Super Science

//**IPHONES ON THE GOLF COURSE**

MEASURING GREEN SPEED
IS THERE *REALLY* AN APP FOR THAT?

By Marcus Jones, Ph.D.

Many superintendents record green speed and use this data to tailor agronomic practices. Typically superintendents use a Stimpmeter to get speed measurements.

The iStimp is a recent application supported by iOS devices such as the iPod Touch, iPhone and iPad. The iStimp is available to anyone who has an iOS device for a fee of $0.99. A green speed measurement is obtained by rolling a golf ball off the iOS device and measuring the distance the ball travels with a built-in ruler. The iStimp application then uses algorithms to generate a Stimpmeter value. A comparison of the iStimp on the iPad, iPhone and iPod touch has not been conducted. The objective of this study was to determine the accuracy of the iStimp application compared to the USGA Stimpmeter.

Researchers in Iowa and Indiana put the iStimp to the test. The results were less than stellar.

PHOTO BY: QUINCY LAW

Stimpmeter measurements were recorded on putting greens at two different golf courses with medium and fast green speeds according to USGA green speed definitions. Stimpmeter readings were obtained with the three iOS devices and a USGA Stimpmeter. A research Stimpmeter, which is known to produce equivalent results to the USGA device, was also included. Three people, each with varying experience using Stimpmeters, operated each device. All accessories (cases, etc.) were removed from each iOS device with the exception of screen protectors.

The research Stimpmeter produced a statistically similar reading of 11.8 feet. Research Stimpmeters have proven to yield green speed values similar to the USGA device. The three iOS devices equipped with the iStimp app failed to produce Stimpmeter values similar to the USGA device. The iStimp application when utilized on the iPad 2 underestimated Stimpmeter readings by 9 percent. In contrast, the iStimp application overestimated Stimpmeter readings on the iPhone 4 and iPod touch 4th Generation by 21 percent and 16 percent, respectively.

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NEWS UPDATE

BASF PREVIEWS TWO NEW FUNGICIDES

During the recent American Phytopathological Society annual conference BASF discussed research regarding two fungicides the company expects to receive EPA registration on this fall: Xzemplar fungicide and Lexicon Intrinsic brand fungicide. Both contain the active ingredient fluxapyroxad, while Lexicon Intrinsic brand fungicide also contains pyraclostrobin.

Tested in trials during 2008-2013, the research shows that Xzemplar and Lexicon provide consistent, long-lasting protection against a broad range of turf diseases.

"The research indicates that the new active ingredient fluxapyroxad is absorbed quickly and evenly transported into turf leaves," said Renee Keese, Ph.D., Biology R&D Project Leader, BASF. "The consistent uptake and delivery provide preventative and early curative disease control."

Both products are expected to be available for sale in spring of next year.

"SUPERINTENDENTS ACROSS THE COUNTRY ARE STRUGGLING WITH THIS ISSUE AND THEY DO NOT EVEN KNOW IT."

Scott McElroy, Ph.D., on herbicide resistant annual bluegrass.
(see full story on page 34)

//WEED CONTROL

Herbicide resistant annual bluegrass

Coming soon to a course near you!

By Scott McElroy, Ph.D.

In my opinion, herbicide resistance is a major cause of reduced annual bluegrass control. Superintendents normally place the blame of unsuccessful annual bluegrass control on misapplication, mistiming and unfavorable environmental conditions — but in my research and observation, herbicide resistance is a widespread problem that is rarely considered as a possible cause of the problem.

In this article, I will define and explain herbicide resistance, relate this information to annual bluegrass and discuss how there are not easy solutions to solving the problem of herbicide resistance.

HERBICIDE RESISTANCE DEFINED

When a herbicide is labeled for use, there is a given expectation for weed control.

FIGURE 1

A classic case of a herbicide resistance pattern. In this case, a sulfonylurea herbicide was applied for postemergence control of *Poa annua*. Clearly some plants died as they should have and others did not. The pattern is seemingly random and there is no obvious spray pattern that could have caused the effect.

A labeled herbicide rate is established to provide an average level of control that is consistent based on potentially hundreds of research trials. Herbicide resistance arises when a weed species is able to survive and reproduce following a labeled herbicide treatment that has been confirmed to kill the given plant species. There can be varying degrees of resistance, from 1.5 to 2 times the normal labeled rate to resistance over 100 times the normal labeled rate. The degree of resistance often depends on the type of resistance pressure to which the plant has been exposed.

