Getting to the Root of Weed Control

Scientists have tried for years to understand how plant roots grow downward. Now, MIT geneticists have isolated the gene responsible, suggesting the potential for new herbicides that will wipe out weeds without hurting the environment.

BY DOUGLAS PAGE

Science may be digging deeper to the root of the weed problem.

Geneticists at the Massachusetts Institute of Technology recently isolated a plant gene that plays a critical role in the ability of roots to grow properly. Their ongoing research suggests that genetics could help scientists save time and money developing a new generation of more effective and safer herbicides.

Researchers at MIT's Whitehead Institute for Biomedical Research located the gene (called Ethylene Insensitive Root 1, or EIR1) while working with a tiny weed, Arabidopsis thaliana. When this gene is removed from A. thaliana weeds, the mutant roots lose their ability to grow downward. Hence, the weeds perish.

"These findings provide important new insights into age-old mysteries about root growth," states Gerald R. Fink, a founding member and director of the Whitehead Institute.

The finding could eventually lead to herbicides designed to alter the gene.

Scientists have tried for more than 200 years to understand exactly how plants direct roots downward in search of the earth, at the same time sending their shoots upwards in search of the sun. So great is the plant's imperative that if a root is reoriented to lie horizontally to the surface of the earth — in other words, turned 90 degrees with respect to gravity — it responds by altering its direction of growth, curving downward again until it finds its way into the earth.

Scientists have known that during root growth, the redistribution of a plant hormone called indole acetic acid (IAA) to the root tip is responsible for gravitropism, the organism's reflex in response to gravity. When roots are oriented horizontally, IAA accumulates along the lower side of the elongating zone. Cells on the top part of the root

elongate, causing the downward curvature of the root.

Researchers have speculated that the transport of IAA is facilitated by a gene that acts as a pump to redistribute the hormone up and down root cells as needed. The EIR1 gene isolated by the research at the Whitehead lab may represent this pump.

The Whitehead findings could lead to the design of new classes of compounds targeted at plant-specific genes like EIR1. But so far, according to a DuPont spokesperson, this is "not currently a major focus."

Many questions and challenges remain, including concerns about mutant weeds somehow being released into the environment. Although any EIR1-type herbicide product would ideally destroy any weed before it could reproduce, skeptics are as abundant as dandelion shoots.

"A concern I might have is that whatever weeds this gene could be inserted into might be released into the wild and possibly cross with other species (possibly crops or endangered species), which could reduce their fitness to survive," says Tom Lanini, a weed ecologist at the University of California, Davis. "In the current state of genetically mutated organisms, I doubt the public would want to see this gene released into a field setting."

Genetic manipulation is a popular concern, even among superintendents eager to reduce or eliminate the use of conventional herbicides.

"It sounds almost too good to be true," says Cary N. Lewis, superintendent at Renaissance Vinoy Resort in St. Petersburg, Fla. "It'll be a great day when we could manage our turf without the need for herbicides. If this EIR1 gene is the tool to lead us to that day, fantastic.

"But I'm not a fan of changing the genetic makeup of things and turning them loose in the environment, although I support continued research and I would love to reduce chemical use in turfgrass management," Lewis adds.

Still, most superintendents are intrigued by the possibilities presented by the research, however remote an actual product may be.

"The ability to genetically control weeds in turfgrass would revolutionize the way we treat our turfgrass," says Joe T. Boe, superintendent of Coral Oaks GC in Cape Coral, Fla. "I haven't found a herbicide on the market that kills weeds and has no adverse effect on turfgrass."

Reliance on herbicides as the primary weapon in the weed wars is tempting and understandable. The active ingredients in herbicides enters plants through their crowns, roots and shoots. The major site of physiological activity is within developing plant tissues found in the growing points of roots and shoots of susceptible plants, where the mode of action disturbs or inhibits mitotic cell division, development and growth.

However, overreliance on herbicides adds one more toxic chemical to the environment already soused with insecticides, fungicides and liquid fertilizers. About 175 chemicals, comprising the active ingredients in several hundred formulations of herbicides, are currently available for control of weeds in Florida, for instance.

All of the herbicides at superintendents' disposal have such an impact on surrounding turfgrass that fertilizers or micronutrients need to be added so the turfgrass plant retains its vigor and is able to fill in the area where the weeds were present.

"The main problem I can see is that this product will probably have to be spot-sprayed so the surrounding turfgrass will retain a healthy root system — which, as all superintendents know, is our main means of job security," Boe says.

Even though gene isolation may be a step in the direction of a lasting solution to the weed problem, some observers fear losing touch with the fundamentals of turfgrass health.

"Many people attribute our downfall to the continual quest for shorter grass or faster greens, but I think the real challenge of the future lies in managing traffic," says Jeff Carlson, president of Wild Side Golf Consulting in North Eastham, Mass. "Our desire to use less water and nitrogen and our fascination with low-impact grasses work well until confronted with 30,000-plus rounds." ■

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CARY LEWIS, *Superintendent*

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