

USER GUIDE FOR THE PRODUCTION OF GENETICALLY MODIFIED MAIZE

*Effective stalk borer control
with Yieldgard® maize*

*Optimum weed control in
Roundup Ready® maize*



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Legislation

The GMO Act, Act 15 of 1997 (which regulates the use of genetically modified crops), the Plant Improvement Act, Act 53 of 1976, and the Plant Breeders Rights Act, Act 15 of 1976, all regulate the use of Roundup Ready® soybean. Consequently it is an infringement of the law to:

- plant Roundup Ready® or Yieldgard maize without a valid, signed license agreement with the patent holder, Monsanto South Africa (Pty) Ltd
- be unaware of, or disregard the license conditions. (Please take note of the penalty clauses contained in the license agreement, which may be applied should the agreement conditions not be met).



EFFECTIVE CONTROLL OF STALK BORER WITH YIELDGARD®-MAIZE



*Your most deadly enemies
- the maize stalk borers!*

Wherever maize is produced, the two stalk borers (*Busseola fusca* and *Chilo partellus*) rob farmers of some of their production.

It's known that damage from maize stalk borers can cost growers from 6% to 30% of their yield.

Borers feed on all parts of a maize plant – leaves, stalk, sheath, ear collar, shank and ears – causing damage, reducing the flow of water and nutrients throughout the plant, thereby reducing the yields.

Damage and losses to growers in South Africa run into hundreds of millions of rands.

Maize farmers have to battle two or three generations of borers each season.

The standard chemical methods of controlling stalk borers can be time-consuming and ineffective, often because of the successive infestation during the season.

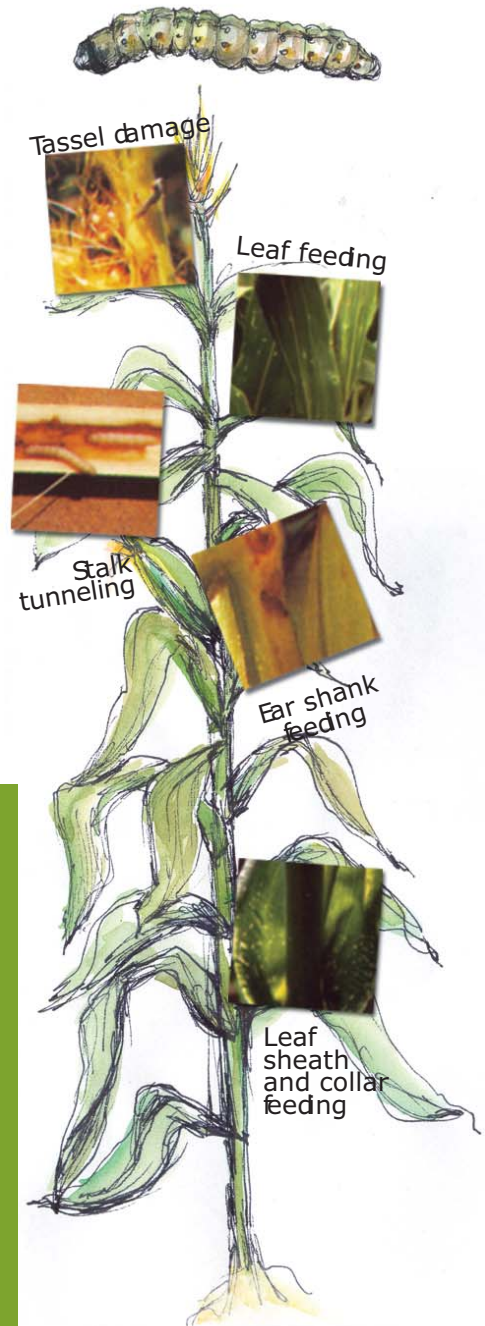


So, timing is crucial with narrow application windows in order to be effective. Multiple applications are necessary to suppress succeeding generations.

Even so, season long control of maize stalk borers is unlikely.

*Introducing
YieldGard™ Insect
protected maize:*

The first BT-maize that protects the stalk, leaves, sheaths and ears against *Busseola fusca* and *Chilo partellus*.





