glyphosate resistance.

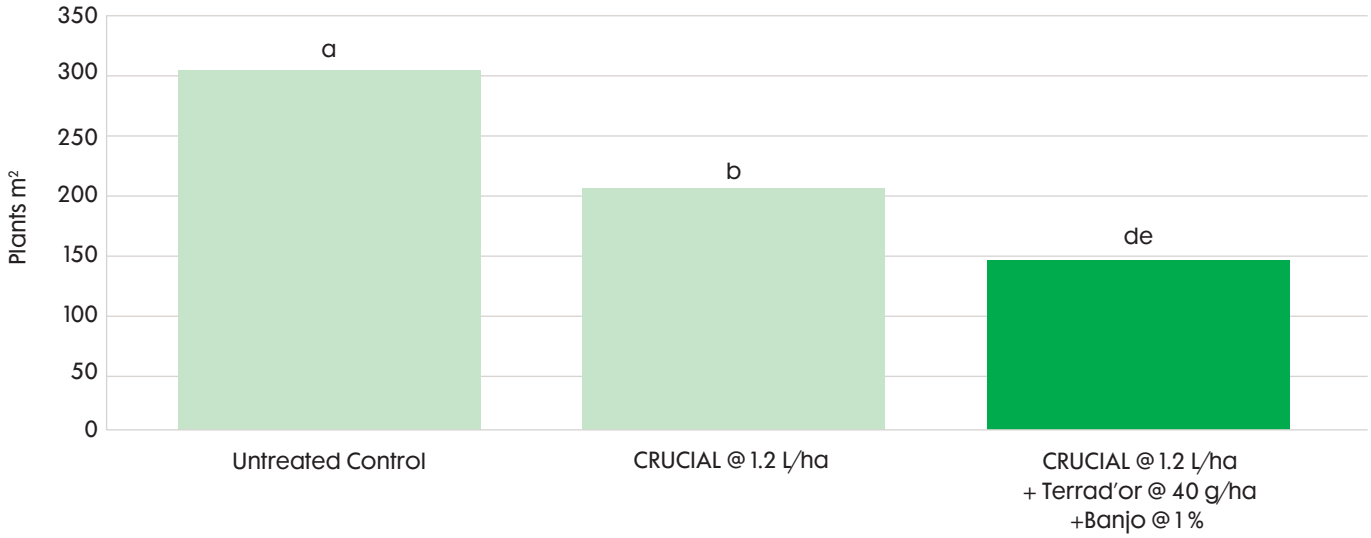
Annual Ryegrass resistance often starts from only one or two plants within a population in a paddock. These individual plants will often survive the "traditionally" used dose of glyphosate and be present within the crop and set seed, slowly increasing the number of plants that have the resistant mutation within the paddock. If growers add Nufarm's Terrad'or to their Nufarm CRUCIAL they have a higher chance of controlling those individual plants, and therefore minimising the risk of increasing glyphosate resistance across the paddock.

From several field trial data sets a multi trial analysis was undertaken and below is the result from these trials conducted on populations with low to moderate glyphosate resistance

These field trials had an average population of 304 Plants/m^2, and when Nufarm CRUCIAL was used at 1.2 L/ha the average population was reduced to approximately 207 plants/m^2. However, a further 67 plants/m^2 were able to be controlled where Nufarm's Terrad'or 40 g/ha was added to the same rate of Nufarm CRUCIAL.

A tank mixture of 40 g Nufarm's Terrad'or and Nufarm CRUCIAL provides higher levels of final control to annual ryegrass plants with a weak level of glyphosate resistance; compared to applications of glyphosate standalone.

Annual Ryegrass Plants / m² (20-23DAA)



