

USER GUIDE

FOR THE PRODUCTION OF

YieldGard[®], Roundup Ready[®] Corn 2 and YieldGard[®] with Roundup Ready[®] Corn 2



Effective stalk borer
control with YieldGard[®]
maize.



Overall weed control
with Roundup PowerMAX[®]
in Roundup Ready[®] maize.



Success lies in one solution.



May 2012

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LEGISLATION

The Genetically Modified Organisms (GMO) Act (Act 15 of 1997), GMO Amendment Act (Act 26 of 2006), the Plant Improvement Act (Act 53 of 1976), the Plant Breeders Rights Act (Act 15 of 1976), the South African Patents Act (Act 57 of 1978), and the South African Trade Marks Act (Act 194 of 1993), amongst others, all have a bearing on the use of YieldGard[®], Roundup Ready Corn 2[®] and YieldGard[®] with Roundup Ready[®] Corn 2.

Consequently it is unlawful to:

- plant YieldGard[®], Roundup Ready[®] Corn 2 and/or YieldGard[®] with Roundup Ready[®] Corn 2 without a valid, signed Monsanto Technology and Stewardship Agreement ('the agreement');
- breach or disregard the terms of the agreement;
- not comply with this User Guide; and
- breach the terms and conditions of the permits issued in respect of the YieldGard[®], Roundup Ready[®] Corn 2 and YieldGard[®] with Roundup Ready[®] Corn 2.

LEGISLATION

In the premises, the user recognises, acknowledges and accepts that:

- the permits set strict conditions subject to which the seed has to be cultivated and planted;
- if the permit conditions are not adhered to, the permits may be withdrawn, which would result in significant irreparable harm to Monsanto, other seed companies and the Agricultural Sector of South Africa;
- non-compliance with these conditions by users may cause the development of weed resistance against glyphosate and insect resistance against the technology;
- the user, Monsanto and other seed companies are obliged to take all reasonable steps to limit the risk of weed resistance against glyphosate and insect resistance against the YieldGard® maize and YieldGard® with Roundup Ready® Corn 2 developing; and
- compliance with the Insect Resistance Management Programme (IRMP), Weed Resistance Management Programs (WRMP) and User Guides is an essential and imperative requirement of the agreement. The user shall therefore strictly comply with the letter and spirit of the IRMP, WRMP and User Guides in respect of the seed of each type of crop, as provided for herein.

YieldGard® maize, Roundup Ready® Corn 2 and YieldGard® with Roundup Ready® Corn 2 are protected by patents and/or conditional release permits in South Africa and elsewhere.

What is YieldGard® maize?

YieldGard®, or MON 810 to give it its “event” name, was introduced commercially in South Africa in 1998. This event produces one *Bt* protein in *Bt*-maize plants. When stalk borer larvae feed on MON 810 *Bt*-maize plants, they ingest the protein, which kills the larvae after about 72 hours. This *Bt*-protein is very specific to certain lepidopteran caterpillars, including the maize stalk borers, but is generally harmless to other insects and animals. Since 1998, farmers have become accustomed to using YieldGard® (MON 810) technology.

Why is Roundup Ready® Corn 2 so unique?

These hybrids are genetically improved to enable the user to spray Glyphosate, eg. Roundup PowerMAX®, 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 spraying directed onto weeds is allowed. Roundup Ready® hybrids are recognised with the suffix “R” or “BR” behind the name.

PRODUCT STEWARDSHIP

Control of insect pest populations by means of genetically modified crops only emerged in 1996 (www.isaaa.org). Through modern biotechnology, the introduction of a gene from *Bacillus thuringiensis* (*Bt*) enabled protection of crop plants against economically important pests. Experience with the use of insecticides, showed that effective Insect Resistance Management (IRM) strategies would also be required with genetically modified insect tolerant crops to prevent or delay the onset of resistance in the target insect species. Research by industry as well as academic scientists over the past decade has improved the understanding of the major elements of an IRM strategy for *Bt* crops.

These elements include –

1. Knowledge of pest biology and ecology;
2. Gene deployment strategy;
- 3. Refugia to support the development of *Bt* susceptible insects;**
- 4. Monitoring and reporting of incidents of pesticide resistance development;**
- 5. Employment of integrated pest management practices;**
6. Communication and education plan;
7. Development and deployment of products with alternative modes of action ; and
8. Actions to be taken if localised insect resistance occurs after commercial introduction of insect protected maize.

The introduction of YieldGard® in South Africa in 1998 gave South African farmers the first taste of “Product Stewardship” and “Insect Resistance Management”. To some extent, implementation of refugia has been successful, in that only after a decade of intense use, has some evidence of resistance to YieldGard® become apparent in certain areas. It should also be mentioned that better implementation of refugia during this period would probably have lengthened the effective use of YieldGard® in all maize production areas and it is for this reason that the implementation of refugia will be strengthened and monitored more intensely. The Insect Resistance Management Strategy for this technology encompasses all of the above elements.

Refugia to support the development of *Bt* susceptible insects

A refuge area is a part of the farm that is strictly planted with non-*Bt* maize, and is not sprayed with *Bt* based insecticides. It is an area where stalk borers are never exposed to *Bt*, and where stalk borer deaths do not occur as a result of *Bt*. Under such conditions the selection pressure for *Bt* resistance is negligible, and the individual stalk borers that emerge from a refuge are almost all susceptible to *Bt* technology.

