Herbicide Resistance:

A Problem on the Horizon for Athletic Field Managers?

▶ **A DORMANT** bermudagrass athletic field

ALTHOUGH CERTIFICATION PROGRAMS are in place to limit the presence of weeds in turfgrass seed and vegetative material (i.e., sod, sprigs, etc.), infestations are common on warm- and cool-season athletic fields. Weeds such as crabgrass (Digitaria spp.), goosegrass (Eleusine indica) and annual bluegrass (Poa annua) can be found on fields at all levels of play. Controlling these species is important to athletic field managers in that weed infestations can reduce both field quality and safety. Implementing sound agronomic practices and integrated pest management strategies can help discourage the presence of weeds on athletic fields. However, in many cases herbicide applications are often required for complete eradication.

HERBICIDE RESISTANCE IS A PROBLEM

Herbicide resistance has been defined as the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type (Vencill et al. 2012). The onset of herbicide resistant weed biotypes is a global problem of agriculture, turf included. Nearly 400 biotypes of herbicide resistant weeds have been reported worldwide, spanning over 200 different plant species (Heap 2013). The rate at which herbicide resistant weeds have developed in agricultural production has increased following the adoption of herbicide-tolerant crops (i.e., Roundup Ready). This technology allowed for herbicides targeting a single site of action (i.e., herbicides that work in a similar manner) to be repeatedly used for effective weed control; thus, reducing the diversity of techniques used for weed management (Vencill et al. 2012). As a result, selection pressure for herbicide resistant weed biotypes increased.

Despite the fact that herbicide resistance in crop production has been an issue since 1970, several reports of herbicide-resistant turfgrass weeds have surfaced in recent years, illustrating that herbicide resistance is an emerging problem of turfgrass weed management requiring intervention. While most of these cases of herbicide resistance have occurred on golf courses, it is imperative that athletic field managers A) become aware of this emerging issue and B) make changes to their programs to prevent herbicide resistance from becoming widespread on athletic fields in the near future.

▲ **GLYPHOSATE** resistant annual bluegrass (Poa annua) in dormant bermudagrass.

WHAT CAUSED THE PROBLEM?

While herbicide tolerance traits (i.e., Roundup Ready) are not used in the turfgrass industry, diversity of weed management techniques is often lacking. Turfgrass managers often repeatedly apply the same herbicides for control of problematic weeds year-after-year. This has led to the development of herbicide resistant biotypes of annual bluegrass (Poa annua), goosegrass (Eleusine indica), and smooth crabgrass (Digitaria ischaemum) in turfgrass.

GLYPHOSATE RESISTANCE

Bermudagrass (Cynodon spp.) athletic fields

enter a period of dormancy during winter where growth ceases. Non-selective herbicides such as glyphosate (e.g., Roundup, etc.) that normally would be injurious to turfgrass can be used to control weeds during this dormancy period (Anonymous 2010). Many athletic field managers in the transition zone apply glyphosate for weed control during bermudagrass dormancy. Glyphosate applications to dormant bermudagrass fields often provide effective and more economical broad-spectrum weed control during winter conditions than other materials, particularly inhibitors of acetolactate synthase (ALS) such as foramsulfuron (e.g., Revolver), trifloxysulfuron (e.g., Monument), and flazasulfuron (e.g., Katana).

As a result, many weed populations on bermudagrass athletic fields are under intense glyphosate selection pressure, similar to that which has been reported following the advent of glyphosate-tolerant crops in agricultural production systems. Recently two biotypes of annual bluegrass with resistance to glyphosate have been reported in Missouri and Tennessee (Binkholder et al. 2011; Brosnan et al. 2012). In both cases, repeated applications of glyphosate were used to control annual weeds during periods of winter dormancy for over 10 consecutive years.

RESISTANCE TO OTHER HERBICIDES

Resistance is an issue with herbicides other than glyphosate. ALS-inhibiting herbicides such as foramsulfuron (e.g., Revolver), trifloxysulfuron (e.g., Monument), and flazasulfuron (e.g., Katana) are commonly used on warm-season athletic fields to remove overseeded perennial ryegrass (Lolium perenne) and control other problematic grassy weeds such as annual bluegrass and goosegrass. Repeated use of these herbicides for annual bluegrass control has led to the development of annual bluegrass biotypes with resistance to ALS inhibiting herbicides. Cross et al. (2013) identified multiple biotypes of annual bluegrass in the southeastern United States resistant to foramsulfuron and trifloxysulfuron. Populations of annual bluegrass in Tennessee have recently been identified that are tolerant to 8x label rate applications of foramsulfuron and trifloxysulfuron.

Photosystem II (PSII)-inhibiting herbicides such as simazine (i.e., Princep) and amicarbazone (i.e., Xonerate) are used for annual bluegrass control in warm-season turf. Repeated use of these materials, particularly simazine, has led to populations of annual bluegrass resistant to PSII-inhibiting herbicides in Alabama, Mississippi, North Carolina, Oregon, and Virginia (Heap 2013). Hutto et al. (2004) documented the presence of simazine-resistant annual bluegrass on 43% of the golf courses in Mississippi.

Dinitroaniline (DNA) herbicides such as pendimethalin (e.g., Pendulum) and prodiamine (e.g., Barricade) are regularly used for preemergence control of grassy weeds such as crabgrass, annual bluegrass, and goosegrass. Multiple biotypes of annual bluegrass and goosegrass resistant to the DNA herbicide prodiamine have been reported in the southeastern United States as the result of repeated use of prodiamine (Cutulle et al. 2009; Isgrigg et al. 2002; Lowe et al. 2001; McCullough et al. 2013; Mudge et al. 1984).

WHY ANNUAL BLUEGRASS (POA ANNUA)?

To date, the majority of instances of herbicide resistance in turf have occurred in annual bluegrass. The reason for this phenomenon is not completely understood; however, herbicide resistance is most common in annual species (Heap 2013). Prolific annual bluegrass seed production may result in more rapid and effective dispersion and survival of herbicide resistant plants (McElroy et al. 2004). In agricultural production systems, many weed species developing herbicide resistance, such as Palmer amaranth (Amaranthus palmeri) and horseweed (Conzya canadensis), produce copious amounts of seed as well (Nandula et al. 2006; Norsworthy et al. 2008).

WHAT CAN BE DONE?

In order to prevent herbicide resistance from becoming a problematic issue on athletic fields, turf managers must change their approach to weed control. The first step is to learn the manner in which different herbicides work to control weeds. Be sure to consult with local University Extension offices for more information on this important topic. Acquiring this knowledge will not only improve the professionalism of athletic field managers in general but it is also critical for developing weed control programs to prevent resistance development on warm- and cool-season athletic fields. Applying a rotation of different herbicides targeting varying sites of action (i.e., using products that work differently) will reduce selection pressure for herbicide-resistant weeds. However, it is critical that field managers rely on more than just herbicide applications to control weeds. Diversified weed management programs involving sound agronomic practices, integrated pest management strategies, and herbicide applications will ensure that herbicide resistance does not become a problem of athletic field turf in the future. ■

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