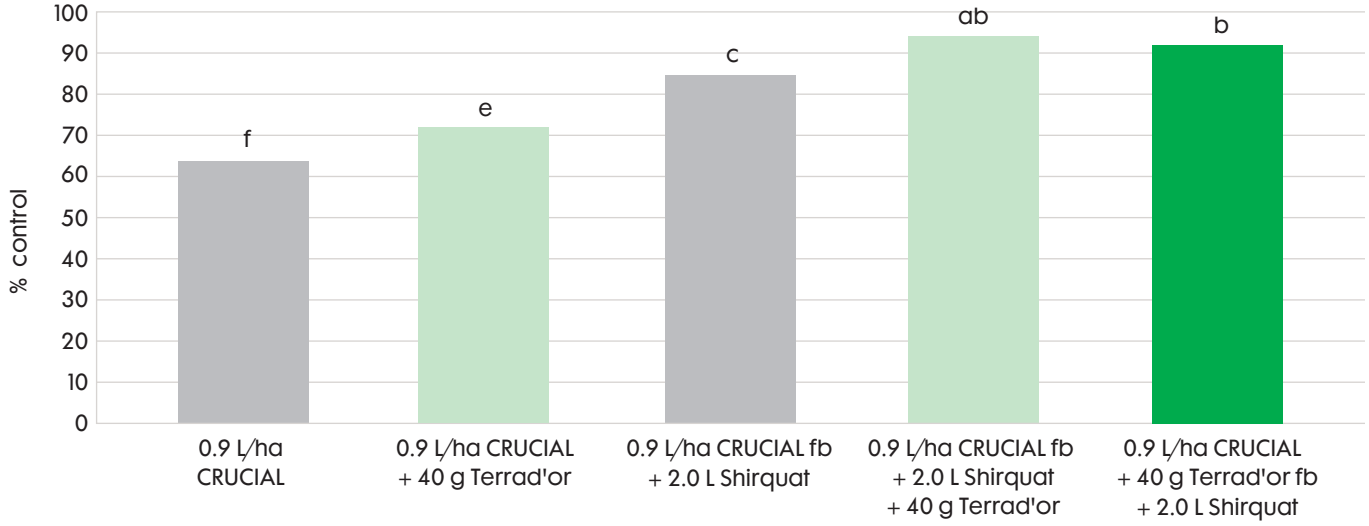
Field Trials conducted on populations with low to moderate glyphosate resistance.

Trials conducted on populations with weak to moderate glyphosate resistance. Different glyphosate rates used due to varying levels of glyphosate resistance Trial references: NUSA-20-21340500-H06, NUSN-20-21340500-H07, NUWA-20-21340501-H03, NUVC-20-21340500-H03

DOUBLE KNOCK – ANNUAL RYEGRASS CONTROL

The double knock strategy – applying glyphosate in the first pass, followed by a second pass with paraquat – is the most optimal strategy in the battle against glyphosate resistance in annual ryegrass. The addition of 40g Nufarm's Terrad'or in the double knock, in either the first or second pass, significantly improves ryegrass control compared to the traditional double knock. Nufarm's Terrad'or added to paraquat in the second knock consistently achieves the highest levels of control.

Annual Ryegrass Control - Multi-Trial Analysis – 2021 (21DAA)