A refuge area is a necessary and integral component of the IRM strategy. For YieldGard® to kill all the susceptible stalk borers in a population, as well as the individuals that carry the resistance characteristics, it is necessary to continually “replenish” the numbers of susceptible individuals. The purpose of a refuge is exactly this – to replenish that part of the population of stalk borers that are susceptible to YieldGard®. If replenishment did not occur, the proportion of susceptible stalk borers would decrease rapidly (due to the YieldGard®) and soon the entire population would consist of individual stalk borers that were tolerant to YieldGard®. Planting a refuge ensures that susceptible stalk borers are produced in enough numbers to reproduce with tolerant individuals, thereby producing the next generation of susceptible stalk borers. Planting a refuge each season is thus critically important to ensure the long-term efficacy of YieldGard®. Failure to plant refugia will result in stalk borers becoming resistant to YieldGard® and users having to resort to increasing dependence on insecticides.

Another important aspect of successful refugia implementation is continuous monitoring of the maize crop and stalk borer populations. Frequent scouting/monitoring will enable users to step in and apply insecticides the moment it appears that stalk borer populations are NOT CONTROLLED by YieldGard®. Timely and accurate application of a suitable insecticide under these circumstances will reduce the proportion of tolerant stalk borers and delay the onset of resistance.

Planting of refugia on farm requires careful planning and compliance with guidelines and “rules”, which are described in this Product User Guide and the agreement.

Monitoring and reporting of incidents of pesticide resistance development

Compliance with the IRM strategy and in particular compliance with the refuge requirements will be monitored through –

- on-farm compliance monitoring by an independent third party; and
- general compliance monitoring at individual seed company level during user visits.

In order to assist with compliance monitoring, and in terms of the agreement, the user shall permit, allow and assist Monsanto and/or its representatives within normal business hours subject to at least 48 hours prior arrangement to:

- inspect land farmed by or under the control or the direction of the user (including refuge areas);
- monitor compliance with this agreement, the IRMP, WRMP and the User Guides;
- examine, take and analyse samples of crops, crop residue or seed of any nature located therein;
- take photographs and video material, GPS readings, and make copies of relevant documentation under the control or direction of the user; and
- complete a compliance report.

Monitoring and reporting of incidents of pesticide resistance development

Further to facilitate on-farm compliance with planting of refugia, licensee/sub-licensee selling YieldGard® technology will ensure that the following steps are carried out:

- No YieldGard® (or YieldGard® with Roundup Ready® Corn 2) seed will be ordered or delivered on farm without the user having signed a valid Monsanto Technology and Stewardship Agreement.
- No YieldGard® (or YieldGard® with Roundup Ready® Corn 2) seed will be delivered on farm without refuge (i.e. non-Bt, non-YieldGard®) seed also being delivered to the same farm, unless the user can provide proof that sufficient volumes of refuge seed is available for the users' use.
- With every delivery of YieldGard® (or YieldGard® with Roundup® Ready Corn 2) seed, the user will be provided with a user guide and informed of the following:
 - (i) Requirements pertaining to planting a suitable refuge.
 - (ii) The on-farm compliance monitoring programme and implications should a user be in partial-compliance or non-compliance with the refuge requirement.
- Annual Stewardship and refugia training will be given to all seed sales teams to enable seed representatives to assist users in planting the required refugia.
- Communication campaigns concerning Stewardship will be conducted.
- Independent, third-party, on farm compliance monitoring will be expanded to cover more farms.

Monitoring and reporting of incidents of pesticide resistance development

The critical importance of on-farm compliance with Stewardship, in order to continue to preserve and lengthen the shelf-life of YieldGard®, leaves Monsanto with no alternative but to implement these measures. Monsanto, as the permit and technology owner, has a responsibility to the larger industry, including all users who use this technology, so that maximum benefit can be obtained for the longest possible time period. For users who are uncomfortable with these measures, an alternative in the form of conventional maize production exists.

Incidents of partial-compliance or non-compliance by users will be taken very seriously. The following actions will be taken where partial-compliance or non-compliance is discovered:

- The user will be notified in writing of the partial-compliance or non-compliance and instructed to attend a compulsory meeting with the relevant seed company. During this meeting the user will:
 - be reminded of his/her contractual obligations under the Agreement.
 - receive educational material and training on the importance of IRM and the requirements that must be observed. The users' understanding of the principles and requirements will be assessed.
- The user will again receive an on-farm compliance visit during the next growing season.
- In the event that a user is found to be partially compliant for four growing seasons or non-compliant for two seasons, the user will be refused access to all of Monsanto's genetically modified seed, including YieldGard®. Such a user would only be eligible to purchase the technology again after completion of a full training and rehabilitation programme.

Monitoring and reporting of incidents of pesticide resistance development

The following can be expected in terms of the on-farm visit:

- An independent third party will contact the user to determine a suitable date and time to conduct the visit.
- During the visit the user will be requested to provide the following information to the third party:
 - User's name, the name of the farm, postal address, contact number and the GPS coordinates of user's farm.
 - The Technology and Stewardship Agreement number. It is advisable that the user always keep a copy of the signed agreement at hand.
 - Confirmation that the refuge was planted and the refuge option chosen (i.e. 5% refuge or 20% refuge).
 - Confirmation of adherence to all the refuge planting requirements.
- The user will be requested to indicate where the refuge area is located in order for the third party to perform a strip test on a small leaf sample to confirm the absence of the YieldGard® technology. It is advisable that users clearly mark their refuge area during planting in such a manner that the refuge areas can be easily located throughout the growing season.
- The results of the visit will be recorded in a report and the user will be requested to sign the report as confirmation that the visit did take place. The user will receive a copy of the report.

Employment of integrated pest management practices

Insect protected maize is not a stand-alone measure for insect problems in maize. Insect populations adapt to even the best insecticides if those insecticides are not managed correctly. Industry experiences with chemical insecticides resulted in the development of an Integrated Pest Management (IPM) approach. IPM may be defined as the utilisation of different control strategies that maintain insect populations below economic thresholds without eliminating these insect populations. (Eborá & Sticklen 1994). Pertinent components of IPM include: host plant resistance, biological control, chemical control, and agronomic practices (Wiseman 1994, Luckmann & Metcalf 1982).

