# The Imazapyr Pandemic

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Dr. Roberts has researched many issues in Michigan's plant industry, including Oak Wilt, Dutch Elm Disease, Diplodia Tip Blight of Pines, along with a variety of cultural problems such as plant nutrition and herbicide toxicity. During his career, he has discovered a variety of new diseases and pests such as Phomopsis Canker of Spruce and the first bacterial wilt disease of turfgrasses in North America.

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## INTRODUCTION:

Herbicides are widely used throughout our industry whether in nursery, landscape, lawn, right-of-way, or a variety of environments for the control of "invasive" plants. Herbicides are safe, labor saving and highly effective if utilized correctly. Herbicides also have a serious downside if used improperly (Photo 1). Two of the most widely marketed herbicides are Glyphosate (the most widely used herbicide in the world) and Imazapyr. The patents of both herbicides expired years ago; hence, many chemical companies are now manufacturing these chemicals and marketing them singly or in combination with other chemicals under various trade names. Some of the most widely marketed combination products include Glyphosate and Imazapyr; some common trade names of these products include Roundup® Extended Control, Roundup® 365, Ortho® GroundClear® and RM 43 (Photo 2), etc. A comparison of these chemicals is summarized in Figure 1, according to the author. Please note that my experiences differ somewhat from some of the literature you may find on the web. For example, some sources claim that Glyphosate and Imazapyr are both soluble in water and will move in water and in soil. I have not experienced movement of Glyphosate in water or soil but have encountered movement of Imazapyr in the same numerous times. Some literature also suggests that they are both persistent and long-lived. In my experience, Glyphosate is relatively short-lived, becoming inactive on contact with soil and organic matter, apparently the primary reason Imazapyr is added to many Glyphosate-containing products. It is generally understood that Glyphosate breakdown chemicals may persist, but they appear to be largely inactive. While I would never claim to be an herbicide specialist, I have witnessed herbicide impacts (nontarget) on trees and other landscape/nursery plants for more than 40 years.



Figure 1: A comparison of the attributes of Glyphosate and Imazapyr, two commonly used herbicides in Nursery and Landscape.

| Glyphosate | Imazapyr |
|---|---|
| Nonselective | Nonselective |
| Systemic | Systemic |
| Short-Lived Activity | Long Residual & Activity |
| Inactive on Contact w Soil | Active on Contact w Soil |
| Doesn't Move in Water | Moves in Water |
| Direct Plant Exposure for Absorption | No Direct Exposure Needed for Plant Absorption |


## About Imazapyr:

I summarized the attributes of Glyphosate in the article **"Roundup®: The Controversy Continues"**, *The Michigan Landscape,* Sept/Oct 2019, Pages 39-46. In this article, I wanted to devote primary attention to Imazapyr, the chemical with which I experience the most toxicity problems to plants in our industry. Imazapyr and its close relative, Imazapic, belong to a class of herbicides known as Imidazolinone. Research on this class began in earnest in the 1980s; Imazapyr was patented in 1989. Like Glyphosate, the patent on Imazapyr expired many years ago, meaning that many chemical companies are now producing it under various trade names. The herbicide's mode of action is to disrupt DNA/protein synthesis, which stops cell growth. Imazapyr concentrates in the meristematic (active growth) tissues where it inhibits cellular growth. Essentially if a plant cannot reproduce new cells, it ceases to grow and eventually dies. For many of us, the lack of foliage on a plant in the summer indicates "death". However, death is not always the case with Imazapyr exposure. Symptoms of Imazapyr on plants include stunted growth, bushy growth, distorted and gnarled foliage, no growth, and death (Photos 3A, 3B, 3C &

**P1** This award-winning commercial landscape was severely harmed by a "lowest bid" application of Imazapyr to tree rings and other mulched areas of the landscape for long term weed control (also see Photo 4).