Herbicide resistance is a process of selection (some say natural selection, but herbicides are not very natural, so let's just say selection.) If one were to apply the same mode of action annually one would be applying selection pressure. Selection pressure with a herbicide eliminates the plants that are susceptible and only allows resistant plants to survive. Over several years one could eliminate a susceptible population entirely, only allowing for resistant plants to survive.

There are two basic ways in which a weed species can develop resistance — non-target site and target site. Target site resistance is a change in the protein or enzyme that a herbicide binds to or interferes with that causes plant death. Small changes of just one amino acid in a 500 amino acid enzyme can change the way a herbicide binds, thus preventing the herbicide from acting. Target site resistance is known to occur in mitotic-inhibiting herbicides (prodiamine, pendimethalin, oryzalin), PS II-inhibiting herbicides (atrazine, simazine, diuron, amicarbazone) and acetyl-CoA carboxylase inhibitors (fluazifop, diclofop, fenoxaprop.)

Non-target site herbicide resistance changes the way the herbicide behaves or is treated within the plant. Simply preventing the herbicide from absorbing in the plant would be a form of non-target site resistance. Other ways include changes that limit how the herbicide moves within the plant and the degradation of the herbicide within the plant. Such changes are actually not simple at all and would require multiple genetic changes to achieve such a resistance mechanism. Non-target resistance is most common in glyphosate resistant weeds.

PHOTO BY: RICHIE EDWARDS, SUPERINTENDENT, HOLIDAY GC, PANAMA CITY, FLA.

Herbicide resistance is a process of selection... Selection pressure with a herbicide eliminates the plants that are susceptible and only allows resistant plants to survive.

HERBICIDE RESISTANT ANNUAL BLUEGRASS

Separate populations of annual bluegrass have developed resistance to almost all herbicides in use. The International Survey of Herbicide Resistance currently reports annual bluegrass resistance to photosystem II inhibitors (atrazine, simazine, diuron), photosystem I inhibitors (paraquat), inhibitors of very long-chain fatty acids (ethofumesate), mitotic-inhibiting herbicides (prodiamine, pendimethalin) and 5-enolpyruvate shikimate-3-phosphate inhibitors (glyphosate).

With this amount of resistance, there are very few herbicides that are still effective in all situations. Those

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What if annual bluegrass populations develop resistance to Velocity (bispyribac) which my research group has found? What are your options?

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herbicides that are effective are Specticle (indaziflam), Kerb (pronamide) and Finale (glufosinate.) See Ian Heap's website **http://www.weedscience.com** for more information on herbicide resistant weeds throughout the world.

WHY IS ANNUAL BLUEGRASS SO ADAPTABLE?

There are a few reasons why annual bluegrass is so adaptable to herbicide treatment. First, there is a lot of seed out there. Imagine all the potential millions of plants that are treated on one golf course in a given season. Now compound that with more golf courses and applying herbicides in successive years. There are an incalculable number of individual plants that would be treated. With that many plants, you eventually will find the one that is herbicide resistant (Figure 1.)

Second, annual bluegrass is a polyploid. Polyploids are species that are hybrids of two similar species or whose genomes have simply doubled. Think of it this way, humans (you and I, presumably) are diploids — this means that we have two sets of chromosomes. Polyploids have more than two sets of chromosomes.

In the case of annual bluegrass, it is a tetraploid — meaning that it has four sets of chromosomes — two sets from Poa infirma and two set from Poa supina, which are its ancestral parents.

But why is polyploidization beneficial? Think of it this way: If you have a diploid plant that has only two sets of the acetolactate synthase gene, one copy of the gene could be mutated to be resistant, which will eventually become two copies of the gene with the mutation if herbicide treatments continue to be applied.

The problem is that most mutations actually make the plant less fit or simply weaker compared to non-mutated plants. With a tetraploid, two copies of a gene from one parent can mutate and two copies of the same gene can remain in their fit form. So one plant, annual bluegrass in this case, can have the best of both worlds — it can make two fit copies of the gene for when no herbicide is being applied and makes two less fit herbicide resistant copies of the gene to help plants survive when herbicides are being applied.