Host plant resistance (HPR) and biological control are viewed by many as the maize cornerstones of an IRM program. HPR insures that the first line of defense, the plant, is protected from insects. Biological control seeks to keep the pest in check through the use of naturally occurring disease organisms and beneficial insects such as parasitoids and predators. Therefore, in IPM, insecticide sprays are utilised judiciously based on monitoring and associated thresholds. Natural enemies aid in the control of target and non-target pests and help to keep pest populations in check. Local beneficial insect populations also provide a first line of defense against potential *Bt*-resistant pests. In the event that stalk borer larvae become resistant to the *Bt* proteins, the presence of various natural enemies of stalk borers will help to remove the resistant individuals and their resistance gene(s) from the population. Furthermore, due to the mobility of most beneficial insects, their preservation in maize can have positive effects on pests in neighbouring fields of maize or other crops. Therefore, chemical insecticides should only be used if thresholds are exceeded. In cases where chemical control is not possible, cultural control practices could be applied.

Employment of integrated pest management practices

Of all pest control measures, chemical controls have provided users and consumers with some of the greatest successes and biggest disappointments. This is largely due to an over reliance of the user on a single, all-encompassing, control measure. Chemical control will continue to play a role in the cropping system to control excessive populations of key pests and other non-target pests, but it will be used more strategically since current IPM practices seek to de-emphasise chemical control and emphasise HPR and biological control.

Agronomic practices also will remain an important component of an IPM-based IRM strategy. The major agronomic practice relevant to stalk borer resistance management is planting strategy. The user will decide which hybrids to plant, whether they are insect protected or not and will be advised to implement the most effective refuge option. Other agronomic practices such as destruction of the overwintering habitat of the stalk borers and other insects by shredding of the stalks and ploughing will also continue to be important.

ISOLATION OF FIELDS PLANTED WITH YIELDGARD® AND YIELDGARD® WITH ROUNDUP READY® CORN 2

Maize pollen is known to move short distances and possibly between fields. This is, for example, visible in the case where a field of white maize is sown adjacent to a field of yellow maize. Evidence of pollen movement can be seen in the few yellow kernels found in the white maize ears.

In the case of YieldGard® maize, the flow of pollen may be problematic where it is planted adjacent to fields destined for marketing channels with restrictions on transgenic (GM) maize. If you are concerned that your neighbours may be planting maize destined for non-GM channels, including specific export markets, contact your seed sales representative for additional information.

To minimise the risk of cross-pollination of transgenic (GM) and non-transgenic maize specifically cultivated for non-transgenic contracts, the following practices are recommended:*

- Temporal isolation: Ensure at least three weeks between planting of transgenic and non-transgenic hybrids.
- Spatial isolation: Ensure at least 400 m between transgenic and non-transgenic hybrids.
- Combination of temporal and spatial isolation: combining both practices reduces the risk of cross-pollination more than by using just one of the practices.
- It is also recommended that you discuss with your neighbours what their plans are for the coming season, and whether they have any requirement to grow “Bt-free” or “GM-free” maize. This discussion should take place before planting begins, so that appropriate steps can be taken to avoid cross-pollination if necessary.

(* Full implementation of these steps cannot completely avoid the risk of cross-pollination)

EFFECTIVE CONTROL OF STALK BORERS WITH YIELDGARD® MAIZE

Wherever maize is produced, stalk borers rob farmers of some of their production. Stalk borer damage can cost users between 6-30% of their yield. YieldGard® targets two of the most important stalk borer species in South Africa, namely *Busseola fusca*, the African stalk borer, and *Chilo partellus*, the Sorghum stem borer, also known as the spotted stalk borer. Stalk borers feed on all parts of the maize plant - leaves, stalk, sheath, ear collar, shank and ears - causing damage which reduces the flow of sap and nutrients throughout the plant, thereby reducing potential yields substantially. Damage and losses to users in South Africa run into hundreds of millions of Rands each season. Maize users have to battle two or three generations of stalk borers each season. Standard chemical control methods can be time consuming and rendered ineffective through extreme weather conditions, often necessitating a second spray. Furthermore, timing is crucial with relatively narrow application windows in order to be effective.

YieldGard® maize offers excellent season long control of target stalk borers and together with Roundup Ready® Corn 2 (stacked product), this maize offers not only control of target stalk borers but a broad spectrum weed control system, allowing the application of Roundup PowerMAX® (L7769, Act no. 36 of 1947) over the top until the V8 stage of maize growth which provides the user with increased flexibility in managing difficult weeds, the ability to tailor herbicide applications to weed height or stage and the ability to apply directed weed control sprays to maize after the V8 stage.

THE YIELDGARD® SPECTRUM

THE YIELDGARD® SPECTRUM

YieldGard® controls:

- *Busseola fusca*
- *Chilo partellus*.

YieldGard® has no effect on:

- Cutworms
- Beneficial insects like bees, natural predators and other wildlife.

