"The EMS framework makes sense for golf operations by helping to identify all aspects of your facility's environmental impact."

DAVID SMALLWOOD
DIRECTOR OF AGRONOMY, KAPALUA GOLF (HI)

QUESTIONS AND ANSWERS

The EMS edition

BY KEVIN A. FLETCHER, PH.D.

Environmental improvements made throughout golf since the early 1990s have been noteworthy. The Environmental Institute for Golf's 2007 *Environmental Profile Survey,* and their subsequent surveys since, have revealed numerous areas where golf has embraced environmental stewardship as a way to conduct business — from spill prevention to Integrated Pest Management practices.

Yet the industry has lacked a truly comprehensive approach to address facility-wide (i.e., not just the golf course) regulatory compliance, risk management, liability containment and improvements in best management practice adoption.

Enter the Environmental Management System framework. For over a decade, more sophisticated Environmental Management Systems (EMS) have been providing businesses of all shapes and sizes the type of credible and effective approach to managing environmental impacts and opportunities that the regulatory community and environmental organizations alike expect. The most-widely adopted type of EMS is the internationally-recognized ISO 14001 EMS standard (see sidebar, page 32) first introduced for worldwide use in 1996. This management standard is based on a "Plan/Do/Check/Act" approach to handling environmental expectations, obligations and aspirations and built to provide organizations a clear path to environmental excellence.

The ISO 14001 Environmental Management System standard provides a number of advantages for golf course owners and operations — namely, it is established, proven, "ready-to-use" and already widely accepted. It is globally pervasive (in use in over 140 countries) and has already been adopted by hundreds of thousands of organizations, including businesses, governments, schools and nonprofits alike.

In other words, since it is consensus-based, transparent in its development and already internationally recognized, the ISO 14001 EMS framework is ready to work for golf with no further caveats.

An EMS specific for golf

The e-par Environmental Management System for Golf is an online platform that allows anyone with knowledge of operations to develop an ISO 14001-compliant EMS for the golf course, clubhouse and pro shop. Initially developed in Australia over a decade ago and now in use in over two dozen countries, the e-par EMS was brought to the U.S. about two years ago.

The e-par EMS platform is "live" and has

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PHOTO BY: JOHN R. JOHNSON/GOLFPHOTOS.COM

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been "in-use" in the field for over a year now. So, what has been learned so far about the value Environmental Management Systems in general, and the e-par EMS for Golf, specifically? Are the benefits that other business sectors have experienced from EMS adoption also being experience by golf professionals? We picked a handful of potential EMS benefits and asked e-par EMS for Golf members to respond.

CAN IT HELP TO EFFECTIVELY AND EFFICIENTLY MANAGE ENVIRONMENTAL ISSUES?

"The EMS framework makes sense for golf operations by helping to identify all aspects of your facility's environmental impact. It made a lot of sense for us to adopt the program at Kapalua because we are such a large facility that has many moving parts. E-par's EMS specifically enabled us to identify all of our potential environmental risks and map out plans of how we could proactively manage our interaction with the environment."

DAVID SMALLWOOD
Director of Agronomy
Kapalua (Hawaii) Golf

CAN IT HELP MEET GROWING INDUSTRY STANDARDS?

"This is a huge step in the process to help keep the game of golf moving forward in its sustainability and environmental efforts. Being proactive rather than reactive will serve us well with our membership, allied associations, the golf world and maybe most importantly, with those who are the detractors of the game, question its effect on the environment, and question if we are responsible stewards of the lands we manage."

Pete Grass

PETE GRASS, CGCS
Hilands GC, Billings, Mont.

CAN IT HELP MEET EXPECTATIONS OF THE REGULATORY COMMUNITY?

"If I am talking with Department of Environmental Conservation, insurance representatives, or government officials, I speak mostly about e-par and our Environmental Management System."

MATT CEPLO, CGCS
Rockland CC, Sparkill, N.Y.

CAN IT HELP MEET COMMUNITY EXPECTATIONS?

"We're surrounded by homes, with an older development and a newer one. The people in the older development decided that they should be concerned about the rural water supply and the quality of the water. They were concerned about their wells. I was able to use the EMS to demonstrate that we are taking responsibility and had documented our strengths and weaknesses for water best management practices. I also mentioned to the local residents that the EMS met the ISO 14001 standard. While most people don't know what that really is specifically, it gave us some real legitimacy that our environmental management approach wasn't just pulled out of thin air, that it was based on an internationally-recognized standard."