Better protection and higher yields through Biotechnology

For any grower, the bottom line is yield. The better you can protect your crop against yield-robbing insects, the bigger the payoff. Now you can make maize production more profitable, with healthier plants and higher yields than ever before.

With Monsanto's new gene technology YieldGard™, season long maize borer protection is contained within the maize plant itself.

How YieldGard™ protection works

The protection comes from a naturally occurring soil bacterium called *Bacillus thuringiensis*, or Bt.

With Monsanto's advanced biotechnology, this Bt-gene becomes part of the maize plant itself, where it produces a protein that the maize stalk borer simply can't digest. From the first bite, the protein binds to the receptors



in the insect stomach, causing a breakdown of the lining. After a few bites, the maize stalk borer stops eating and dies within 72 hours.

But the real reason that Bt is so effective is that it provides protection throughout the plant, throughout the season.

For emergence to maturity it is effective everywhere the borers feed. Through multiple generations of borers YieldGard™ provides protection from planting to physiological maturity. Your crop has the chance to reach its full potential. However, a heavy infestation of maize borers just after flowering may lead to slight damage. Spraying may be required in the case of late planting.

Putting a price to productivity

YieldGard™ is your insurance against constant damage by stalk borers. For example, if you have an infestation that reduces yield by 15% (easily possible), and you harvest 3 tons per hectare, you're missing out on 0.45 tons/hectare. If maize prices are at R1000 a ton, that's a total loss of R450 on every hectare. The economic value of YieldGard™ lies in the fact that it reduces application costs of insecticides, reduces labour, reduces lodging and protects yield and quality. So you can see that the protection of YieldGard™ pays for itself many times over.

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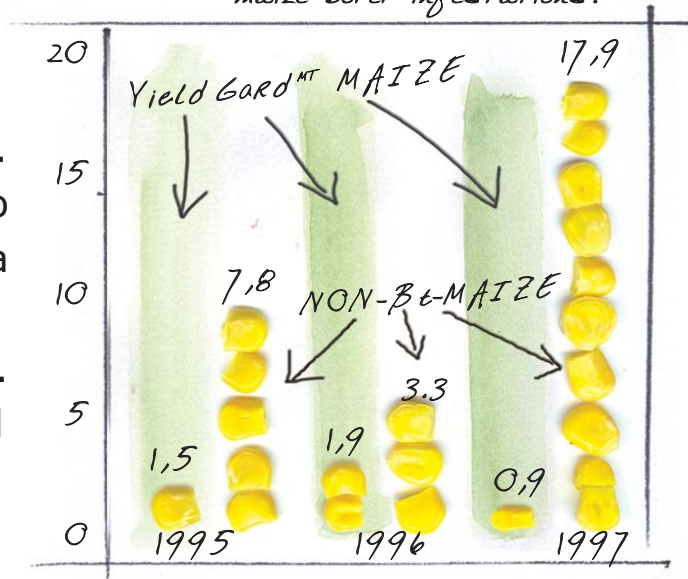


*Healthier, more productive,
higher-yielding maize*

When maize is protected from stalk borers, optimal levels of vital nutrients and water are available to produce higher yields. That's vitally important in years of adverse weather, such as the frequent semi-drought conditions of South Africa.

Broken stalks and lodged plants caused by stalk borers are no longer a problem. This all adds up to more maize and a more productive farming operation. Independent field tests indicate a yield increase of

Number of infected kernels per ear:
Source: 1995-97 Iowa State University Research, natural European maize borer infestations.





10% to 30% with YieldGard™, and more that 95% control of stalk borers (*Busseola fusca* and *Chilo partellus*).

By controlling maize stalk borers less damage appears on the ears of maize plants. This means that there are fewer sites available for fusarium to grow. Fusarium fungi produces toxins – the most important one being *fumonisin*. The ears on YieldGard™ have less fusarium-

YieldGard™ and Safety

Importantly, this Bt-protein acts only on a very narrow insect range – certain lepidopterans – which include maize stalk borers. Except for these Bt-sensitive insects, no living organism has those specific receptor sites. So Bt-protein keys cannot work in any other living organism's stomach, just as a cassette tape can't work in a CD player.