THE BENEFITS OF YIELDGARD®

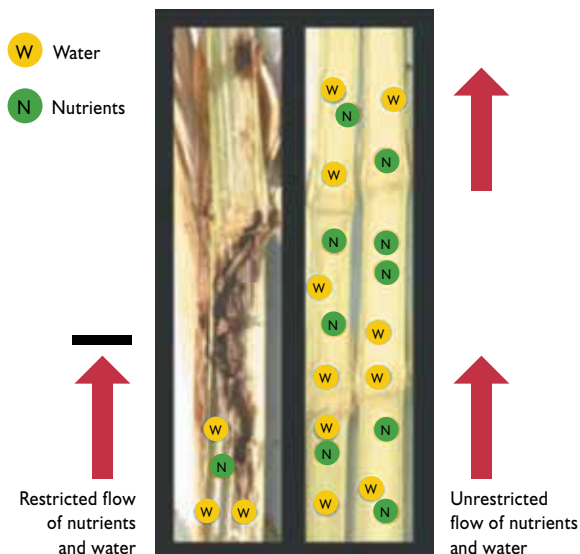
Feature	Advantages	Benefits
<ul style="list-style-type: none">• Increased productivity	<ul style="list-style-type: none">• Effective control of maize stalk borers (<i>Busseola fusca</i> and <i>Chilo partellus</i>)• Healthier plants	<ul style="list-style-type: none">• Increased yields vs. chemical control• Healthier plants• Improved grain quality• Reduced insecticide costs• Increased profits
<ul style="list-style-type: none">• Ecologically friendly	<ul style="list-style-type: none">• Reduced use of insecticides• Target specific	<ul style="list-style-type: none">• Reduced handling and exposure to insecticides• Survival of beneficial insects
<ul style="list-style-type: none">• Convenient management	<ul style="list-style-type: none">• Simplified crop management	<ul style="list-style-type: none">• Peace of mind• More time for other farming activities

YIELDGARD® ENSURES INCREASED PRODUCTIVITY



Stalk borer damage in conventional maize (left) and zero damage in YieldGard® maize (right)

YIELDGARD® ENSURES INCREASED PRODUCTIVITY



When maize is protected from stalk borers, optimal levels of vital nutrients and water are available to produce higher yields. This is critical during the semi-drought conditions that are experienced in South Africa. When stalk borers are controlled, less damage occurs on the ears. This means fewer sites available for fungal pathogens, like *Fusarium sp.*

ONLY THE BEST MAIZE HYBRIDS ARE BEING DEVELOPED WITH YIELDGARD® TECHNOLOGY

Improving maize hybrids with YieldGard® technology does not mean missing out on existing genetic advantages. With YieldGard® technology, the best stalk borer control is added to the best hybrids, allowing these hybrids to realise their full yield potential.

AGRONOMY OF YIELDGARD® MAIZE

- In order to realise the full yield potential of the maize germplasm in a YieldGard® maize hybrid, you need to care for it in exactly the same way that you would care for highly productive non-YieldGard® or conventional maize.
- YieldGard® hybrids are exactly the same as conventional hybrids, except that they are less subject to stalk borer damage.
- Only top performing hybrids contain YieldGard® technology.
- In order to obtain the best results with YieldGard® hybrids, management practices should provide for optimal availability of plant nutrients, nitrogen and phosphorous in particular.
- Maintain optimum irrigation scheduling in order to maximise the benefits from YieldGard® hybrids.
- Plant YieldGard® maize at the same time as you plant your refuge maize (see section on Insect Resistance Management).
- The greatest impact on the yield potential of conventional or YieldGard® maize is from weed competition between weeks 2-6 after germination. It is therefore critically important to keep your fields weed-free during this period.
- The efficacy of YieldGard® protection may be reduced if host plants of stalk borers are among the weeds present. Although unlikely, stalk borer larvae can mature on weedy hosts and then migrate to YieldGard® maize plants. Under these circumstances, the protection afforded by YieldGard® technology may be reduced. Volunteer maize plants, including those containing YieldGard® I, are also stalkborer host plants. Control volunteer maize to preserve YieldGard® II efficacy, and maintain IRM integrity.
- Inspect your YieldGard® maize weekly from emergence for insect attack.
- **All insect pests excluding stalk borers:** apply recommended insecticides if economic thresholds are exceeded. Insecticides must be applied according to the manufacturer's recommendations.

AGRONOMY OF YIELDGARD® MAIZE

- **Stalk borers:** Occasionally, when stalk borer attack is particularly severe and normal economic thresholds are exceeded, it may be necessary to apply an insecticide to control surviving larvae. Please report **any lack** of stalk borer control by YieldGard® to the nearest representative of the seed company from which you purchased your YieldGard® seed.
- Please note that some stalk borer damage may occur in later stages of growth in the maize plant. This damage may be due to the sub-optimal control of stalk borers during the “window” period in *Bt* crops. This window period is caused by reduced expression of the *Bt* protein in the reproductive parts of the maize plant. A limited number of stalk borer larvae may thus survive on the silks and tassel, which at a later stage penetrate the upper parts of the plant and cause damage. Damage due to this late infestation should not be regarded as resistance. Surviving larvae at this stage should be assessed on a case-to-case basis in terms of the need to apply insecticides to control above-threshold damage. Please report this damage to the nearest representative of the seed company from which you purchased your YieldGard® seed.

INSECT RESISTANCE MANAGEMENT

- Although the *Bt*-proteins in YieldGard® maize plants are produced in sufficient quantities to kill stalk borers, there are always some individual stalk borers that are naturally tolerant to the *Bt*-proteins. These individuals are very rare and users must follow certain procedures to ensure that they remain rare in the population. This set of procedures is called the “Insect Resistance Management” programme, or “IRM”.
- Scientists believe that the best way to prevent the tolerant individuals from increasing in the population is to combine effective control with YieldGard® in maize fields, with a nearby “refuge” area.
- A “refuge” or “refugia” is an area where only non-*Bt* maize is cultivated and where no *Bt*-based insecticides are used. In this area, maize stalk borers which are susceptible to the *Bt*-protein can feed and breed. These susceptible stalk borers can in turn breed with any of the few naturally tolerant stalk borer individuals, which survive in the YieldGard® maize fields.
- If a susceptible stalk borer breeds with a tolerant one, the offspring are also susceptible. In this way users can preserve the efficacy of the YieldGard® technology and ensure that they continue to reap the benefits for many years to come.

