e-GRO Alert

Ornamentals

Volume 15 • Number 18 • March 2026

Chemical Control of Weeds for Greenhouse Ornamental Production

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Introduction:

Weeds are among the most damaging pests to crops in greenhouse and container production systems. Intensive fertilization and the controlled environment in greenhouses favour the development and proliferation of weeds. Weeds not only infest the containers and nursery trays but also spread across benches and greenhouse floors (Fig 1 and 2). It is well established that weeds compete with crops for moisture, nutrients, space, and they also serve as alternate hosts for plant pathogens and insect pests (Fig 3). Common weed management practices in greenhouses include preventive measures, sanitation, cultural practices such as mulching, and hand-weeding (Fig 4). Although these non-chemical methods are important components of integrated weed management, they are often insufficient to control weeds.

Figure 1. Weeds are growing like thick mats under the benches inside greenhouse conditions. Photo credits: Debalina Saha, MSU Horticulture.

In addition, they can be labor-intensive, difficult to implement consistently, and costly to maintain large greenhouse operations. Therefore, chemical methods of weed management may need to be integrated with cultural practices to achieve effective weed control in greenhouses and other controlled environment production systems. Followings are some of the commonly used chemical products for greenhouse weed control.

Chemicals used for weed control inside greenhouse:

A. Organic chemical herbicides:

Organic chemical herbicides are naturally derived biodegradable products obtained from plants or naturally derived compounds. These herbicides are generally nonselective in nature and primarily act as contact herbicides. Organic herbicides can be applied when crops are present in the greenhouse, if it is on the label and when directions are strictly followed. Followings are some of the commonly used organic products for greenhouse weed control.

Axxe® (ammonium nonanoate) is a postemergence contact herbicide. The active ingredient is a C_9 saturated fatty acid salt that disrupts plant cell membranes and causes rapid desiccation of plant tissues, and it has no residual soil activity (EPA, 2001). It is used to suppress and control the growth of grasses, vines, mosses, tree suckers, and liverworts (BioSafe Systems, 2020).

GreenMatch EX® (lemongrass oil) is a postemergence foliar contact herbicide. It is not translocated in plants; therefore, injury occurs only on the plant tissues directly covered by the spray solution (Marrone Bio Innovations, n.d.). As a result, regrowth may occur if underground plant structures remain intact, and control is generally less effective on biennial and perennial weeds compared with annual species.

Scythe® (pelargonic acid) is a Group 26 herbicide (WSSA, 2014). It causes rapid burndown activity in pants, and symptoms may be expressed within one to several hours of application. The REI for this herbicide is 12 hours. It is used as a blossom thinner in certain horticultural crops and also as a sanitizer. It can be applied to young weeds under benches, along walkways, or along the edge of greenhouses.

WeedPhram® and Grass Killer® (acetic acid) are non-selective contact, group 4 herbicides. They are effective against young weeds at the three to five leaf growth stage (Becerra-Alvarez, 2025). Optimal control is generally achieved when application is made under warm conditions, typically at temperatures above 50°F (10°C).

Figure 2. Weeds infesting containers and trays inside greenhouse. Photo credits: Debalina Saha, MSU Horticulture.

Figure 3. Weed infested ornamental liner trays inside greenhouse. Weeds are competing for space, moisture, nutrient, light and can harbor pests and pathogens. Photo credits: Debalina Saha, MSU Horticulture.

Figure 4. Hand weeding is extremely laborious, time consuming and costly. Photo credits: Debalina Saha, MSU Horticulture.

B. Synthetic Chemical herbicides:

There are a limited number of synthetic herbicides recommended for use inside greenhouses, and many of them are restricted to applications under benches, in walkways, or on greenhouse floors rather than directly in containers or planting beds (Neal, 2015; Saha & Hill, 2020). In most cases, the greenhouse must be empty during the application of these herbicides to avoid crop injury. Followings are some of the commonly used synthetic products for greenhouse weed control:

Marengo® (indaziflam) is a preemergence herbicide that controls many annual grasses and broadleaf weeds. It is a broad-spectrum herbicide labeled for use in field and container nurseries. Marengo is commonly used to prevent weed establishment on greenhouse floors, under benches, and around the foundations (Neal, 2015). However, the greenhouse should be vacant during application, and plants should only be moved back into the structure after the Restricted Entry Interval (REI) i.e., 12 hours, has elapsed. Indaziflam has a relatively long soil half-life, more than 150 days, which allows it to provide residual control of weeds. Marengo may also be tank-mixed with certain postemergence herbicides to improve overall weed management. Several cases of resistance against indaziflam are reported in annual bluegrass (*Poa annua*) in different parts of the USA (Heap, 2026).

SureGuard® (flumioxazin) is a broad-spectrum preemergence herbicide primarily used to control broadleaf weeds. SureGuard is commonly applied to greenhouse floors and other non-crop areas to prevent weed emergence, and its residual activity can last for several months depending on environmental conditions (Neal, 2015). The greenhouse should be empty during the application, but plants may be reintroduced after completion of the Restricted Entry Interval (REI) i.e., 12 hours. SureGuard also offers postemergence control of weeds. Herbicide resistance to flumioxazin has been reported in annual bluegrass (*Poa annua),* annual ryegrass *(Lolium perenne ssp. Multiflorum)*, and common ragweed (*Ambrosia artemisiifolia)* (Heap, 2026).