Bt has no effect on anything but these insects – not on other insects, or birds, fish, animals or humans. Fewer insecticide applications also result from the use of YieldGard™. Apart from the general benefit to the enviroment, you and your farmworkers are less exposed to hazards of insecticides.



The best hybrids are being developed with YieldGard™ technology

Improving maize with the YieldGard™ gene does not mean missing out on some other genetic advantage. With YieldGard™ the best maize borer control is added to the best hybrids, allowing these hybrids to reach their full yield potential.



*The key to a higher-yielding future:
Insect Resistance Management*

Mother Nature, through the constant shuffling of genes, is good at producing resistance. Our researchers believe that the best way to prevent resistant populations arising is to combine effective control in the target area with a nearby refuge. This is an area where strictly non-Bt maize is planted, and no Bt-based insecticides may be used. Within this refuge, susceptible maize borers may feed and breed without being exposed to the Bt protein. While this may not sound like a good



idea, it preserves a population of borers that is still susceptible to the Bt-maize protection. When members of this population mate with tolerant insects that may emerge from the YieldGard™ protected fields, their susceptible genes dominate any tolerant genes in the overall gene pool.

The farmer is ensuring that a small but very important population of susceptible insects is close enough that susceptible insects can survive and overcome any resistance that might develop.

The "Refuge": Managing insect resistance

Follow these simple steps to effectively control maize borers with YieldGard™:

1. Plant YieldGard™ maize for effective control of maize borers.
2. Within seven days after planting of YieldGard™ maize, plant a nearby refuge of conventional non-Bt maize with a growth season of the same period as the YieldGard™. This ensures a safe refuge where non-resistant borers can survive and counteract any potential resistance.
3. The refuge area must be on the same land and be

B.

planted under the same growing conditions as the YieldGard™.

4. Non Bt-based insecticides may be used in refuge areas. In the case of Option A other registered insecticides may be applied. In Option B, no insecticides may be applied.
5. Monitor and scout your fields frequently. If you detect 10% or more leaf damage due to maize borers immediately contact your Monsanto rep, seed dealer or technology consultant.
6. For more specific information, also contact the above.