OPTIONS FOR REFUGIA

User shall, whenever he plants maize seed containing the *Bt* trait, in addition, plant non-*Bt* maize seed as a refuge area ('refuge') as follows:

Option A: 5% non-*Bt* maize seed, which shall not be treated with any insecticide/ bio-pesticides registered or effective specifically against stalk borers.

In practice this means that for every 95 hectares planted with YieldGard® (or YieldGard® with Roundup Ready® Corn 2) maize, the user must plant 5 hectares of non-*Bt* maize (thus maize without any *Bt* genes);

OR

Option B: 20% non-*Bt* maize seed that may be sprayed with an insecticide/ bio-pesticide registered or effective specifically against stalk borers, but not with insecticides/ bio-pesticides that contain any *Bt* proteins.

In practice this means that for every 80 hectares planted with YieldGard® (or YieldGard® with Roundup Ready® Corn 2) maize, the user must plant 20 hectares of non-*Bt* maize (thus maize without any *Bt* genes).

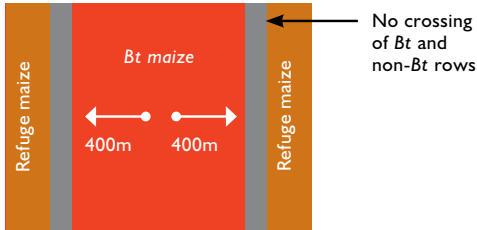
OPTIONS FOR REFUGIA

In addition to planting a refuge according to Option A or B, the user must also adhere to certain important requirements when planting the refuge. The current requirements are listed below:

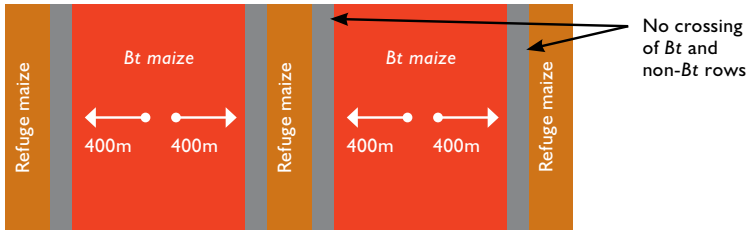
- The user shall ensure when planting the non-*Bt* maize seed in the refuge area that it is done:
 - such that the germinated plants have a similar maturity as the YieldGard® (or YieldGard® with Round Ready® Corn 2) maize;
 - within seven days from planting the YieldGard® (or YieldGard® with Roundup Ready® Corn 2) maize;
 - under the same growing conditions applicable for the YieldGard® (or YieldGard® with Roundup Ready® Corn 2) maize; Thus, if the YieldGard® (or YieldGard® with Roundup Ready® Corn 2) maize is planted under irrigation, the refuge maize must also be planted under irrigation;
 - such that no *Bt*-plant is more than 400 m away from a non-*Bt* plant; and
 - the area should be clearly marked.
- Every user must plant his/her own refuge maize. Thus, non-*Bt* maize fields of neighbouring users cannot serve as a refuge.
- Refuge “strip” areas must be at least 6 rows wide, except in smallholder farms where 6 rows could exceed a 5% refuge area.
- Refuge areas must be positioned in such a manner that some refuge is planted at least on two outside borders of the YieldGard® (or YieldGard® with Roundup Ready® Corn 2) maize;
- Mixing of *Bt* maize seed and non-*Bt* maize (refuge) maize seed is not allowed and crossing of *Bt* rows and non-*Bt* rows are not allowed. Volunteer maize must be controlled to prevent mixing of YieldGard® I and non-YieldGard® I maize plants.
- Users must monitor and scout their fields at least once a week and immediately contact their seed sales representative if 10% or more leaf damage due to maize borers is detected in the YieldGard® (or YieldGard® with Roundup Ready® Corn 2) (IPM component).