WHAT IF…?

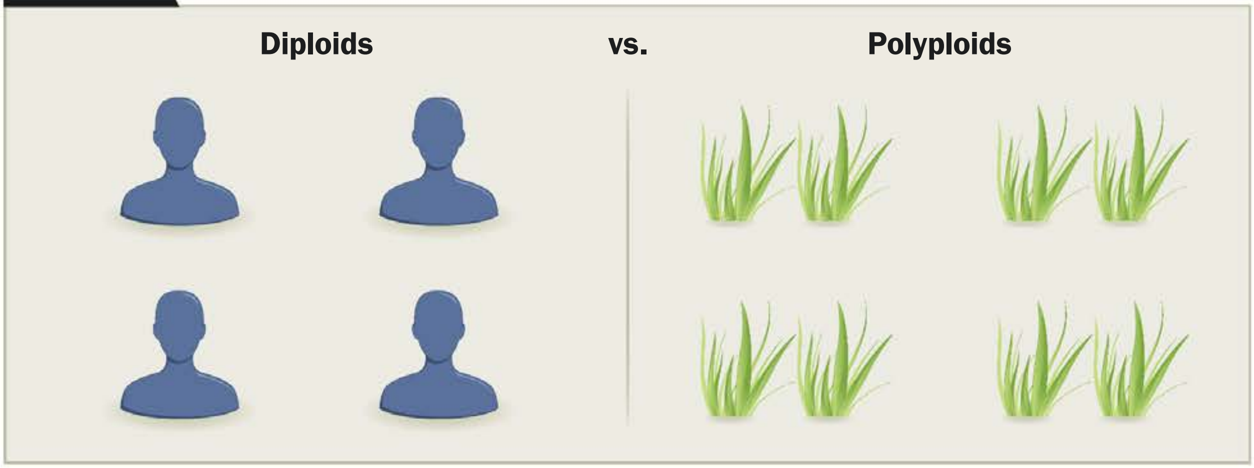
So what if one has an annual bluegrass population that develops resistance to a given herbicide or a class of herbicides with the same mode of action? The most immediate response is to change to another herbicide or herbicide mode of action, right?

Changing to another herbicide may not be that easy. Depending on the desirable turfgrass to be treated, adjacent turfgrass to the treated area and the level of weed control desired there maybe few to no options available.

Consider controlling annual bluegrass in bermudagrass surrounding a creeping bentgrass putting green. What if annual bluegrass develops resistance to dinitroaniline herbicides (prodiamine, pendimethalin) and is cross-resistant to dithiopyr? What are your options now?

One could use oxadiazon, but it has to be applied as a granular to dry turf to prevent injury and can only be applied as a liquid to dormant turfgrass. Glyphosate and glufosinate are options, but bermudagrass dormancy is questionable in greens surrounds and drift onto the putting green is possible. Sulfonylureas are options, but they are prone to off-target movement with surface water or tracking via tires and foot

FIGURE 3



Why is annual bluegrass so adaptable? One reason — it's a polyploid. Humans are diploids, which means we have two sets of chromosomes. Polyploids have more than two sets of chromosomes. Annual bluegrass actually has four sets of chromosomes.

ISTOCKPHOTO

traffic. Specticle (indaziflam) is a very effective preemergence herbicide for annual bluegrass, but it has off-target movement issues similar to sulfonylurea herbicides. Paclobutrazol can control annual bluegrass with multiple applications but bermudagrass green-up delay can occur. Sureguard (flumioxazin) is a new option that reportedly has less possibility for off-target movement, but lateral movement and traffic movement in turfgrass is difficult to predict. Xonerate (amicarbazone) is a new herbicide that controls annual bluegrass, but controlling larger plants may take two applications.

Confused yet? What would you choose to do?

Consider creeping bentgrass fairways or even greens. What if annual bluegrass populations develop resistance to Velocity (bispyribac), which my research group has found? What are your options?

One could use dinitroanilines or dithiopyr, but these herbicides present potential problems with root pruning and creeping bentgrass' ability to tolerate stressful conditions. Xonerate can be used in creeping bentgrass fairways, but repeat applications are needed in fairways, and very low rates and repeat applications are needed on greens. Even with these precautions, some injury is possible. Paclobutrazol can control annual bluegrass

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with repeat applications, but growth regulation and slight injury will occur. Oxadiazon, glufosinate, glyphosate, flumioxazin are not options.