10. Refuges and Resistant Management

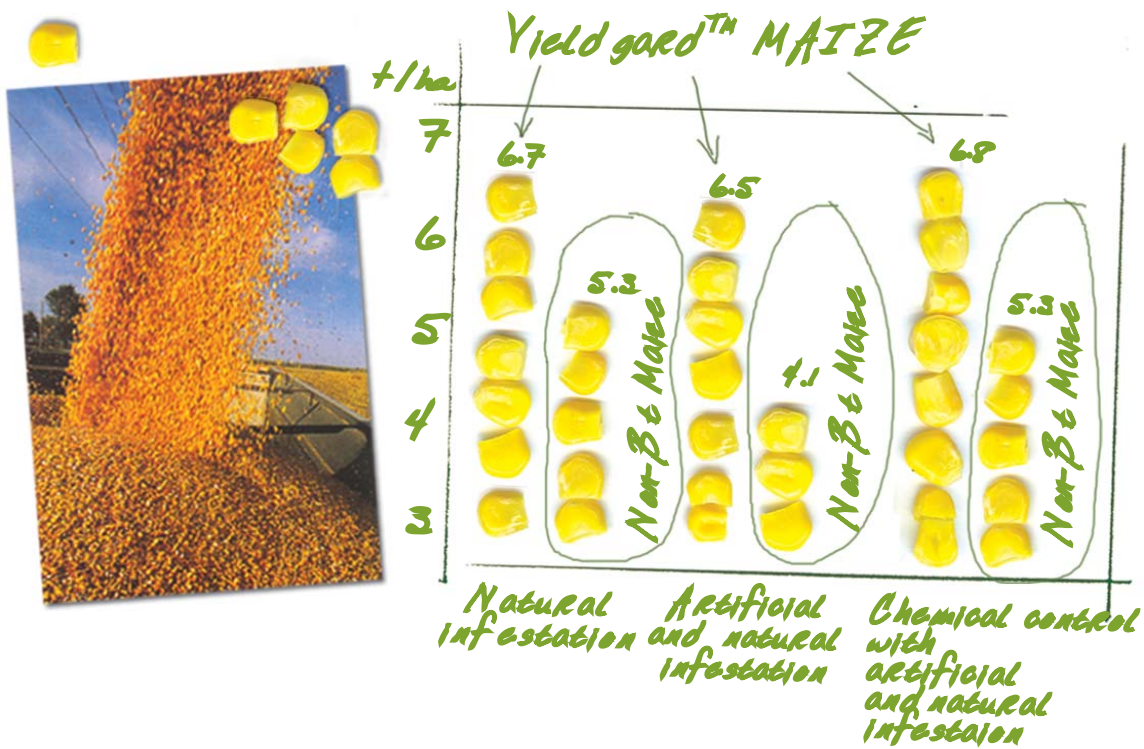
R Resistant

S Susceptible



Yield Data

Source: S. Afr. Tyaskn Plant Grand 1999, 16 (D)



Isolating your Bt-maize plantings:

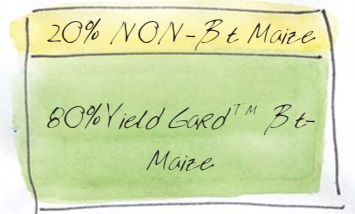
To help prevent cross-pollination of Bt-maize with non-Bt maize specifically cultivated for Bt-free contracts, the following steps are recommended:

1. A "time-isolation" differential of not less than three weeks between the flowering period of the YieldGard™-maize and non-Bt maize. This will ensure that pollination of the separate areas will occur at different times.



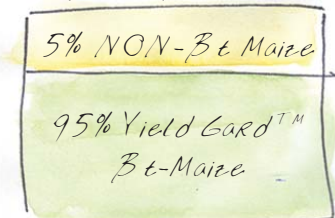
2. A separation of at least 400m between land planted with YieldGard™ and any areas planted with non-Bt maize. This is to discourage cross-pollination as, for instance, can occur between white and yellow maize.
3. The combination of both of the above. The practice described in (2) generally limits cross-pollination but is no guarantee. Factors such as strong wind and insects can effect cross-pollination over distances

Option A: 80/20



20% of the area of land given over to YieldGard™ must be planted with non-Bt maize within 100 metres of the YieldGard™ plantings. Example: For every 80 hectares planted with YieldGard™, also plant 20 hectares of maize that does not contain the YieldGard™ gene. This maize can be treated with insecticides (excluding those with Bt-containing substances) registered for the control of maize borers *Busseola fusca* and *Chilo partellus*.

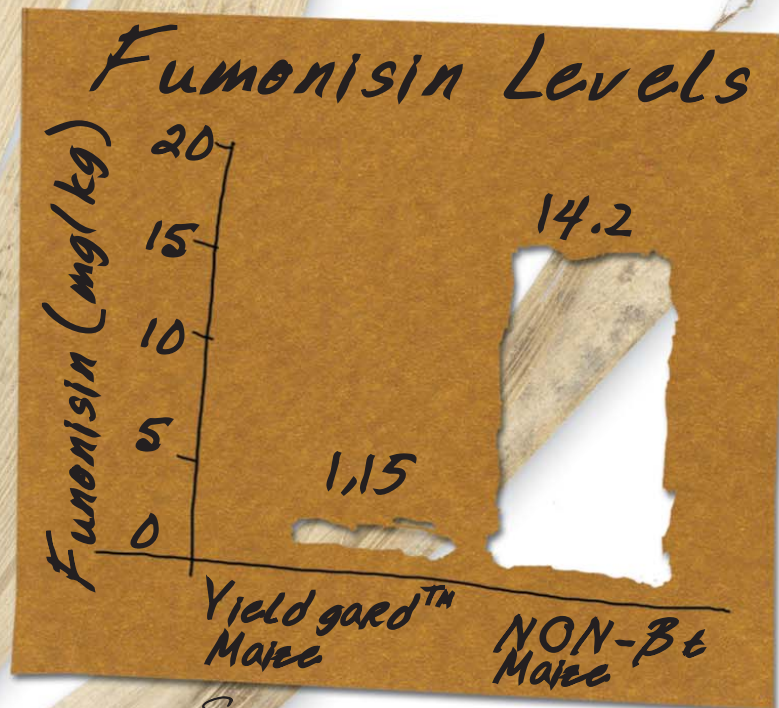
Option B: 95/5



5% of the area given over to YieldGard™ must be planted with non-Bt maize. Example: For every 95 hectares planted with YieldGard™ maize, plant 5 hectares of non-Bt maize without the YieldGard™ gene. This maize may not be treated with any insecticide registered for the control of maize borers *Busseola fusca* and *Chilo partellus*.