CORRECT POSITIONING OF THE REFUGE AREAS

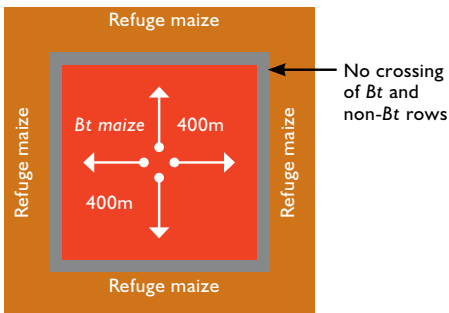
Block Positioning



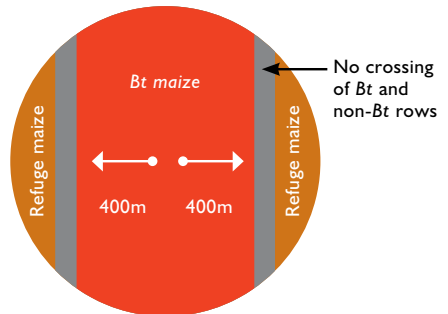
Strip Positioning



Perimeter Positioning

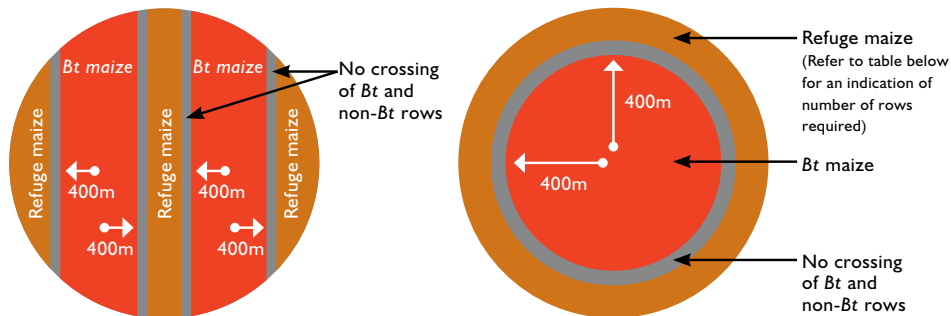


Pivot Positioning



CORRECT POSITIONING OF THE REFUGE AREAS

Pivot Positioning



Pivot size		Minimum number of rows required per row width in m (circular plantings)					
radius (m)	ha	0.60 m	0.75 m	0.91 m	1.00 m	1.20 m	1.50 m
178	10	8	6	6	6	6	6
252	20	11	9	7	6	6	6
309	30	13	10	9	8	7	6
357	40	15	12	10	9	8	6
399	50*	17	13	11	10	8	7
437	60*	18	15	12	11	9	7
472	70*	20	16	13	12	10	8
505	80*	21	17	14	13	11	9
535	90*	23	18	15	14	11	9
564	100*	24	19	16	14	12	10
592	110*	25	20	16	15	12	10
618	120*	26	21	17	16	13	10

*User must also plant at least 6 rows in the centre of the pivot, in addition to the rows on the outside.

OPTIMAL WEED CONTROL WITH ROUNDUP READY® CORN 2

The launch of Roundup Ready® Corn 2 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 user understands the value of this technology and how it works, in order to obtain the optimum benefit.

THE BENEFITS OF ROUNDUP READY® TECHNOLOGY

Feature	Advantages	Benefits
<p>Broad spectrum weed control</p> <ul style="list-style-type: none"> Both grass and broad leaf weeds are controlled, annual and perennial, systemic and non-selective. 	<ul style="list-style-type: none"> Effective control of big seeded weeds e.g. Cocklebur (<i>Xanthium</i>) and Large thorn apple (<i>Datura</i>). Effective control of grass weeds e.g. Crab finger grass (<i>Digitaria</i>) and other annual weeds. Effective control of difficult to control weeds e.g. Yellow nutsedge (<i>Cyperus esculentus</i>), Johnson's Grass (<i>Sorghum halapense</i>) and Couch Grass/ Kweek (<i>Cynodon dactylon</i>) in extended spray programmes. Effective control of grasses and broad leaf weeds on field perimeters and contours. 	<ul style="list-style-type: none"> Reduced labour costs and elimination of unwanted weed seeds in the grain sample. Lower herbicide costs because of elimination of weed specific herbicides. Higher yields due to better weed control, especially grass weeds. Reclaiming of fields lost to high weed pressure. Better management of conservation tillage. Simplification of management and peace of mind. Spreading of weeds to crop fields and fire risk minimised.
<p>Proven crop safety</p> <ul style="list-style-type: none"> Roundup PowerMAX® with Transorb™ is developed for Roundup Ready® crops. 	<ul style="list-style-type: none"> No stressing or stunting of maize plant. 	<ul style="list-style-type: none"> Maximum yield potential obtained. Maximum profitability for grain producer. Peace of mind.
<p>Application flexibility</p> <ul style="list-style-type: none"> Roundup PowerMAX® is a non-selective systemic herbicide based on Transorb™ technology for exceptionally fast uptake (rainfast in one hour), with no residual activity. Can be applied at any growth stage of the crop. After the 8th leaf stage, only directed spraying is approved. 	<ul style="list-style-type: none"> Effective weed control from plant to harvest. Climatic conditions play a far lesser role on effectiveness because of rapid uptake/ rainfastness. Application dosage can be adapted to weed growth stage. Roundup PowerMAX® is less dependent on soil moisture and not at all dependent on clay content. 	<ul style="list-style-type: none"> Simplified management and reduced costs. Number of "Sprayable" days increases. Greatly reduced risk of respraying, with resultant cost savings. Absence of soil residues implies no crop rotation limitation. Spray only if weeds present.

THE SEED BED AT PLANTING

- Begin with a weed free seed bed to eliminate early weed competition.
- Difficult to control winter weeds e.g. Fleabane (*Conyza spp. = Erigeron spp.*) will not be controlled effectively with Roundup PowerMAX® at the normal dosage. Remove mechanically or implement an alternative pre-plant herbicide programme.
- If Couch grass/Kweek (*Cynodon dactylon*) is present, a pre-plant Roundup Turbo® spray or mechanical tillage should be applied.

WEED CONTROL PROGRAMS

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® Corn 2 , Monsanto implemented a series of herbicide trials in combination with Roundup PowerMAX® herbicide in the different production areas. The results of these trials are available within each region. Recommended weed control programmes were established based on these trial results, however, it is ultimately only the user who has an intimate knowledge of his own weed spectrum and production practices (e.g. planting density and row width). The user is therefore the person who should ultimately decide on a specific programme. 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 are 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 safened acetochlor (e.g. Guardian S®) at planting, followed up with a spray of Roundup PowerMAX® herbicide before the weeds reach a height or diameter of 10 cm. Follow up with a second application if required. Refer to the respective product labels for specific recommendations.
- 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 PowerMAX® herbicide after planting and before weeds are 10 cm high, is followed up by a tank mix of unsafened acetochlor (Harness® Extra) and Roundup PowerMAX® herbicide, again before weeds reach a height or diameter of 10 cm. This programme extends the period of effective control to take care of late germinating weed. Refer to the respective product labels for specific recommendations.