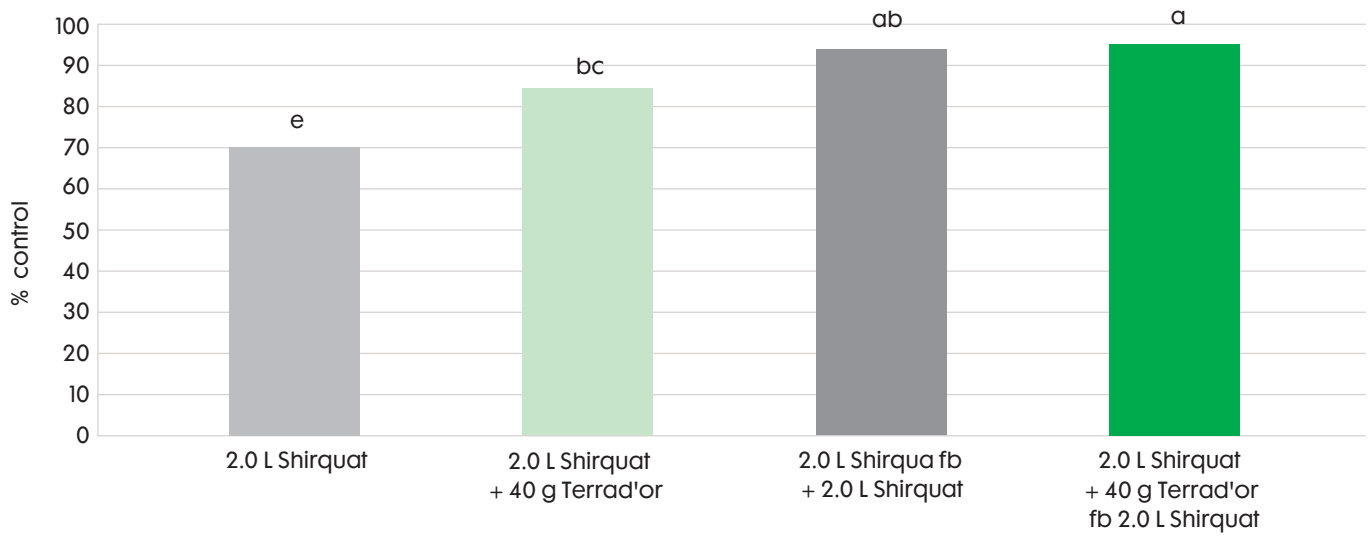


Trial References: NUWA-21-21340500-H01, NUSN-21-21340500-H02, NUVC-21-21340500-H12, NUSA-21-21340500-H15

Standalone paraquat applications make a viable alternative to glyphosate for the control of annual ryegrass in some situations. However, the addition of 40 g Nufarm's Terrad'or to paraquat can significantly improve final control of annual ryegrass compared to paraquat standalone.

A paraquat double knock, featuring sequential sprays of paraquat, can be improved with the addition of Nufarm's Terrad'or in the first pass. The standout treatment was 40 g Nufarm's Terrad'or + paraquat followed by a double knock of paraquat and had significantly improved final control of annual ryegrass compared to paraquat followed by paraquat.

Annual Ryegrass Control - Multi-Trial Analysis – 2021 (21DAA)

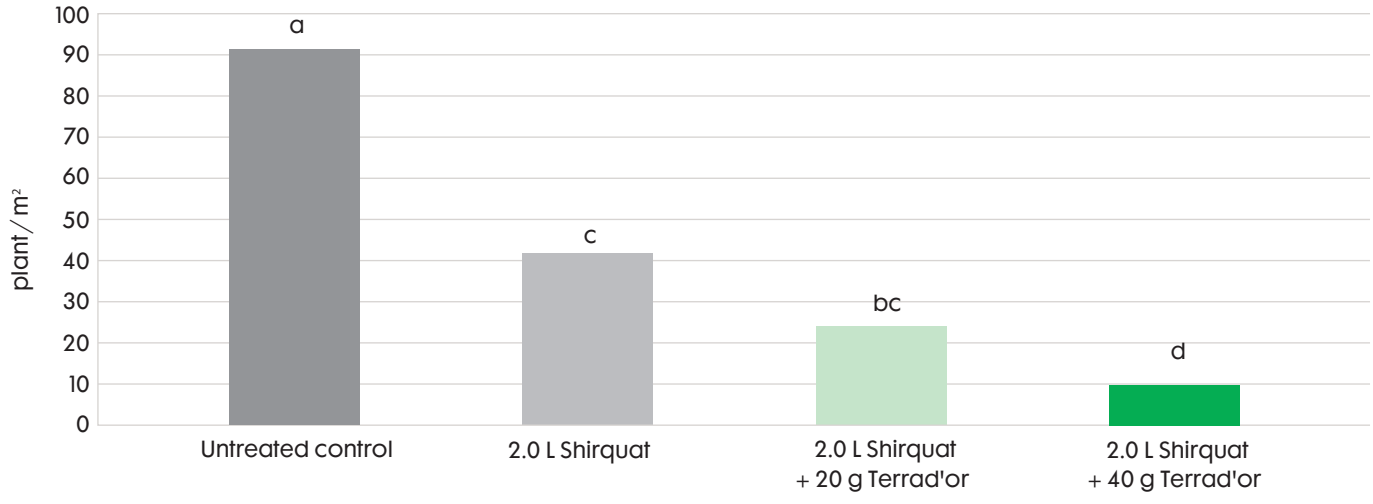


Trial References: NUWA-21-21340500-H01, NUSN-21-21340500-H02, NUVC-21-21340500-H12, NUSA-21-21340500-H15