NON-Bt Maize vs. Bt Maize



Source: 1995-97 Iowa State University Research, natural European maize borer infestations



Eight excellent reasons to choose YieldGard™:

The most important motivation in maize farming is generating optimal profits. Crop protection with YieldGard™ offers:

- The first effective control of maize stalk borers that lasts from planting to physiological maturity throughout the plant.
- Healthier plants that are better able to withstand adverse weather (drought), and disease.
- Simplicity in crop management and stalk borer control.
- Reduced handling of, and exposure to insecticides.
- Cost savings in insecticides and applications.
- Time labour savings, especially during busy summer months.
- Better grain quality – less mechanical damage and fusarium infections to ears.
- Peace of mind – with much of the worry taken out of management. .
- Verminderde hantering van enblootstelling aan insekdoders.

USER GUIDE ROUNDUP READY® - MAIZE



Introduction

The launch of Roundup Ready maize introduced the South African farmer to a totally new strategy in the battle against weeds. This new technology changes the existing concept of weed control in maize. It is therefore essential that the producer understands the value of this technology and how it works, to obtain the optimum result.

Legislation

It is of the utmost importance that the producer should take note of the legislation regulating the production of Roundup Ready maize on page.... of this guide before buying any seed for production.

Why is Roundup Ready so unique?

These cultivars are genetically modified to enable the farmer to spray Roundup Ready herbicide (L6702), a non selective herbicide, over the top of the crop up to and including the true 8 leaf stage without causing any damage to the maize.. After the 8 leaf stage only **directed (hooded) spraying is approved.**



Benefits of the Technology

- Roundup Ready® herbicide (containing glyphosate) is one of the most effective broad spectrum, non selective herbicides available on the market. This makes it possible to control most weeds with one or two applications.
- This unique quality presents unsurpassed versatility to the farmer – gone are the days of spraying within the limits of a certain period or in restricted circumstances e. g. moisture content or temperature.
- Because Roundup Ready herbicide has no residual activity there is no waiting period and follow up crops may be planted directly after the application of the herbicide.

Guidelines for the application of the Herbicide

NOTE: This guide is not a substitute for the Roundup Ready herbicide label – adhere strictly to the guide lines on the herbicide label to ensure success. Roundup Ready herbicide is registered for use on Roundup Ready crops including Roundup Ready maize. This herbicide contains a unique surfactant system formulated to enable the active ingredient, glyphosate, to be absorbed immediately and to be translocated to the roots of the weed without damaging the maize plant.

Traditionally glyphosate products contain surfactants that damage and burn the leaf surfaces of targeted



weeds. Roundup Ready technology means that for the first time, the herbicide is sprayed directly over the crop. "Softer" surfactants in the Roundup Ready herbicide formulation ensure that crop leaf surfaces are not damaged, and plant stress, which can lead to a yield reduction, is avoided..

By using the correct product the optimal yield potential is ensured. Monsanto does not accept any responsibility for any damage to Roundup Ready crops sprayed with any glyphosate formulations other than Roundup Ready herbicide.

Weed control programmes

Regional differences in climate and other factors, means that crop plant density, weed density and weed spectrum differs from farm to farm. It is therefore very difficult to recommend one specific weed control program that will be suitable for all regions and practices. With the introduction of Roundup Ready maize, Monsanto implemented a series of herbicide trials in combination with Roundup Ready herbicide in the different production areas. The results of these trials are available within



each region. Recommended weed control programs were established based on these trial results, however, it is ultimately only the grower who has an intimate knowledge of his own weed spectrum and production practices (e.g. planting density and row width). The grower is therefore the person who should ultimately decide on a specific program. Monsanto's herbicide distributors are also available for advice.