**P2** These are a few of the common Imazapyr-containing products readily available in the marketplace.

**P3A -3D** Common symptoms of Imazapyr on plants include stunting (3A, Lilac), distortion (3B, Climbing Hydrangea), bushiness or witches' broom (3C, Maple), and "apparent" death (3D, Privet hedge). Plants affected by Imazapyr may appear dead but could eventually recover, provided there is green cambium (3D Inset) (also see Photo 1 and Photo 4).


P3B


P3C


P3D

3D). After exposure to Imazapyr, whether lethal or sublethal doses, the cambium of plants may remain alive for one or several years (Photo 3D Inset); therefore, I distinguish symptoms of "no growth" from "death". This is an important characteristic of Imazapyr when investigating plant problems, especially herbicide issues; some plants exhibiting no growth may not be dead... and may recover with time (Photo 4). Another vital characteristic is that symptoms of Imazapyr toxicity on trees/plants may not appear until the year following its application. This aspect confuses many users of products containing Imazapyr.

The purpose of the article is to alert people about the dangers of the specific herbicide known as Imazapyr. To qualify, Glyphosate is also a nonselective herbicide that can adversely affect trees and other plants if improperly applied; application, for example, to thin bark trees and shrubs, to water sprouts (epicormic shoots) arising from the trunk or roots, and drift has harmed or even killed many trees and plants. However, I have documented far more problems with Imazapyr than Glyphosate. Over many years, I have found that laypeople and professionals alike are not always aware of which herbicides are safe/dangerous for use around trees and shrubs in landscapes and nurseries. Also, I find that many individuals do not recognize symptoms of herbicide damage... nor associate plant decline and death with their activities associated with herbicide application. Following are some examples of Imazapyr phytotoxicity in various uses in our industry. Some of the names and locations have been changed or are purposely vague to protect the innocent and the guilty.


P4

## Homeowners and Imazapyr:

Most of the products containing Imazapyr and Glyphosate are readily available to the homeowner market in the big box stores such as Lowes, Home Depot and Menards. After encountering so many instances of Imazapyr damage caused by homeowners, I have often thought that these products should not be available to persons not qualified to apply them. However, despite possible misuse or misapplication, some of the problem lies with vague herbicide labels. Some products prescribe use of the product on patios, driveways, walkways (paths), and tree rings right on the front of the package. Other products express "do not use in the vicinity of tree roots" in very fine print buried deep in the label that hardly anyone ever reads.

**Susan in Rochester Hills:** A company representative who manages Susan's turf and landscape asked me to visit her home where a Privet hedge was dying back (Photo 5). Susan was apparently making insinuations that the company may have done something wrong. Upon arrival, I immediately knew the problem was Imazapyr. Through investigation, I learned that Susan had applied both Roundup® Extended Control and Roundup® 365 to her rock mulch to keep weeds at bay. The damage in Photo 5 was due to an application the year before. The really depressing aspect for Susan and me is that she had made another application just a few days before my visit!

**P4** All but two of the Maple trees in Photo 1 recovered 2-3 years after an application of Imazapyr. Often, plants die from acute Imazapyr exposure. However, it is wise to be patient.

**P5** This Privet hedge was severely affected by applications of products containing Imazapyr by the homeowner who had insinuated that her landscape/lawncare professional may have caused the problem. She was simply unaware of the dangers of Imazapyr.

**Henrietta near Gull Lake:** A professional arborist asked me to visit Henrietta's after attending one of my lectures and learning about herbicide phytotoxicity. Several large walnut trees had "died" due to an application of Roundup® 365 to her patio and brick walk (Photos 6A & 6B). Lumberpersons were eagerly bidding to have access to the purchase of such large old walnut trees.

## Arborists/Landscapers and Imazapyr

While we might expect homeowners to not understand herbicides or be more likely to misapply them, a startling large number of professional applicators are having similar experiences. I think a significant portion of the problem could be, again, poorly worded and misleading labels. Also, there is clearly a misunderstanding of the chemicals in some of the products that are being applied by professionals. Photo 1 and Photo 4 represent a "misapplication" by professional applicators to a large commercial site where many trees and shrubs were killed (Photo 7).

