Series: How to get the most out of your weed management program in Christmas tree production?



Managing Herbicide Resistance In Weeds

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Introduction: A Problem We Can't Ignore

If you've been growing Christmas tree for a while, you've probably noticed it, certain weeds just aren't dying the way they used to. Even after a solid herbicide application, some still push through, competing with your tree crop and making production practices more frustrating. That's not just coincidence or poor application. It's likely herbicide resistance, and it's becoming more common across agricultural landscapes. To be precise, two hundred and twenty weed species around the world have developed resistance to common herbicides, and the problem is getting worse. Some weeds can now survive multiple types of weed killers, leaving growers with fewer control options. In Christmas tree production system, common ragweed (Ambrosia artemisiifolia) (Fig 1) and horseweed (Conyza canadensis) are two examples which have become resistant to Stinger (clopyralid) and Roundup (glyphosate) herbicides, respectively. No new herbicides with fresh ways of killing weeds have been developed in over 30 years, and stricter regulations are removing older ones from use. As a result, herbicide-resistant weeds are spreading fast (Heap, I. 2014). The good news is that this problem, while serious, is manageable. And more importantly, it can often be prevented. This article takes a practical look at what causes herbicide resistance, how to keep it off your farm, and how to deal with it if it's already there. Through integrated weed management, there's a solution to every problem.



Figure 1 – *Stinger (clopyralid) resistant common ragweed (Ambrosia artemisiifolia) whose seeds were collected by MSU Plant and Pest Diagnostics, and it was grown at MSU greenhouse for research purpose.* Photo credits: Debalina Saha, MSU Horticulture.



Figure 2 – *Horseweed (Conyza canadensis) is one of the most problematic weed species which has become resistant to Roundup (glyphosate) in Christmas tree production.* Photo credits: Debalina Saha, MSU Horticulture.

Understanding Herbicide Resistance

At its core, herbicide resistance happens when a weed survives a chemical application that used to kill it. Over time, if the same kind of herbicide or the herbicide with same **mode of action** is used again and again, the more resistant weeds survive and reproduce. Eventually, they make up a big part of the population which will become a major management issue (Perotti et al,2020). There are a couple of ways this resistance shows up. According to Riechers et al 2024, in some cases, the weed may change the part of its biology where the herbicide is supposed to act, this is called t**arget-site resistance**. In other situations, the plant finds a way to block the herbicide or break it down before it can do any damage. This is known as **non-target-site resistance**. Either way, the outcome is the same: more herbicide-resistant weeds and fewer easy solutions. **Cross-resistance** (Torra et al,2021) critical concept in weed science, occurs when a single genetic or biochemical change in a weed provides resistance to several herbicides, typically those that share a similar site or mode of action. There are two main types:

- **Target-site cross-resistance (TS-CR):** Caused by mutations in the herbicide's target enzyme, leading to resistance against all herbicides that act on that site.
- **Non-target-site cross-resistance (NTS-CR):** Involves mechanisms like enhanced metabolism or reduced herbicide uptake, which can confer resistance to herbicides with different modes of action.

How Resistance Develops in the Field

Resistance doesn't happen overnight. It builds slowly, often unnoticed at first. A few resistant weeds might survive a spray one year and go to seed. The next year, their offspring survive again, and within just a few growing seasons, those resistant plants can dominate the field. The most common cause of this is the repeated use of the same herbicide or herbicide mode of action year after year, especially without rotating crops or using other weed management strategies.

There are several other practices that can unintentionally encourage resistance. Sticking with a single crop for multiple years in a row makes weed cycles more predictable and easier for them to adapt to. However, this might not be applicable to Christmas tree production systems as crop rotation is not possible as the trees take 8-10 years' time to reach its harvestable size. Relying solely on herbicides without incorporating tillage or mechanical methods allows resistant weeds to gain ground. Even skipping scouting or delaying application timing can lead to weeds getting too large to control effectively. And underdosing, applying below the labeled rate can leave some weeds alive, giving them another opportunity to pass on resistance traits.