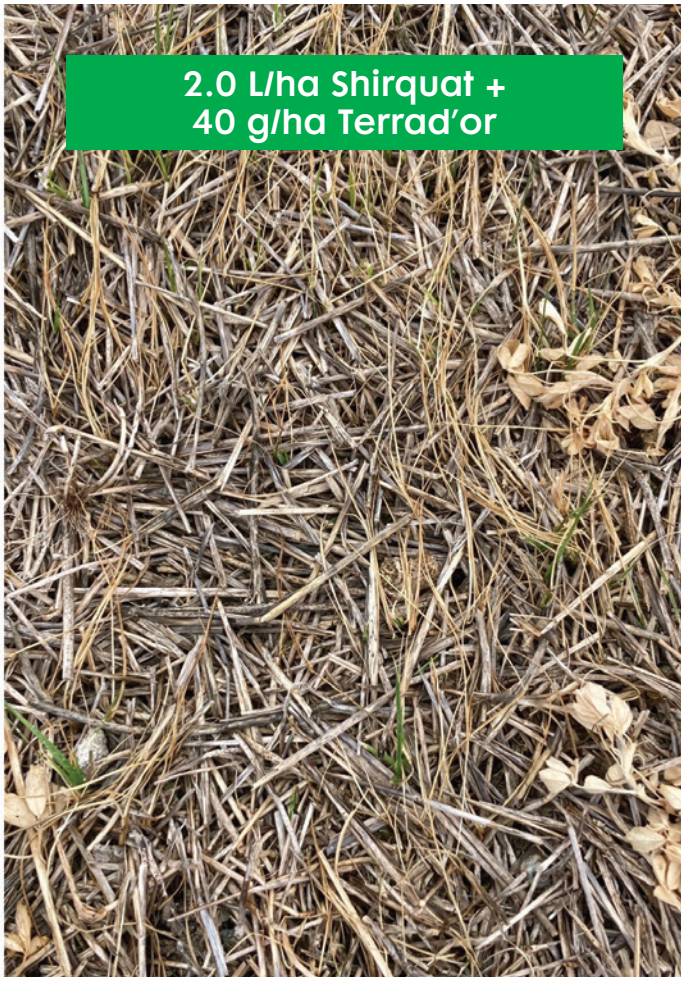
Annual ryegrass is also developing paraquat resistance and an effective way to assist in the management of resistance in paddocks is to include multiple modes of action in each herbicide application. The trial below shows the benefit of the addition of Nufarm's Terrad'or to paraquat where a population of ryegrass had confirmed paraquat resistance.

Paraquat Resistant Annual Ryegrass Control – Keith SA 2021 (16DAA)

Herbicide	Herbicide Group	Paddock Sample Carew Road	
		Survival	Rating
Paraquat 1.6 L/ha + 0.2% BS1000	Group L	20	R
Paraquat 2.4 L/ha + 0.2% BS1000	Group L	15	R



Trial Reference: NUSA-21-21340500-H18



There are a number of grass weeds that Nufarm's Terrad'or has good activity on and these include:

Annual Ryegrass *(Lolium rigidum)*

Barley grass *(Hordeum spp.)*

Volunteer wheat *(Triticum aestivum)*

Wild oats *(Avena spp.)*

RESISTANCE

Although Nufarm's Terrad'or can be another tool to help manage and prolong the use of non-selective's, it is strongly recommended resistant management strategies are adopted. A great strategy is to use the Weedsmart big 6.

1. Rotate crops and pastures
2. Double knock – to preserve glyphosate
3. Mix and rotate herbicides
4. Stop weed seed set
5. Crop competition
6. Harvest weed seed control – the holy grail

