Herbicide Resistant Turfgrasses — Panacea or Problem?

Will herbicide resistant turfgrasses solve your problems or add to them? This author offers his opinion

By Dr. Joseph C. Neal

Just about every turfgrass manager (and home gardener) would love to have a product they could spray over the top of their lawn or golf turf to kill all weeds, as well as not injure the turfgrass, be environmentally friendly and be essentially non-toxic.

Not many years ago, this would be dismissed as a dream; however, with recent advances in genetic engineering and plant breeding, that dream is now quite possible and very close to becoming a reality.

Researchers at Rutgers University demonstrated the potential by genetically engineering creeping bentgrass for resistance to the herbicide glufosinate (Finale, by AgrEvo).

Researchers at The Scotts Company are currently engineering and breeding turfgrasses for resistance to glyphosate (Glyphosate, by Monsanto).

Imagine if you will, that you could spray glyphosate over your bluegrass lawn without injuring the bluegrass; finally, there would be a way to remove all the unwanted grass species like tall fescue, colonial bentgrass and even bermudagrass.

Similarly, would not golf course superintendents' battles with annual bluegrass become a thing of the past if a glufosinate-resistant bentgrass variety were available?

Selectively controlling perennial grasses like this velvetgrass (Holcus lanatus) in a Kentucky bluegrass lawn may be possible if herbicide resistant turfgrasses become a reality. But at what cost? (Photo by J. Neal)

Listing the positives

The list of positive attributes for herbicide-resistant, particularly glyphosate-resistant, turfgrass is long. Weed control would be simple and complete. No more wondering about which product will control a particular weed. No more worries about overseeding bare spots in herbicide treated turf.

We could reduce the environmental load of herbicides used in turfgrass management; and, since herbicides account for the majority of pesticides used in turf maintenance, the

overall environmental load of pesticides used in the turfgrass industry would be reduced.

However, there are serious negative impacts which must be considered with the implementation of this new technology. Foremost among these negative impacts are the evolution of herbicide-resistant weeds, escape of the herbicide-resistant grass into surrounding areas and transferal of herbicide resistance to closely related grass species.

Would they fit?

Not long ago, most weed scientists (I among them) did not believe that resistance to glyphosate would naturally occur, and if this unthinkable event did happen, that the glyphosate-resistant weeds would not be ecologically "fit" (in other words, a glyphosate-resistant weed would not be able grow and reproduce efficiently).

After all, it took over a decade of intense research in laboratories and genetic engineering to create the first glyphosate-resistant crop species.

Boy, were we wrong!

In 1996, researchers in Australia reported a population of rigid ryegrass (Lolium rigidum) had developed resistance to glyphosate following 15 years of treatment with that herbicide. More recently, similar resistance has been reported in California.

Okay, rigid ryegrass is not a major turf weed, so why should we care? Rigid ryegrass is a genetically diverse grass that is considered by many to be one of the species most prone to developing herbicide resistance. Broad genetic diversity and selection pressure of continued use of a single herbicide mode of action is a recipe for herbicide resistance development.

The mechanism of the development of a resistant is fairly straightforward. In a genetically diverse population, there can be several to many population members that have naturally evolved characteristics that allow these individuals to survive a specific herbicide application. If these individuals can successfully reproduce, they can rapidly become the dominant portion of a population, particularly if repeated applications of the same herbicide puts the resistant members at a competitive advantage.

Kentucky bluegrass encroaches into landscape beds via rhizomes. (Photo by J. Neal)

Do we have similarly genetically diverse weed species in turf? Yes! Annual bluegrass.

One resistant species

Annual bluegrass is a genetically diverse species with many biotypes and it is prone to herbicide resistance. Following continuous use of a single herbicide for several years, annual bluegrass has been reported to have developed resistance to the triazine herbicides (simazine and atrazine) and the dinitroanaline preemergent herbicides (benefin, oryzalin, pendimethalin, prodiamine, and trifluralin), as well as the general vegetation control materials amitrole and paraquat.