The point is that changing to another herbicide or herbicide mode of action is not as easy as simply substituting another herbicide in for the one you lost. It is much more dynamic than that. In most situations one will have to totally restructure your application regime and modify your expectations for control. Trying to simply place a new herbicide in your current management plan is often the proverbial square peg in a round hole.

PREVENTING HERBICIDE RESISTANCE

When herbicide resistance prevention is discussed the first prevention strategy that is mentioned is "rotate modes of action." But what does this mean?

Let's use the example of using Specticle, which currently does not have any resistance issues, for preemergence control. Does rotating modes of action mean that in one year you should use Specticle and the next year use something completely different? And how often should you rotate modes of action — 1, 3, 5 years? Or do you change and treat half the acreage with Specticle and half with something else? What about tank-mixing another mode of action? Does that count as 'rotating herbicides?'

A final thought is that "spraying low herbicide rates increases resistance development." There is little to no evidence for this. It is possible that spraying low rates can aid in selection of non-target resistance mechanisms but not target site, but that is only speculative. One could also speculate that increasing herbicide rate, which increases selection pressure, could speed-up resistance development. In either case, one has to remember that herbicides do not cause the mutation, herbicides select for the mutation. Applying lower rates actually lowers the selection pressure.

Herbicide resistant annual bluegrass is a real and immediate problem in turfgrass management. Superintendents across the country are struggling with this issue and they do not even know it. Herbicide resistance will likely continue to develop in other weed species in the future as well.

Scott McElroy, Ph.D., is an associate professor of turfgrass science at Auburn University and can be reached at jsm0010@auburn.edu.

Ad Index

Companies featured in this issue

//SNOW MOLD CONTROL

PCNB Turns 50

A look at the past, present and future of one of the industry's most economical snow mold control products.

By Charles Silcox, Ph.D.

This fall marks the 50th snow mold season since PCNB was first registered in 1964. An active ingredient must possess a unique combination of characteristics to remain viable in the marketplace for five decades. PCNB continues to be selected by superintendents based on its performance, economical cost, mode of action and versatility.

This active ingredient is currently marketed in two formulations under the Turfcide brand — Turfcide 400 flowable turf fungicide and Turfcide 10-percent Granular turf fungicide.

Turfcide products are renowned for their cost-effectiveness. And after nearly 50 years of use on golf courses, there has been no evidence of resistance development by pink and gray snow molds. So Turfcide products have an important role to play in maintaining our ability to control snow molds over the long run and are viewed by many superintendents as the foundation of their snow mold control program.

Their versatility makes these products ideally suited for this role. They may be applied to golf course fairways, greens and tees and they may be applied alone or Turfcide 400 may be tank-mixed with other fungicides. Used alone, Turfcide products provide cost-effectiveness. Used in tank-mixtures, Turfcide 400 makes good products better and better products best.

After 50 years on the market, Amvac Environmental Products looks to the future at how to better control pink and gray snow molds.

TARGET DISEASES AND APPLICATION TIMING

Turfcide products are primarily applied for control of pink snow mold (*Microdochium nivale*) and gray snow molds (*Typhula incarnata* and *T. ishikariensis*). Turfcide products should be applied just before the first snowfall or when temperatures remain below 60 degrees F and extended wet conditions are expected. Many superintendents make their application soon after the last mowing in the fall.

In most locations, pink snow mold is the primary species confronted by superintendents because its development does not require snow cover. If cool, wet conditions persist without snow cover, then additional applications of Turfcide products can be made at 4 to 6 week intervals if conditions warrant them. Gray snow mold development requires 60 and 90 days of continual snow cover for *T. incarnata* and *T. ishikariensis*, respectively, so superintendents make sure that their fungicide application is on the ground before winter settles in for good.

APPLICATION RATES AND POST-APPLICATION IRRIGATION

The labeled application rates for Turfcide 400 applied for snow mold control are 12 to 16 fluid ounces of product per 1,000 square feet. Turfcide 10 percent Granular is applied at 5 to 10 pounds per 1,000 square feet for gray snow mold control and from 5 to 7.5 pounds per 1,000 square feet for pink snow mold control. The active ingredient must be moved into the thatch to ensure effective control. Thus, applications must be followed by 1/4 inch of either irrigation or rainfall on the day of application.