If all the different variables are taken into account three main weed control scenarios can be identified:

- Where the plant density and soil moisture is high, such as under irrigation or in the eastern production areas, weed competition is at its highest early in the season often with difficult to control weeds like Yellow Nutsedge. For this scenario the recommendation is a tank mix of Roundup Ready herbicide and safened acetochlor (Guardian S) at planting, followed up with a spray of Roundup Ready herbicide before the weeds reach a height of 10 cm.
- The second scenario is where the plant density is lower and problem weeds germinate later in the season, typically in the western production areas. In this situation a spray with Roundup Ready herbicide after planting and before weeds are 10 cm high, is followed up by a tank mix of a acetochlor (Harness®) and Roundup Ready herbicide, again before weeds reach a height of 10 cm. This program extends the period of effective control to take care of late germinating weeds.
- The third combination is applied in a reduced tillage or irrigation situation, where planting densities are high, and where the seedbed is not disturbed by tilling. High planting density, such as under irrigation provides for shading of weeds which reduces emergence and growth. For this scenario an initial application of Roundup Ready herbicide before weeds reach a height of 10 cm, followed up with a further Roundup Ready spray (again before flushing weeds reach a height of 10cm) will normally be sufficient.

• Irrespective of which scenario applies, weed pressure should be monitored throughout the season. Under emergency conditions, or where weed control is not acceptable, additional applications of Roundup

Ready herbicide may be made. Consult your Monsanto agronomist or herbicide agent under these conditions.

Note that after the 8th leaf stage of the maize crop, applications of Roundup Ready should be directed at the base of the plant, and not applied "over the top".

It is clear that no single program for every weed situation. A very wet season may demand alterations to the program. Monsanto chemical agents and Monsanto seed representatives and agronomists are well trained to assist growers with the application of this technology and should be consulted when advice is required.

What can go wrong with the application of this technology?

1. Low efficacy:
 - Poor water quality
 - Wrong dosage for the weed spectrum
 - Incorrect use of residual herbicides
 - Incorrect spray volume/ nozzles/poor calibration
2. Crop damage
 - Wrong glyphosate formulation
 - Spray in the whorl after the 8 leaf stage (i.e. "over the top" after the 8 leaf stage)
3. Spray drift
 - Roundup Ready herbicide is not registered for aerial applications
 - Do not spray if the wind speed exceeds 10kmh. Check with your neighbour as to the proximity of non Roundup Ready crops, and do not spray when conditions are not optimal.

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The Roundup Ready® Label

NOTE: The following information is not a substitute for the recommendations on the Roundup Ready® label. Always read the Roundup Ready label before spraying.

Supplementary information to the Roundup Ready® herbicide label for Roundup Ready® Maize

A. Broadcast application

Broadcast (over the top) applications can **ONLY BE APPLIED FROM THE GROUND CRACKING STAGE UP TO THE V8 STAGE. THIS STAGE IS REACHED WHEN THE FIRST PLANTS IN THE FIELD HAVE 8 LEAVES WITH CLOSED COLLARS AROUND THE STEM.**

Do not make broadcast applications if mechanical crop damage due to the passing of the spray rig may occur. **BROADCAST APPLICATION AFTER THE V8 STAGE MAY RESULT IN CROP LOSS OR DELAYED MATURITY.** If follow up sprays for the control of a specific weed e.g. Yellow nutsedge (*Cyperus esculentus*) is necessary it may not occur within 10 days of the previous application. If the maize have already reached the V8 stage, a post directed (see below) application must be used.



B. Post directed spray

Post directed sprays after the V8 stage can be made where row spacing allows the passage of the spraying equipment without damage to the maize crop. Row spacing of 150cm and 210cm will most probably be the best for tractor mounted spray rigs.

C. Pre-plant, pre-plant incorporated, pre-emergent and post-emergent applications

Roundup Ready herbicide treatments may be applied to Roundup Ready hybrids in combination with Guardian S, Lasso® MT, or Bullet® as a pre-plant applications for residual weed control. Please follow the recommendations on the label of the manufacturer.

Roundup Ready herbicide treatments may be applied to Roundup Ready hybrids in combination with Harness® or Lasso MT as a post-emergent application for residual weed control. Please follow the recommendations on the label of the manufacturer.