**Lawn Care in Sterling Heights:** Gary, an arborist with a well-known company in Michigan, asked me to visit a site in Sterling Heights where he suspected Oak Wilt might have killed several oak trees. Upon arriving at the property of his client, I witnessed two "dead" red oaks straddling the drive (Photo 8). The red oaks 30-50 feet from the drive






**P6A &6B** Another homeowner who lives on the shores of Gull Lake (near Richland, MI.) had killed this large walnut tree simply by applications of Roundup® 365 to her brick walkway near her house. The large trunk of the tree (compared to handymen in Photo 6B) was straight and limbless for the first 25-30 feet, prompting lumberpersons to salivate.

**P7** Many of these shrubs were killed after an application of Imazapyr to mulch areas. Application was made by a licensed professional to a commercial site. Note dead areas of turf from movement of the herbicide by precipitation and irrigation.

**P8** It is presumed that a lawncare company had applied Imazapyr to this drive to control weeds. However, the company claimed to have used only straight Glyphosate. Several trees adjacent to the drive were affected by the herbicide application. Red oaks were especially sensitive to Imazapyr and died. The maples were moderately affected, and white oak (center left) showed no symptoms of herbicide toxicity indicating a differential sensitivity to the herbicide.

showed a few dead branches but most importantly many branches exhibited stunted growth typically associated with Imazapyr. The property owner stated that she thought her lawn care company had applied an herbicide to the drive to suppress weeds. Gary called the lawn care company whose personnel admitted they had used Roundup® but only straight glyphosate. Are you sure?

## Nurseries and Imazapyr

Luckily, I do not see too many plant problems associated with Imazapyr in nurseries. I don't know if nursery owners/managers simply haven't contacted me or if they are more cognizant of the dangers of various herbicides. I'll provide one example where Imazapyr wreaked havoc with a nursery's crops.

**Imazapyr, not Nutrition:** Nursery owners were having conniptions over the weird symptoms they were having on many of their crops. They believed they were encountering nutritional issues, which were causing distortions of foliage and stems, stunted growth, and chlorosis (yellowing)… all of which could be associated with nutrition and media/water pH issues. They had been conducting soil and water tests for months, trying to make corrections based upon what the tests showed, to no avail. In exasperation, one of the owners called Amy Upton, Executive Director of MNLA, to ask her if she knew anyone who could help them. Amy recommended me. Within minutes of my arrival at the nursery, I knew what was causing the problem: Imazapyr. With my revelation, I could tell the nurserypersons were not completely accepting my diagnosis. I continued to press on with my charm and attempts to use logic. At some point I asked what herbicides they had been using. They disclosed several products including Mohave, which had been applied the year before. Mohave, which contains Imazapyr and Diuron, was recommended by a supplier to keep weeds controlled on driveways and paths throughout the nursery, as well as around potted material. The Imazapyr was applied, washed into holding areas (Photo 9A), and eventually into their retention pond (Photo 9B), from which they watered their nursery plants (Photo 9C). The nursery began doing Imazapyr testing, confirming my diagnosis. It could take several years to "flush" the Imazapyr from the nursery system.




**P9A -9C** An Imazapyr containing product (Mohave) was applied for weed control in this nursery. The herbicide washed into holding areas causing severe phytotoxicity issues with these dogwoods (9A), ended up in their retention pond (9B) from which they watered their nursery stock (9C), which developed a variety of symptoms mimicking nutritional disorders.

## Government and Imazapyr:

Government, whether local or federal, is sometimes misinformed about Imazapyr and the various products that contain the herbicide. Government departments may have their own licensed personnel apply herbicides or they may accept bids from contractors for plant control. Here are several examples I encountered over the last couple of years.