As strange as it may sound to superintendents in the northern regions of

PHOTO AND FIGURES COURTESY: AMVAC ENVIRONMENTAL PRODUCTS the country, it is often difficult for university researchers to achieve high levels of snow mold on the sites where they conduct replicated small plot efficacy trials. This held true during the winter of 2012/2013, in spite of long periods of snow cover in many areas. Under low snow mold pressure, many treatments provide acceptable control. The real effectiveness test comes at sites with intense snow mold pressure. Fortunately, two field trials from AMVAC's 2012/2013 snow mold efficacy program showed very high levels of disease when evaluated in the spring. This level of disease pressure allowed Turfcide to demonstrate its versatility for snow mold control.

Paul Koch, Ph.D. and coworkers at the University of Wisconsin conducted a field trial in Champion, Mich., that developed 78.8 percent disease severity (primarily *T. ishikariensis*) in the untreated plots (Koch et al., 2013). Table 1 shows the results from selected treatments that were included in the trial.

The treatments were applied October 30, 2012 and were rated at 189 days after application on May, 8 2013. The low label rate of Turfcide 400 (12 fl. oz. per 1,000 sq. ft.) provided greater than 90 percent control. A treatment of Turfcide 400 applied at 8 fl. oz. /1,000 sq. ft. was included in the trial as a reference for other treatments where this rate of Turfcide was tank-mixed with companion products. Turfcide was tank-mixed with Banner Maxx II (propiconazole) (2 fl. oz. /1,000 sq. ft.), Daconil Ultrex (chlorothalonil) (3.2 oz. /1,000 sq. ft.) and Interface (3 fl. oz. /1,000 sq. ft.).

Each of these tank-mixtures provided excellent control under high snow mold pressure and the combinations provided significantly better control than did the companion products applied alone. The Interface plus Turfcide treatment was applied at a number of locations last fall and certain results may lead to a new area of further research.

Charles Golob, M.S. and William Johnston, Ph.D. of Washington State University conducted a field trial in Columbia Falls, Mont., that developed 91.3 percent disease severity (65-percent pink snow mold [*Microdochium nivale*] and 35-percent gray snow mold [*Typhula* spp.]) (Golob and Johnston, 2013). Table 2 shows the results from selected treatments that were included in the trial. The treatments were applied November 2, 2012 and were rated for snow mold at 145 days after application on March 28, 2013. Under such severe disease pressure, the high label rate of Turfcide 400 (16 fl. oz. /1,000 sq. ft.) was required to provide excellent control. Tank-mixtures of Turfcide applied at 8 fl. oz. /1,000 sq. ft. with companion products performed exceptionally well in this trial. The combination of Interface (iprodione + trifloxystrobin)

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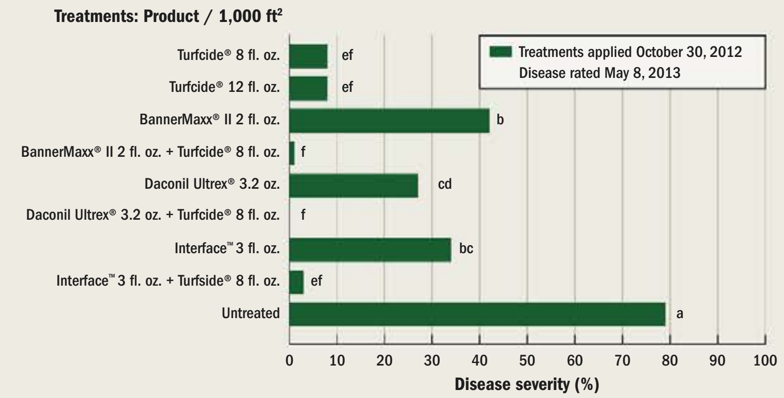
FIGURE 1