WEED CONTROL PROGRAMS

- The third combination is applied in a reduced tillage or irrigation situation, where planting densities are high and where the seed bed 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 a safened acetochlor (e.g. Guardian S®) at planting followed by Roundup PowerMAX® herbicide before weeds reach a height or diameter of 10 cm, followed up with a further Roundup PowerMAX® spray (again before flushing weeds reach 10 cm), will normally be sufficient. Refer to the respective product labels for specific recommendations.

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 PowerMAX® may be made. Consult your agronomist or chemical agent when this occurs. Note that after the 8th leaf stage of the maize crop, applications of Roundup PowerMAX® should be directed at the base of the plant and not applied “over the top”.

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

ROUNDUP POWERMAX® HERBICIDE

Roundup PowerMAX® herbicide is registered for use on Roundup Ready® crops. 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 PowerMAX® 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 PowerMAX® herbicide as we do not test all products commercially available. Roundup PowerMAX® is rain fast one hour after application.

CRITICAL DECISIONS (REFER TO INDIVIDUAL PRODUCT LABELS)

The three critical decisions to be taken to ensure effective weed control are:

1. Weed spectrum

- Determine the total weed spectrum on the field.
- Determine the effect of the Roundup PowerMAX® herbicide on all the weeds which are present on the field.
- Use the dosage on the label required to control the most difficult weeds that are present.
- Note which species will not be controlled (not on the label) or will be difficult to control (due to agronomic or environmental factors or documented resistance).
- Compile a programme to include other products, use higher dosages, or additional treatments, or other measures to obtain optimal weed control on the specific field.

2. Herbicide dosage

- The use of the correct dosage is critical for satisfactory weed control.
- Dosages are bound to a specific TIME and WEED GROWTH STAGE.
- When applying Roundup PowerMAX® in tank mixes with other herbicides the possibility of antagonism between chemicals should be taken into account. Antagonism will reduce the amount of active glyphosate in the tank, which will negatively affect the weed control performance. The recommended percentage Roundup PowerMAX® herbicide should at all time be present in the tank mix.

3. Time of application

- The time of application is based on the weed growth stage, the biomass of the weed and the agronomic and environmental conditions at the time of the application.
- Weed control will not be satisfactory if the weeds are allowed to become too large before the first application.
- The herbicide should not be applied if the plants are under any form of agronomic stress, e.g. waterlogged, drought, cold or insect damage.
- Target the sensitive growth stages of all weeds in the weed spectrum and consider additional control measures to ensure optimal weed control.

THE ROUNDUP POWERMAX® LABEL



NOTE: The following information is not a substitute for the recommendations on the Roundup PowerMAX® label

GENERAL RECOMMENDATIONS FOR THE USE OF ROUNDUP POWERMAX® HERBICIDE

- Roundup PowerMAX® 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).
- The water volume can be reduced to 75 ℓ/ha when using self-propelled sprayers. Limit speed to maximum of 15 km/h.
- A minimum concentration of 1,5% Roundup PowerMAX® 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 PowerMAX® 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 neutralise the glyphosate.
- Spray-water pH must be in the range of 5 to 6,5. Add a buffering agent if necessary before adding the Roundup PowerMAX®. The use of a high quality ammonium sulphate product is recommended at a rate of 2% added to the spray solution before adding Roundup PowerMAX®.
- Do not add any surfactants.
- Do not use in tank mix with any acids such as fulvic, citric, phosphoric or any other organic acids.
- Use the correct spray nozzles and spray pressure to ensure optimal coverage of the weeds.
- Roundup PowerMAX® is not registered for aerial application.
- Rain or irrigation within one hour of application will reduce the efficacy of the herbicide.

DOSAGE RATES:

A. Annual grasses and broad leaf weeds:

1,3 ℓ/ha - Applied before 100 mm in height or the 8 leaf stage.

1,7 ℓ/ha - Applied between 100 and 200 mm or up to the 12 leaf stage.

B. Species requiring a follow-up spray and/or increased rate (Variable control *):

**Commelina benghalensis* – Wandering Jew

2,0 ℓ/ha - Apply at the three-leaf stage followed by 2,0 ℓ/ha (apply 10-20 days later).

**Ipomoea purpurea* – Morning glory

2,0 ℓ/ha - Apply at the 4-5 leaf stage followed by 2,0 ℓ/ha (apply 10-20 days later).

**Portulaca oleracea* - Common purslane

2,0 ℓ/ha - Apply before flowering.

Tribulus terrestris – Devil's thorn

1,7 ℓ/ha - Apply before first flowers appear.

C. Biennial and Perennial weed species:

2,0 ℓ/ha - Apply before 100 mm in height or the 8 leaf growth stage. Efficacy on weeds like Tall fleabane (*Conyza albida*), Flax-leaf fleabane (*Conyza*

bonariensis) and Horseweed fleabane (*Conyza canadensis*) may be variable. Biennial and perennial weeds should be controlled mechanically before planting.

Cyperus esculentus – Yellow nutsedge

2,0 ℓ/ha - Apply at the three to four leaf stage followed by 2,0 ℓ/ha (apply 10-20 days later).

DOSAGE RATES:

The following weed species will not be controlled at these recommended rates:

Cynodon dactylon – common quick grass (see below)

Convolvulus arvensis – field bind weed

Oenothera stricta – evening primrose

Panicum maximum – common buffalo grass

Paspalum spp. – common paspalum.

***Cynodon dactylon* (common quick grass) control:**

Spray the plants with Roundup Turbo® at the recommended rate prior to any cultivation shortly before planting the crop. Apply in-crop sprays as for *Cyperus esculentus* (Yellow nutsedge) recommended above. A late season spot spray when the crop is mature and drying off is also recommended.

1. 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*) are necessary they may not occur within 10 days of the previous application. If the maize has already reached the V8 stage, a post directed (see below) application must be used.