**Phragmites Control in the Great Lakes:** Melinda and her family had an enviable home and property on a bay in the Great Lakes. Melinda was very conscientious about the environment and her family's health. For example, she always spent extra money from the family budget to purchase organic produce and healthy foods whenever she could. Imagine her horror one day when a helicopter's whomp, whomp, whomp announced a helicopter buzzing over the bay. Her daughter, who was playing with other children in the yard, captured in a video on her smartphone the helicopter spraying something as it flew over the bay. Melinda contacted the County Government whose officials produced a contract that Brian (Melinda's husband) had purported to sign, agreeing to phragmites control in the bay; the contract had been forged. When Melinda threatened to sue, the County Government invoked "Government Immunity". Melinda decided to seek help from other sources. Among the potential resources, she contacted me and the Michigan Department of Agriculture and Rural Development (MDARD); MDARD confirmed the misapplication of Imazapyr. During my visit I witnessed dead trees and shrubs along the shoreline and in Melinda's landscape and neighbors' landscapes (Photo 10A). Symptoms of Imazapyr were found on trees as far inland as 50-100 yards or more (Photo 10B). We can well imagine the horror that Melinda and Brian experienced as the helicopter's spray drifted over their

property where their children were playing in the yard. Melinda and Brian decided to sue the aerial application company that had contracted with the county to perform the application of Imazapyr. According to Melinda, the helicopter company delayed and delayed in an apparent attempt to outspend Melinda and her husband through attorney fees. The case was finally settled with far less than satisfactory results for Melinda and her family. Melinda and Brian retired from their jobs and moved to another location.

**Tourist City:** One of Michigan's premier tourist cities along Michigan's west coast has many lovely restaurants, shops, and brew pubs. The city has been pursuing an ambitious tree replacement program after the Emerald Ash Borer destroyed so many of the ash trees that lined its beautiful streets. Unfortunately, many of the newly planted trees have declined and died for no apparent reason. Never mind, they'll plant more. Outside of one of the brew pubs, these Tree Lilacs exhibit characteristic symptoms of Imazapyr (Photo 12). Whether city employees or contractors were controlling weeds in the tree grates, the dangers of Imazapyr were apparently not understood until I informed the City Forester.

**Tourist City #2:** Another of Michigan's premier tourist cities on the west coast is a quaint town but a very popular place for visitors from out of state and Michiganders alike to visit. The small city is literally bustling throughout the summer months. Its large, protected bay is ideal for sailing, motor boating and other water sports. I was invited by an arborist to teach a 2-hour program on tree issues to local arborists and landscapers at "City Hall". After the program, a landscape tour by participants of the lovely park adjacent to the bay was scheduled to look at tree problems firsthand. The park is generally well maintained if not manicured to provide a pleasant environment for cycling, walking, and relaxation on its park benches. All that marred the otherwise beautiful, picturesque bay and associated park was the presence of declining trees (Photo 11A). Some of the trees had died. On trees not completely deceased were the telltale


**P10A &10B** Trees/shrubs on Melinda and Brian's property were affected by an aerial application of Imazapyr for phragmites control in a bay of the Great Lakes. The county had contracted with a commercial company that specialized in aerial application. Trees and shrubs in both directions along the shore were killed (10A); symptoms of Imazapyr were evident on trees as far inland as 100 yards (10B). Melinda and Brian's daughter captured this blurred image of the helicopter as it flew over the bay spraying Imazapyr for phragmites control (10A Inset).


**P12** This Tree Lilac on a city street in one of Michigan's premier tourist cities is being affected by application of Imazapyr for weed control to the tree grates in the sidewalk. I'm very suspicious that city employees or contractors were unaware of what was causing the decline until I informed the city forester.

signs (stunted, distorted growth) of herbicide damage, specifically Imazapyr (Photo 11A Inset). The herbicide had been applied by city employees to tree grates and pavers in the park for long term weed control. Apparently the city did not know why their well-established maples and other desirable species were declining and had begun a gradual replacement program with ornamental pear…which had also begun to decline from Imazapyr applications. It is interesting that trees in the lawn areas exposed to lawn herbicides were absolutely beautiful; no evidence of herbicide injury or decline was evident in lawn trees (Photo 11B).