Keeping Resistance Off Your Farm

The most effective way to manage herbicide resistance is to prevent it from ever developing. That means building a weed control program that doesn't rely entirely on herbicides. Prevention is a lot easier and cheaper than trying to clean up a resistance problem later.

According to Prather et al,2000, one of the most powerful tools is **rotating herbicides** with different modes of action. Each herbicide works in a specific way, and switching between them makes it harder for weeds to adapt. Just as important is **rotating crops**. Different crops support different growing conditions and weed management strategies, which helps disrupt weed life cycles. Another smart practice is using cover crops. These can shade the soil, outcompete early emerging weeds, and reduce the weed seed bank over time. By shading the soil and growing quickly in early spring or fall, they help suppress weed emergence and limit the need for chemical control. Similarly, mulching whether organic mulches like straw or crop residues, or synthetic weed barriers can block sunlight and prevent weeds from germinating and growing. **Regular scouting** is also essential. By walking your fields and checking for weed escapes after herbicide application, you can identify potential resistance problems early when they're still manageable by looking for weedy patches in patterns consistent with application problems and **hand-weed** patches that are not in patterns consistent with application problems. Always perform **Good Farming Practices** (GFP's) like Applying herbicides at the **proper timing** and rate as when you cut rates or spray too late, you're giving weeds a fighting chance to survive and adapt. **Solarizing** the soil once a year not only kill the weed seeds but also the overwintering bacterial and fungal pathogens, using **certified seeds and seedlings** ensures clean seed with no mixtures and **clean equipment**. Depending on your operation, including some mechanical control, by **cultivating** such as occasional tillage or inter-row cultivation, can also help keep resistance in check. The more varied your approach, the harder it is for weeds to outsmart your system.

What to Do If Resistance Is Already in Your Fields

If you've already spotted herbicide-resistant weeds in your fields, all is not lost but action is needed quickly. The goal shifts from prevention to containment and suppression. First, it's important to correctly identify the resistant weed species and confirm which herbicides it no longer responds to. This can help avoid wasting time and money on ineffective treatments. It is recommended to contact your county Extension educator who can help in sending samples to Michigan State University Plant and Pest Diagnostics laboratory to get confirmation of herbicide resistance development. At that point, stop using the herbicide that's no longer working. Continuing to

apply it just encourages resistance to build even more. Instead, use a **new herbicide** with a different mode of action and, if possible, combine that with other control methods such as cultivation, mulching, mowing, or targeted hand removal in smaller areas. In some cases, using a tank mix with multiple effective herbicides can help get the problem back under control, though label directions and compatibility must always be followed.

Another key step is to manage the weed seed bank by **Good Farming Practices (GFP's)**. That is through -

- The use of clean equipment to prevent those resistant weeds from going to seed is critical as combines and tillage tools can easily carry resistant seeds from one area to the next.
- Always enter fields with resistant weeds last, after completing work in all other fields. This helps prevent the transfer of resistant weed seeds on your clothes or equipment to clean fields.
- Watching for the small weed patches that appear in the same place in the next crop.
- Controlling weeds suspected of herbicide resistance before they can produce seed.
- This might include late-season control, post-harvest spraying, or other practices aimed at minimizing seed returns.

Conclusion

There's no one-size-fits-all fix for herbicide resistance. It's a complex issue that calls for a comprehensive, flexible approach. That's where integrated weed management comes in. By combining chemical, cultural, and mechanical controls, farmers can stay ahead of resistance, maintain the effectiveness of existing herbicides, and protect the long-term productivity of their land. Herbicide resistance might seem like a frustrating setback – but it doesn't have to be a dead end. With careful planning and commitment to diverse management strategies, Christmas tree growers can tackle this challenge head-on and come out stronger on the other side.

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