2. 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. Contact with the reproductive parts should be avoided.

DOSAGE RATES:

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

Roundup PowerMAX® herbicide treatments may be applied to Roundup Ready® hybrids in programs with Guardian S®, Bullet® or Atrazine SC as a pre-plant application for residual weed control. Please follow the recommendations on the label of the manufacturer. Roundup PowerMAX® herbicide treatments may be applied to Roundup Ready® hybrids in combination with Harness® Extra or Astron® 480SC as a post-emergent application for residual weed control. Please note that Bullet® and Atrazine SC may not be tank mixed with Roundup PowerMAX® herbicide should it be included in any of the programmes. Roundup PowerMAX® application can be followed up by Crown® for improved *Cyperus esculentus* control. Follow label recommendations.

4. Tank mixes

For the improved control of certain broad leaf weeds MCPA and 2,4-D amine can be used in combination with Roundup PowerMAX® herbicide. Consult the Roundup PowerMAX® label for more information on tank mix options. Tank mixing of Roundup PowerMAX® and foliar nutrients should be avoided due to potential antagonism.

Some of the insecticides and fungicides (formulation types SL and EC) are compatible with Roundup PowerMAX®. Always do a small scale compatibility test. Always remember that the target of Roundup PowerMAX® is the weeds and insects and fungal diseases are the target of insecticides and fungicides.

CONTROL OF VOLUNTEER ROUNDUP READY® MAIZE PLANTS

Volunteer Roundup Ready® maize can be controlled with a pre-plant spray of Pantera®. Consult individual product labels and your chemical representative. The following practical considerations can help to prevent the occurrence of volunteer maize:

- The use of YieldGard® maize (YieldGard® with Roundup Ready® Corn 2) hybrids eliminates damage by stalk borers, which prevents the stalks from toppling over;
- Select maize hybrids with good standability;
- Enhance the efficacy of the harvest process; and
- Reduce soil disturbance.

RESISTANCE MANAGEMENT

Roundup PowerMAX® is a group G herbicide. Any weed population may contain individuals naturally resistant to Roundup PowerMAX®. The resistant individuals can eventually dominate the weed population if these herbicides are used repeatedly. These resistant weeds may not be controlled by Roundup PowerMAX® herbicide or any other group code G herbicide.

Monsanto has launched the **Roundup Ready PLUS™** weed management concept to ensure that growers follow best practices. Use Roundup PowerMAX® as the basis of the herbicide program and add herbicides with other modes of action, i.e. at the time of planting or post emergence.



ROUNDUP READY PLUS™

WEED MANAGEMENT SOLUTIONS

RECOMMENDATIONS FOR EFFECTIVE WEED RESISTANCE MANAGEMENT

- Begin with a weed free seed bed after an effective pre-spray or mechanical tillage.
- Determine a weed control program and products to ensure optimal weed control. This include the use of Roundup PowerMAX® herbicide and/or the use of additional herbicides if you have to deal with difficult to control weeds.
- Apply integrated weed management practices. Use multiple herbicide modes-of-action with overlapping weed spectrums in rotation, sequences, or mixtures.
- Always apply the recommended dosage as stipulated on the label. The reduction of the dosage carries the highest risk for the development of resistance. The dosage is determined by the most difficult to control weed in the spectrum. Avoid tank mixes with antagonism towards Roundup PowerMAX® or that reduce the amount of active glyphosate.
- Scout regularly and report any reoccurrence of ineffective weed control to Monsanto for further investigation.



WEED MANAGEMENT SOLUTIONS

PROBLEM SOLVING

The three critical decisions to be taken to ensure effective weed control are:

1. Low efficacy

- Poor water quality.
- Wrong dosage for the weed spectrum.
- Incorrect use of residual herbicides.
- Incorrect spray volume, nozzles or poor calibration.

2. Crop damage

- Unregistered products and/or tank mixes.
- Spray in the whorl after the 8 leaf stage (i.e. “over the top” after the 8 leaf stage).
- Spray on reproductive parts.
- Incorrect nozzle placement.

3. Spray drift

- Roundup PowerMAX® herbicide is not registered for aerial applications.
- Do not spray if the wind speed exceeds 10 km/h.
- Check with your neighbour as to the proximity of non Roundup Ready® crops, and do not spray when conditions are not optimal.

STACK THE BENEFITS OF YIELDGARD® AND ROUNDUP READY® TECHNOLOGY

- Peace of mind
- Higher yields
- Improved grain quality
- Crop-safe weed control
- Broad spectrum weed control
- Flexible weed control programme

The management of stack gene technology is a combination of the management of the two individual gene technologies. Insect resistance management as well as weed resistance management is critical to ensure the future use of the technology. Stack gene hybrids can be recognised by the suffix “BR” in the name.

- Use a Roundup Ready® hybrid as refuge to enable you to apply a single weed control programme on the entire field.

PRODUCT REGISTRATION NUMBERS ACT NO 36 OF 1947

Astron 480 SC®	L8366	Universal Crop Protection (Pty) Ltd
Bullet®	L5623	Monsanto South Africa (Pty) Ltd.
Crown 750 WG®	L8282	Universal Crop Protection (Pty) Ltd
Guardian S®	L4862	Monsanto South Africa (Pty) Ltd.
Harness® Extra	L7703	Monsanto South Africa (Pty) Ltd.
Laudis®	L8525	Bayer CropScience AG
Pantera®	L6451	Chemtura (Pty) Ltd.
Roundup Turbo®	L7166	Monsanto South Africa (Pty) Ltd.
Roundup PowerMAX®	L7769	Monsanto South Africa (Pty) Ltd.

NOTE: Please refer to the complete product labels for more information.

References

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