P11A


P11B


P13


P14

## Aliens and Imazapyr:

It is shocking to learn how many people are in denial about their utilization of herbicides: "I couldn't have killed my tree" or "Never use the stuff". With enough detective work, I can sometimes convince people that they caused the herbicide damage. Sometimes not. In many situations the origin of the herbicide phytotoxicity on their trees remains a mystery. We've all heard about or even perhaps experienced firsthand UFOs and Alien abductions. I didn't realize until several years ago that Aliens (Photo 13) might be applying Imazapyr in the weirdest places, apparently, just to mess with our minds. Here are several examples.

**P11A &11B** In a park near a bay in another west coast city (a "hip town") that is very popular for tourists are these declining trees. City employees (licensed applicators) had been applying herbicides to tree grates and paver areas for weed suppression. The city administration and employees apparently did not connect symptoms of tree decline/death with the application of herbicides, specifically Imazapyr (11A Inset). Not recognizing the issue, the city budgeted for gradual replacement of declining trees with ornamental pear trees, which also began dying with continued Imazapyr treatments. Note that trees in the adjacent lawn area (left), exposed to lawn herbicides, exhibited great health (left) while the trees in the paver/grated areas (right) exhibited decline due to Imazapyr (11B).

**P13** With many cases of herbicide issues, people rarely admit to doing anything that might have harmed their trees or landscape. There's an awful lot of crazy things going on out there, and Aliens might just be involved. We know they exist; I found this one in my basement several weeks ago and it took a lot of "shooing" to get him out.

**P14** Several arborists invited me to view severe tree destruction at a professional Landscaper's home. It was clearly Imazapyr damage, yet the Landscaper maintained he has never applied anything. This photo shows where a sump pump's effluent is discharged. A spill? Aliens?

**Landscaper near Smiths Creek:** Several arborists from a well-known Michigan company asked me to meet them at the home of a professional landscaper who had many declining trees on his property (Photo 14). The arborists and the landscaper were quite perplexed. Upon arrival, I immediately recognized the telltale signs of Imazapyr damage. The Landscaper replied, "Never used the stuff." The affected trees in Photo 14 were near the effluent discharge from a sump pump. So, I tried to imagine a spill that ended up in the sump pump and expelled into the woodland. With persistent denial by the Landscaper, I never could arrive at a definitive answer for the source of the herbicide. See, must be Aliens!

**Derrick in Belleville:** Derrick had several acres on the edge of town where he had spent considerable time and expense on his landscape. Unfortunately, many of his landscape plants were declining and dying, the reason he requested my assistance. He was certain that the 150 bags of mulch he had purchased were "contaminated by something". In examining his extensive landscape and lawn, I realized that his trees and shrubs exhibited symptoms typical of Imazapyr herbicide (Photos 15A & 15B). Unconvinced, he pushed a bag of mulch towards me and asked if I could analyze it. I told him I didn't think it was necessary because I was convinced that Imazapyr was involved. Derrick denied ever using any herbicide in his landscape including the control of weeds in his tree mulch rings and beds. In our ensuing conversation, I gradually inched my way towards his pole barn, asking him about his hobbies and if he had any old cars or motorcycles. In my surreptitious manner, I spied in the corner of his barn what I was looking for: several jugs of Ortho® GroundClear® and Roundup® products in the grey plastic containers (Photo 2). I asked Derrick where he used these herbicides, "Oh, my nephew uses those on the driveway to keep weeds down." Yeah, I thought, I can believe it (Photo 15C)! I asked him if his nephew had applied these herbicides around his trees and mulched areas in addition to the driveway. Derrick was certain his nephew would not have done that. This represents yet another Alien encounter of the Imazapyr-Kind!!