ERIC FOERSTER, GCGS, MG
Ironbridge GC, Glenwood Springs, Colo.

DOES AN EMS HELP TO TRACK AND REPORT ON ENVIRONMENTAL PERFORMANCE GOALS?

"The process of building the EMS really opened my eyes up to the tracking and documentation we really should be doing, and the EMS provides the platform to do that more efficiently. It still takes some time to keep up with it, but it's a lot better than doing it 'hit or miss' like before."

ERIC FOERSTER

DOES AN EMS HELP TO REDUCE AND MANAGE ENVIRONMENTAL RISK?

"I look at an EMS as an insurance program with benefits. No one ever wants to have to use their insurance because that means there has been an accident, but when something does happen you're sure glad it's there."

ADAM IKAMAS, CGCS
Michigan GCSAA Executive Director

Kevin A. Fletcher, Ph.D., is the president and CEO of e-par USA. He can be reached at kevin@eparusa.com.

KEY ELEMENTS OF AN EMS

- Environmental policy and principles
- Legal and other obligations
- Identification of environmental aspects and impacts
- Environmental management plan with objectives and targets
- Structure and responsibilities
- Training and staff awareness, communications, outreach
- EMS documentation
- Operational control (i.e., standard operating procedures)
- Emergency preparedness and response
- Monitoring and measuring
- Nonconformance and corrective action, records
- EMS audit
- Management review

Hosted by Clark Throssell, Ph.D. | *clarkthrossell@bresnan.net*

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.

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.

Marcus Jones Ph.D., Iowa State University, Ames, Iowa and Quincy Law, Purdue University, West Lafayette, Ind. Marcus Jones can be reached at marcusajones@gmail.com for more information.

PHOTO BY: QUINCY LAW

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.

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

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...?

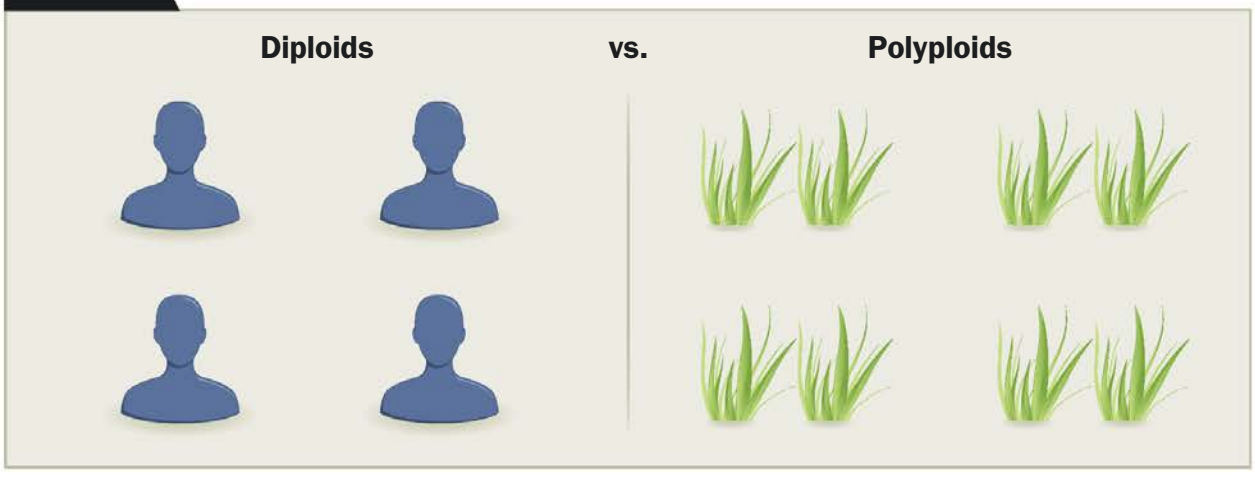
So what if one has an annual bluegrass population that develops resistance to a given herbicide or a class of herbicides with the same mode of action? The most immediate response is to change to another herbicide or herbicide mode of action, right?

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.

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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ISTOCKPHOTO

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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.

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//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