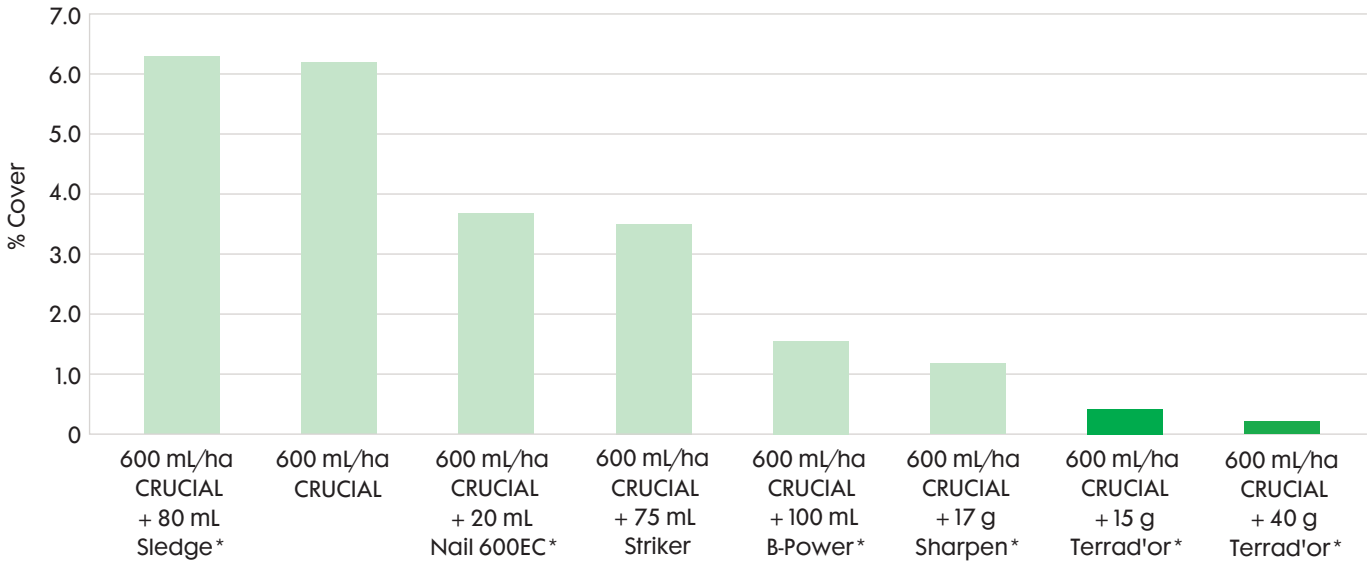
WEED smart
every weed every seed
every farm every year

NDVI CONFIRMS VERY LOW REGROWTH IN NUFARM'S TERRAD'OR TREATMENTS

Normalized Difference Vegetation Index or NDVI is a digital imaging process that can distinguish between photosynthesizing vegetation and dried or non-photosynthesizing plants, based on their reflection of red and near infrared light (NIR). Green plants reflect much of the near infrared light and very little of the red light, while brown plants reflect more red light and less near infrared light. By taking the ratio of red and near infrared reflectance an index of "vegetation greenness" can be defined. A low NDVI value indicates the plant is brown or there is very little plant material present, while a high NDVI value indicates there is significant green plant material present.

NDVI imagery was taken across a trial site in South Australia 38 days after treatments were applied. The NDVI data clearly shows the different amount of green material present from regrowth within the different group 14 plots, Nufarm's Terrad'or shows the least regrowth of all treatments. The site contained the following species Vetch, Medic, Canola, Barley Grass, Ryegrass.

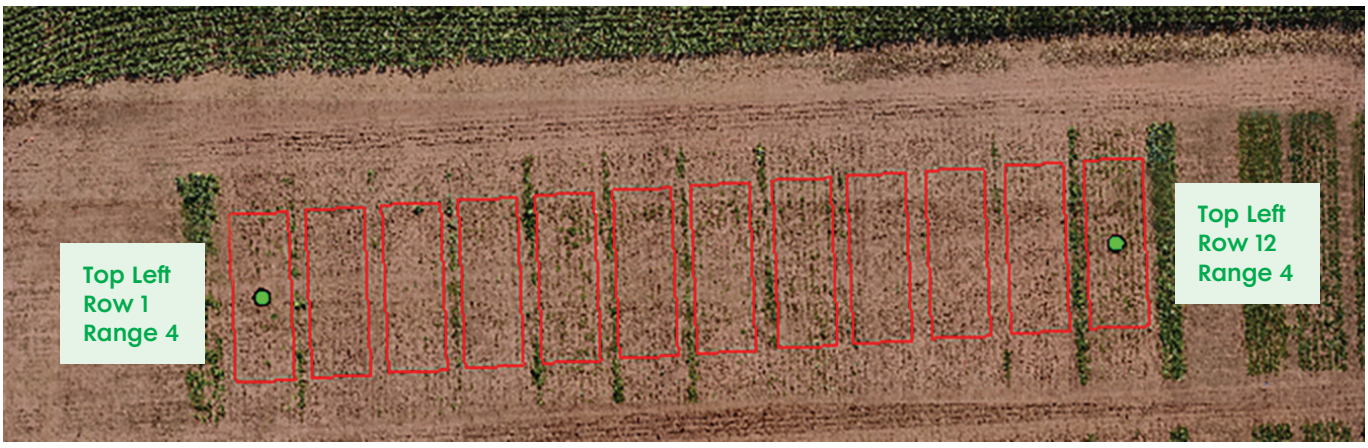
Canopy Cover % (38DAA)