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Annual bluegrass resistance to the triazine herbicides is widespread in golf course turf in the United States and several other countries. Recently, researchers at North Carolina State University reported an annual bluegrass population in golf

course turf that had developed resistance to the pre-emergent dinitroanaline herbicides following just seven years of dinitroanaline use. Even goosegrass, a species not known for its genetic diversity, has developed resistance to the dinitroanaline herbicides in the southeastern U.S., and in Malaysia, goosegrass has developed resistance to glyphosate.

Would glyphosate-resistant weeds develop in a glyphosate-resistant turf? The answer is simple — yes!

In a glyphosate-resistant turfgrass, we could expect to see several applications of glyphosate during the growing season — fall and spring for annual bluegrass and perennial broadleaf weed control, early summer for crabgrass and nutsedge control and other spot treatments for escaped weeds.

Multiple applications per season over several years would increase the selection pressure for herbicide resistance in several weed species. We do not know how long it would take for these resistant populations to develop, but a fair estimate is between 7 and 15 years.

Annual bluegrass in a creeping bentgrass green. Is herbicide resistant turf the answer? (Photo by R. Uva)

Quite a weed

Glyphosate-resistant turf could be quite a weed. Glyphosate, in any one of its many formulations or trade names, is clearly the herbicide of choice for controlling perennial grass weeds that encroach into landscape beds or adjacent properties.

One survey of grounds maintenance operations suggests that glyphosate may account for up to 90% of their pesticide applications in landscape beds. Although there are several postemergence grass herbicides (such as sethoxydim [Vantage], fluazifop [Fusilade or Ornamec], and clethodim [Envoy]) that can be used to control perennial grasses in landscape beds, none control perennial grasses as well as glyphosate does, particularly late in the season.

Our research has also shown that glufosinate (Finale) does not control perennial grasses as well as glyphosate. In short, if a glyphosate-resistant turf were to creep into landscape beds or sand traps, it would be difficult to control because we don't have other tools that are as effective as glyphosate.

Glyphosate is also our number-one tool in turfgrass renovation. Should renovation of the glyphosate-resistant turf be necessary, or if you wish to kill the turf to prepare the site for a landscape bed, how will you get rid of that glyphosate-resistant turf?

Neither the postemergence selective grass herbicides nor Finale are effective alternatives for turfgrass renovation. Other herbicides effective on perennial grasses would leave a soil residual that would prohibit reseeding or planting.

Fumigation would, in my opinion, be the only effective alternative.

With the impending loss of methyl bromide in 2005, we will lose one of our most versatile fumigants and possibly the only rational control material for glyphosate-resistant turf.

Transmission of resistance

It is generally accepted that glyphosate resistance can be transferred when pollen from glyphosate-resistant plants move to the flowers of nearby plants of the same species. Under these circumstances, can glyphosate-resistant offspring be produced? Yes!

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Realistically, most of these new offspring would probably not be ecologically fit and would not survive.

In particular, if these newly resistant offspring were to emerge in a turfgrass area, as with any newly emerged seedling, the likelihood that they will be able to successfully compete with established vegetation is very small. However, if they were to emerge in landscape beds where other competing vegetation has been controlled, they will have the potential to establish, grow and reproduce. The subsequent movement of these resistant species off-site would be inevitable.

Conclusion

I personally believe that glyphosate-resistant turfgrass is a bad idea and, for the reasons I have expressed above, hope it never becomes a commercial reality.

That is not to say that I am completely against the concept of herbicide-resistant turfgrasses. For example, a glufosinate-resistant (Finale resistant) turfgrass could be controlled with glyphosate if it escaped cultivation or if renovation became desirable.

Annual bluegrass has developed resistance to many herbicides. (Photo by R. Uva)

I believe genetic engineering of turfgrass species offers great promise for overall quality enhancement, insect and disease resistance and stress tolerance.

However, researchers engaged in improvement of turfgrasses through genetic engineering must be particularly vigilant and careful not to release a turf type with the potential to become a significant weed or to otherwise negatively impact the environment surrounding our turf. It is always helpful to remember that the law of unintended consequences is in play here.

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