

## Stewardship for Roundup Ready® Bentgrass

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### **Introduction:**

The development of Roundup Ready Bentgrass for use on golf courses may lead to new opportunities and responsibilities for golf course superintendents across the United States. Upon commercialization, the opportunities would include the simplification of weed management and improved playability in golf, while the responsibility would include implementation of 'Best Management Practices' appropriate to these new Roundup Ready Bentgrass cultivars.

### **Background:**

Scott's Co. and Monsanto Co. have joined together to address the technical issues surrounding the introduction of Roundup Ready Bentgrass. Through this effort, lab, growth chamber, and field-research studies have been completed across the United States at the companies' research facilities, selected golf courses, and at a number of land grant universities. Results of these studies have provided data and information needed to understand specific safeguards needed to ensure that this emerging technology can be safely used, and stewardship issues can be effectively managed.

Currently, APHIS is evaluating technical and environmental data submitted by Scott's Co. and Monsanto Co. Once reviews are completed, and questions have been adequately addressed, it is anticipated that Roundup Ready Bentgrass will be given '*Non-Regulated*' status, and Monsanto and Scott's plan to proceed with the commercialization of the product. *Use Guidelines* and *Best Management Practices* are being developed to insure that the technology is used properly and performs to the expectations of customers.

To provide helpful guidance to turfgrass professionals on the use of Roundup Ready Bentgrass, a number of production practices have been implemented. Numerous research studies have also been conducted to determine the impact to the environment of various maintenance activities and cultural/mechanical practices commonly found on golf courses, and to determine the potential impact of movement of plants or pollen from golf courses that could affect crops or native habitats.

### **Best Management Practices:**

#### **1) Controlled Seed Production Area**

The first area of 'Best Management Practices' is centered on the location and production practices defining where and how Roundup Ready Bentgrass seed is produced and how seed are handled post-harvest. Significant research was conducted to define the parameters required to adequately safeguard the environment from the unintentional

release of Roundup Ready Bentgrass. With this information and USDA/APHIS concurrence, the State of Oregon approved and issued permits for Roundup Ready Bentgrass to be grown for seed in a small area in eastern Oregon. Strict guidelines for the production of seed have been employed. Among the precautionary measures undertaken was the establishment of a Control Area Order under the laws of the State of Oregon that includes stipulations that:

- 1) Only varieties of bentgrass that have been developed through the techniques of modern biotechnology may be planted, grown, cleaned, conditioned or handled in the control area. Conventionally bred bentgrass varieties may not be planted, grown, cleaned, conditioned or handled within the control area.
- 2) Bentgrass seed produced within the control area must be processed at a seed cleaning and packaging facility located within the control area. No conventionally bred varieties of grass seed of any type shall be cleaned or packaged at this facility.
- 3) Bentgrass seed produced within the control area must be transported from the field to the cleaning and packaging facility in enclosed containers. Processed bentgrass seed produced in the control area may not leave the control area except in sealed commercial containers.
- 4) Combines used to harvest bentgrass in the control area must not be used for any other crop. Dedicated combines no longer being used to harvest bentgrass in the control area must be fumigated to devitalize all bentgrass seed and thoroughly cleaned before leaving the control area. Containers such as poly bags used to transport unprocessed bentgrass seed and straw must not be used for other agricultural commodities or must be thoroughly cleaned before being used for other agricultural commodities to avoid contamination of other seed sources.

## **2) Control Alternatives**

Roundup<sup>®</sup> agricultural herbicides have often been the preferred tool for the control, removal, and conversion of bentgrass production fields, and in areas where bentgrass turf control/conversion was desired. With the development of Roundup Ready Bentgrass, alternate control methods needed to be identified. A series of studies designed to screen potential herbicides that could be used to kill Roundup Ready Bentgrass identified several effective commercial products. (Table I.)

**Table I. Herbicides that have activity on *Agrostis* spp. based upon herbicide sensitivity studies.**

<b>Herbicide</b>	<b>Active Ingredient</b>	<b>Use Pattern</b>
Roundup Pro	Glyphosate	POST
Fusilade II or DX	Fluazifop	POST
Outrider	Sulfosulfuron	PRE/POST
Arsenal	Imazapyr	PRE/POST
Eptam 7-E	S-ethyl dipropylthiocarbamate	PPI
Direx	Diuron	PRE/POST
Sinbar	Terbacil	PRE/POST
Casoron	Dichlobenil	PRE
Envoy	Clethodim	POST
Finale, Rely	Glufosinate	POST
Goal 2XL	Oxyfluorfen	PRE/POST
Select	Clethodim	POST
Basamid	Thiadiazine	FUMIGANT
Poast	Sethoxydim	POST
Vapam HL	Methylthiocarbamate	FUMIGANT
Assure II	Quizalofop	POST
GramoxoneMax	Paraquat	POST

Tillage practices and hand roguing or mechanical removal used alone, or in combination with effective herbicides have confirmed that alternate control recommendations are available. (Not all of the active herbicides listed in the table above are currently registered for this use. It is a violation of federal law to promote an unregistered herbicide use.)