D. Tank mixes for Roundup Ready herbicide in Roundup Ready maize

Roundup Ready herbicide may be applied for pre-



emergent treatments in tank mixes with Guardian S or Lasso MT or with Harness or Lasso MT for broadcast post emergent and directed applications. Please follow the recommendations on the label of the manufacturer.

Roundup Ready herbicide may NOT be used in a tank mix with Atrazine. Roundup Ready herbicide is NOT registered for aerial application.

GENERAL RECOMMENDATIONS FOR THE USE OF ROUNDUP READY® HERBICIDE

- ROUNDUP READY herbicide must be applied in a maximum water volume of 125 l/ha. Ensure an even droplet distribution on the target leaf surfaces. Avoid spraying to the point of run-off from the target leaf surfaces. (At volumes of 100 to 125 l/ha, run off should not be a concern).
- A minimum of 1,5 % ROUNDUP READY solution in the total spray volume must be adhered to.
- Please ensure that the spray equipment is free of rust, dust or sediment from other chemicals.
- Do not spray if the wind speed exceeds 10 km/h.
- Do not spray if the relative humidity is less than 40%.
- Do not apply Roundup Ready if the weeds are dormant, covered with dew, dust are under stress or damaged by frost.
- Always use good clean quality water. Soil particles and organic material will neutralize the glyphosate.



- Make sure that the water is slightly acidic (pH 4-6.5). Always buffer the water with a product like Bladbuff® 5 before adding the Roundup Ready® herbicide.
- The addition of 2% Ammonium sulphate neutralizes the effect of hard water.
- Use the correct spray nozzles (e. g. XR Teejet 11002VK) and spray pressure to ensure optimal coverage of the weeds.

Rain or irrigation within two hours of application will reduce the efficacy of the herbicide.

The Grower License Agreement OR Monsanto Technology Agreement

The Grower Licence Agreement (GLA) or Technology Agreement contains the terms and conditions of sale for inter alia Roundup Ready maize. The grower must obtain and sign a GLA, before purchasing Roundup Ready maize. To avoid patent infringements. With the signing of the GLA the grower acknowledges that he has read and understood the conditions. The GLA also serves as a discount voucher for the purchase of Roundup Ready herbicide. The PLO contains five different coloured carbon copies of the agreement:

24.



*White copy - Monsanto copy
Yellow copy - Monsanto seed representative copy
Pink copy - Roundup Ready discount voucher
Green copy - Agrochemical agent copy
Blue copy - Producer copy*

*Discount Program:
Roundup Ready®-herbicide*



To encourage the producer to use the correct glyphosate formulation (Roundup Ready herbicide, L6702) on Roundup Ready maize, a discount program has been introduced. This program makes it possible for the producer to buy Roundup Ready herbicide at a discount, and based on the number the number of hectares planted with Roundup Ready maize. Roundup Ready is only distributed by agents of Qwemico, Technichem and Wenkem.

The program works as follows:

1. The grower purchases Roundup Ready maize seed and completes a GLA with the Monsanto seed representative.
2. The Monsanto seed representative determines how many hectares of Roundup Ready maize will be planted with the purchased Roundup Ready maize seed.
3. The Monsanto seed representative calculates how many



liters of Roundup Ready herbicide is needed for two applications of 2.5 liter per hectare (e.g. 10 hectares x 5 liter per hectare = 50 liter). This number of liters is filled in on the GLA in Section B.

4. The grower takes the remaining copies of the GLA to the agchem. agent to purchase the number of liters indicated on the GLA at the determined discount for that season. Discount can only be given for a maximum of five liters per hectare planted with Roundup Ready maize.
5. The agchem. agent must record on the pink, green and blue copy of the GLA the number of liters sold and supplied at the discount. The producer must sign to acknowledge that the product was received in a good condition.

Resistance Management

Any given weed population may include individuals with natural resistance to Roundup Ready herbicide or any other Group G Herbicide. Growers must consult the Roundup Ready label for information on resistance management. Any weed control failures should be reported immediately to Monsanto



All care was taken to assure the correctness of all the information in this document. Should you require any further information, please contact Monsanto at telephone (011) 790 8200, or e-mail: hendrik.kruger@monsanto.com

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