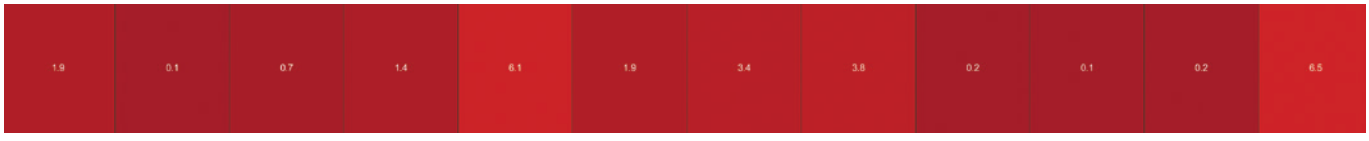
* Included 1 % Banjo

Trial Reference: SA2020 Revees Plains

AERIAL IMAGE OF SPRAYED PLOTS 38 DAA



NDVI Processed image of each plot



RATES AND COMPATIBILITY

15-40 g/ha + 1% Banjo® Spray Adjuvant

Nufarm's Terrad'or can be used as a standalone herbicide for the control of certain weeds at 20-40 g/ha + 1 % Banjo Spray Adjuvant, however best field results will occur when used in conjunction with a non-selective herbicide such as Nufarm CRUCIAL, weedmasterDST or ARGO, Shirquat, Revolver, Biffo. At 15-40 g/ha + 1 % Banjo Spray Adjuvant

For knockdown applications of broadleaf weeds during good Autumn conditions, Nufarm's Terrad'or as a spike with Nufarm CRUCIAL at 15 g – 25 g would be adequate for control for small young weeds.

Applications for control of weak glyphosate resistant Annual Ryegrass a rate of 40 g/ha must be used for consistent results.

Addition of Nufarm's Banjo Spray Adjuvant at 1.0 % v/v must always be used with Nufarm's Terrad'or 700WG.

Rainfast after 1 hour of daylight after application to seedling annual weeds when used with Nufarm's Banjo or with Nufarm CRUCIAL and Nufarm's Banjo (for other mixtures, refer to tank mix partner label for rainfastness information).

COMPATIBILITY

To broaden the weed spectrum Nufarm's Terrad'or may be tank mixed with Nufarm CRUCIAL, weedmasterDST or weedmasterARGO, Shirquat, Revolver, Biffo, Amitrole T, Amicide Advance 700, Estercide Xtra 680, Kamba 750, or Comet 400, Bromicide 200, Diurex, Kyte, TriflurX, Avadex Xtra, Tomahawk, Terbazine.

Nufarm

Terrad'or®

PLANT BACK AND RESIDUAL ACTIVITY

Nufarm's Terrad'or does not have any residual activity at labelled rates. The active ingredient tiafenacil has a rapid degradation rate, it is not tightly bound to soil particles and is therefore readily available for microbial breakdown.

To reduce risk it is advisable to also adhere to the following: Sow following crops with a seeder that will move treated soil away from crop row (e.g. knife point with press wheels). Use of seeding machinery, or planting under conditions where product or treated soil remains or moves back into the crop row may result in crop damage. This is particularly important for susceptible crops such as canola.

DO NOT apply post-sowing pre-emergent.

A number of trials have been conducted to determine plantback periods for most crops. As per the table below.

1 hour		1 week	2 weeks	4 weeks	6 weeks
• Wheat • Barley • Oats • Lupin • Chick pea	• Field pea • Corn • Sorghum • Faba bean • Lentil	• Canola (15–20 g/ha rates only)	• Canola (21–40 g/ha rates only)	• Mung bean	• Cotton

CRITICAL INFORMATION

Product type and formulation	Wettable granule (WG)
Active ingredients	Tiafenacil 700 g/kg WG
Registered use	Knockdown spike for broadleaf and grass weed control
Use rate	15 - 40 g/ha
Rainfast	1 hour
Preferred water volume	Apply in a minimum of 80 L/ha.
Product pack size available	500 g, 5 kg

#1 Nufarm would like to acknowledge Aglink for the contribution of some of the data contained within this document.

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/terrador

Nufarm Terrad'or®

049888r09