### **3) Use Practices**

#### **A. Weed control**

The use of Roundup PRO<sup>®</sup> herbicide simplifies common agronomic and cultural issues regarding maintenance and quality of bentgrass varieties used on golf courses. Roundup Ready Bentgrass has shown outstanding tolerance to Roundup PRO applications and offers significant value compared to current practices in non-Roundup Ready Bentgrass situations. The need for complicated approaches using fumigants, herbicides and plant growth regulators for weed management may be eliminated or significantly reduced. Control of annual bluegrass (*Poa annua*) and roughstalk bluegrass (*Poa trivialis*) has been demonstrated through timely in-season applications. Applications can occur throughout the growing season.

#### **B. Tracking**

A series of tracking studies have been conducted over the past two years to determine the impacts of mechanical tracking across Roundup PRO treated areas onto untreated,

conventional turfgrass. Studies were conducted on a broad range of turfgrass species and at various cutting heights ranging from green-cuts to un-mowed roughs. Tracking methods of: 1) walking (measuring footprint impressions), 2) motorized, and 3) pull-cart traffic (measuring wheel-track markings) were imposed in various timed events of 2-5 minutes, 20 minutes, 60 minutes, and 24 hours following Roundup PRO applications to adjacent 10 foot strips of conventional turf. Applications were made in the presence and absence of dew. Impacts of relative humidity and temperature were also measured as variables.

Results from these studies have shown limited evidence of tracking even under conditions that would favor tracking. Even when tracking injury occurred within 5 minutes of the Roundup PRO application, no long-term turf injury occurred. Tracking damage consistently became less evident with time and the turf recovered fully. Injury was not observed at any location beyond 21 days of the tracking event. Under practical conditions, tracking should not be a commercial concern beyond 5 minutes after application.

#### C. Use and disposition of plugs arising from core aeration

The practice of core aeration on greens and fairways offers the potential for Roundup Ready Bentgrass to move from the golf course to areas outside the intended use area. Burial, composting, and burning, where allowed after drying, represent viable options for effectively devitalizing these propagules. Golf courses that adopt Roundup Ready Bentgrass will follow a set of 'Best Management Practices' that will not allow plugs and viable plant parts to be removed from the golf course property.

#### D. Clipping management

The handling of clippings of Roundup Ready Bentgrass has been evaluated. Preliminary greenhouse data from University of Nebraska showed that clippings taken from Roundup PRO treated bentgrass then spread over Kentucky bluegrass and perennial ryegrass resulted in injury symptoms when applied within 3 days of spraying. Herbicide symptoms were not seen after mowing was delayed for more than three days after application. Since plants grown under greenhouse conditions are often more susceptible than those grown under field conditions, evaluation of this effect is needed under practical conditions in the field. Complete composting and/or returning clippings onto Roundup Ready Bentgrass would seem reasonable alternatives until more defined research can be completed.

#### **4) Escapes**

*Agrostis* species are generally not considered invasive weeds. Invasive weeds are characterized by both their ability to aggressively spread and their ability to occupy a biome to the exclusion of many other native species. Movement of bentgrasses into natural areas is a rare event. Bentgrasses tend to develop or establish themselves more readily in disturbed soils rather than expanding into undisturbed sites. Should Roundup Ready Bentgrass escape from golf courses, a number of grass herbicides, as well as

mechanical removal and other cultural practices, are very effective in controlling bentgrasses. In established stands and under golf course management practices, seedhead development is not expected to occur.

## **5) Weed Management Issues**

The development of weed resistance to glyphosate is much less common than most herbicides. Glyphosate resistance has been confirmed by Monsanto in only two weed species in the U.S. (and four globally) after almost three decades of use. Neither U.S. species is common in golf course turf. The primary weed of interest to golf course superintendents in bentgrass turf is *Poa annua*. Glyphosate has been used to control *Poa annua* in dormant bermudagrass turf in the southeastern U.S. for more than 20 years without resistance development. Weed management programs should be developed on a case-by-case basis considering the nature of the active ingredient, the agronomics of the crop, the biology of the target weed species and the available tools for control. Sponsored research is underway that will refine appropriate weed management programs for reducing the potential for weed resistance in herbicide tolerant turf.

Based on current knowledge, the following is a typical weed management plan for Roundup Ready Bentgrass in golf course turf:

- Renovation practices for fairways and greens will be employed to eliminate all existing *Poa annua* plants, including perennial biotypes, that may be present in the target site.
- The maximum labeled Roundup PRO rate of 3 qts/A will be required one time per year to avoid any lower rate selection of tolerant biotypes.
- Fall applications of Roundup PRO will be made as mixtures with a preemergence herbicide. (eg. Dimension, Barricade or equivalent)
- Aggressive monitoring and follow-up will occur (as is practiced in other Roundup Ready crops) with any performance problems.
- Continued investigation of new postemergence herbicide candidates such as Velocity for fit in *Poa annua* management in Roundup Ready Bentgrass.