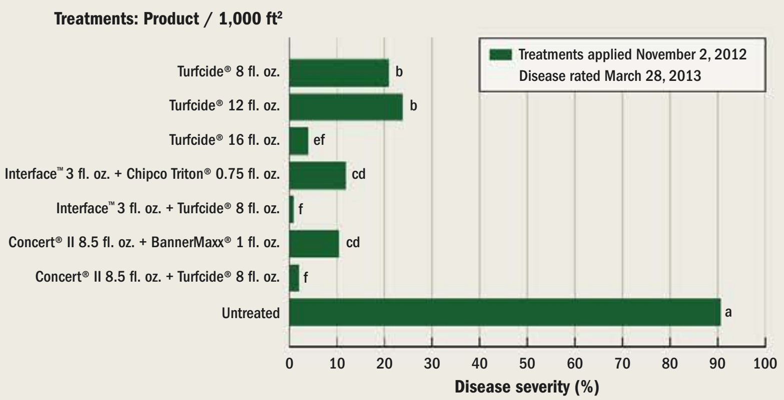
Results of a snow mold trial conducted by Paul Koch, P.J. Liesch, Sam Soper and Jim Kerns of the University of Wisconsin in Champion, MI



Primary pathogen: *Typhula ishikariensis*

FIGURE 2

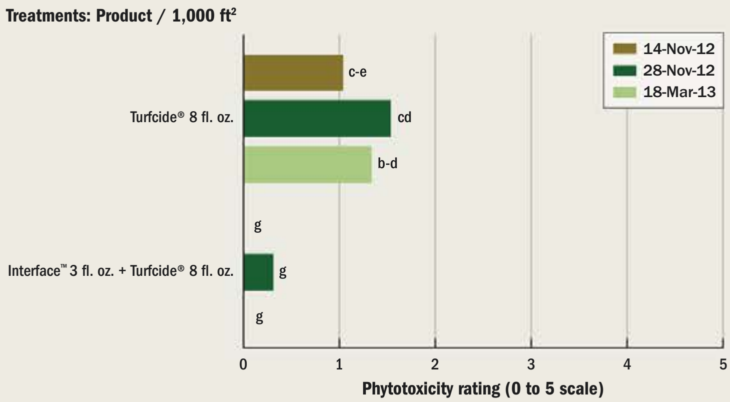
Results of a snow mold trial conducted by Charles Golob and William Johnston of Washington State University in Columbia Falls, MT



65% Pink snow mold (*Microdochium nivale*) and 35% Gray snow mold (*Typhula* spp.)

FIGURE 3

Results from a trial conducted by J. Popko and G. Jung of the University of Massachusetts in Queensbury, NY



Treatments applied November 7, 2012 to an annual bluegrass/creeping bentgrass fairway

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(3 fl. oz./1,000) plus Turfcide at 8 fl. oz. /1,000 sq. ft. provided significantly better control than did the combination of Interface (3 fl. oz./1,000 sq. ft.) plus Chipco Triton (triticonazole) (0.75 fl. oz./1,000 sq. ft.). The combination of Concert II (chlorothalonil + propiconazole) (8.5 fl. oz./1,000 sq. ft.) plus Turfcide provided significantly better control than did the combination of Concert II (8.5 fl. oz./1,000 sq. ft.) plus Banner Maxx II (1 fl. oz./1,000 sq. ft.).

An issue with Turfcide that most superintendents are well aware of is that under certain situations there may be a transient yellowing of creeping bentgrass after application. This has generally been managed through application timing by using the snow mold rates only after the turf has stopped growing in the fall. Applying Turfcide immediately prior to precipitation or irrigating the treated area after application minimizes the potential for yellowing by moving the active ingredient from the leaves into the thatch.

An interesting area for further research has been discovered recently by Geunhwa Jung, Ph.D. of the University of Massachusetts. Table 3 shows phytotoxicity ratings for two treatments from a trial that he conducted in Queensbury, N.Y. (Popko and Jung, 2013). The results show a marked reduction in phytotoxicity of creeping bentgrass when Turfcide 400 was tank-mixed with Interface. These results suggest that the StressGard Formulation Technology that is included in Interface may also help to reduce phytotoxicity by PCNB. As one can imagine, additional research on this topic will be conducted in 2013.

At the completion of their first half-century of use, Turfcide brand products are still an important component of snow mold management programs based on their performance, economy, versatility and mode of action. And current research is focused on expanding these attributes to redefine their place in the market for many years to come.

Charles Silcox, Ph.D., is a Product Development Manager with Amvac Environmental Products and can be reached at charless@amvac-chemical.com.

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