**Henry and Gertrude in Birmingham:** I was called to the home of Henry and Gertrude by an arborist who was perplexed by the symptoms on Gertrude's Oak Leaf Hydrangeas (Photo 16). These shrubs were Gertrude's favorite plants in the landscape and she wanted to get to the bottom of what was happening to her beautiful plants. I diagnosed Imazapyr phytotoxicity. In the ensuing conversation which lasted for a considerable amount of time, Henry insisted he used no herbicides on the property. Even after I pointed to a bare strip along his house's foundation where weeds should have been growing, Henry persisted in his stance. At one point, Gertrude announced they had had problems with the neighbors over the years and wondered if they might be engaged in some nefarious activities. I didn't know how to respond because over my many years in the industry, I have occasionally encountered neighbor disputes where herbicides were used to kill trees and other plants near the border of adjoining properties. With continuing discussion, Gertrude was getting more and more worked up and began to threaten to call their attorney. As she continued to get more riled, reaching a crescendo of red-faced anger, and as I was getting ready to leave, Henry, apparently thinking his wife might just get their attorney involved, declared, "Well, I've got some stuff in the garage I use once in a while." Subsequently, Henry produced two large containers of Ortho® GroundClear®, enough to kill every blade of grass and tree and shrub on their small city lot many times over. As I turned to leave, I saw the glare on Gertrude's face aimed at Henry. I could easily predict Henry wasn't going to get any supper that night. Case closed: not an Alien after all!

## Ameliorating Imazapyr Damage:

Imazapyr was originally marketed for right-of-way use (railroads, service powerlines, county drains, etc.) where tree and shrub death are desired. I am perplexed why this chemical is even marketed for the homeowner segment or for professional use in nursery and landscape. I have been confronted by some suppliers who proclaim that Imazapyr is perfectly safe and that I shouldn't go around bad-mouthing their products. While I suspect Imazapyr might be safe for use in some situations, I continue to witness plant damage every year at many locations, the primary reason why I continue to preach on Imazapyr's threat to the health of trees and other plants. Hence, one of the ways to "ameliorate" Imazapyr damage is to avoid the possibility of phytotoxicity by not using it. As with anything we do, we must be informed and careful by studying the products we use. For any plant professionals who are asked to control weeds or invasive plants, it might be wise to avoid using any herbicide about which they are not familiar. It may be too risky to use Imazapyr with its unpredictable nature.

Inevitably, some of us will encounter plant decline or death due to Imazapyr. What do we do? Don't panic! If Imazapyr was applied very recently, copious applications of water drenches might leach the Imazapyr through the soil profile and out of the root zone, being very careful about lateral movement of Imazapyr-carrying water to other areas. If Imazapyr symptoms are currently showing from an application last year, the best advice is to wait it out. Provided there are green conductive tissues (cambium, Photo 3D Inset), there is a chance, however slim, that the plant may recover. For some types of herbicide or other chemical issues, activated charcoal may be applied to soil for absorption of the offending chemical. Due to the persistence of Imazapyr, it will be difficult to seed (Photos 1, 7 and 15C) or establish plantings into Imazapyr-contaminated soil for at least a year. Contaminated soil can be replaced with non-contaminated soil, but this can be a rather onerous and costly remediation effort.

I'd appreciate it if any readers of this article would contact me if you need assistance or when you encounter interesting examples of herbicide issues so that I can document them for everyone's benefit.

**P15A -15C** Derrick near Belleville was convinced that his problems with his landscape plants were due to contaminated mulch. To me, symptoms appeared identical to Imazapyr: Shrub in 15A and Spruce in 15B. In my "investigation", I found several containers of Imazapyr-containing products, which Derrick assured me was only applied to his driveway by his nephew. Note turf death (15C) from Imazapyr runoff from the drive. Aliens again!!

**P16** Gertrude's prized Oak Leaf Hydrangea was severely deformed by Imazapyr applications. Her husband, Henry, finally fessed up to hiding some of the offending product in their garage after Gertrude threatened to get an attorney. With Gertrude initially thinking the neighbors might be doing something nefarious, I was able to show that neither the neighbors nor Aliens were involved in this matter.