Envoy® (clethodim), a group 1 postemergence herbicide, is effective against annual and perennial grasses, including annual bluegrass. Envoy is not effective against broadleaf weeds. Typical injury symptoms include chlorosis followed by necrosis, which generally appear within 1-3 weeks after application (WSSA, 2014).

The REI for clethodim is 24 hours. Several weed species, including Indian goosegrass (*Eleusine indica*), annual bluegrass (*Poa annua*), and ryegrass (*Lolium spp.*) are reported to have been reported resistant to ACCase-inhibiting herbicides such as clethodim (Heap, 2026).

Finale® (glufosinate) is a broad spectrum, non-selective postemergence herbicide. This herbicide inhibits glutamine synthetase (group 10), leading to the accumulation of ammonia in plant tissues and rapid cellular damage. Symptoms usually appear within 3-5 days after application, and complete necrosis typically occurs within 1-2 weeks (WSSA, 2014). Finale does not provide residual control of weeds. Resistance to glufosinate has been reported in several weed species, including Indian goosegrass (*Eleusine indica*), Palmer amaranth (*Amaranthus palmeri*), and annual bluegrass (*Poa annua*) (Heap, 2026).

Fusilade® or Fusilade DX® (fluazifop-p-butyl) is a group 1 selective postemergence herbicide used to control annual and perennial grasses but has no activity on broadleaf weeds (WSSA, 2014). Following application, chlorosis may develop within several days and progress to necrosis, appearing within 1-3 weeks. The REI for this interval is 12 hours. Resistance to this herbicide has been reported in giant foxtail (*Setaria faberi*) and Johnsongrass (*Sorghum halapense*) (Heap, 2026).

Reward® (diquat) is a group 22, contact herbicide used to control annual weeds. It is also commonly used against aquatic weeds. Since the mode of action of diquat is contact, large weeds will be burned but not killed. It is rapidly absorbed into leaves, and wilting and desiccation begin within several hours after application (WSSA, 2014). The REI for diquat is 24 hours. Resistance to diquat has been reported in weed species such as hairy fleabane (*Conyza bonariensis*) and capeweed (*Arctotheca calendula*) (Heap, 2026).

RoundUp Pro® (glyphosate) is a group 9, non-selective, systemic postemergence herbicide. It can be used for the control of annual and perennial weeds in greenhouses, but it is most effective on the control of annual grasses. Visible symptoms typically appear within 4-7 days in highly susceptible species and may take 10-20 days in less susceptible weeds (WSSA, 2014). Herbicide resistance to glyphosate has been reported in Johnsongrass (*Sorghum halepense*),

Palmer amaranth (*Amaranthus palmeri*), Indian goosegrass (*Eleusine indica*), annual bluegrass (*Poa annua*), sourgrass (*Digitaria insularis*), etc (Heap, 2026).

C. Disinfectants

Effective sanitation is an important component of pest management in greenhouse production systems. Regular disinfection helps reduce populations of plant pathogens, algae, fungi, fungus gnats, and shore flies. Benches, containers, walls, floors, tools, and walkways should be disinfected at regular intervals to maintain a hygienic growing environment. Followings are some of the commonly used disinfectant products for greenhouse weed control:

Quaternary ammonium chloride salts (KleenGrow®) are commonly used disinfectants in greenhouse production systems (Smith, 2015). These compounds are relatively stable and provide broad-spectrum control of diseases, algae, and bacteria. They can be applied to floors, benches, walls, tools, and containers. However, they have limited residual activity and therefore do not provide long-term protective effects.

Hydrogen peroxide and peracetic acid-based disinfectants (ZeroTol® 2.0, Oxidate® 2.0) act as strong oxidizing agents and kill bacteria, fungi, and pathogens upon contact (Smith, 2015). Since products containing hydrogen peroxide, peroxyacetic acid and octanoic acid are strong oxidizing agents they should not be mixed with other pesticides. All of these disinfectants are OMRI listed.

Sodium carbonate peroxyhydrate (GreenClean® PRO and Phycomycin® SCP) is the result of the combination of the sodium carbonate and hydrogen peroxide (EPA, 2002). It is effective in the control of algae, moss, liverwort, slime molds, and their spores. These products are widely used in commercial greenhouses, garden centers, nurseries, and storage areas (USDA, 2014).

Other disinfectants include chlorine bleach solution and 70% alcohol, which are often used for rapid sanitation of tools, benches, and greenhouse surfaces.

Herbicide injury inside greenhouse:

Due to the enclosed structure of greenhouses and the high sensitivity of ornamentals grown in greenhouses, herbicide injury may occur from volatilization, spray drift, or accidental exposure. Therefore, residual chemical herbicides are generally not recommended for direct application on crops grown inside greenhouses.

Common symptoms of herbicide injury include distorted growth, cupped or strapped leaves, stunted plant growth, chlorosis, and in severe cases plant death. Careful application practices, proper ventilation, and adherence to product labels are essential to minimize crop injury.

Precautions to be taken during application of chemicals and disinfectants:

The applicator must read the pesticide label carefully before handling the pesticide. The applicator should always wear appropriate Personal Protective Equipment (PPE), including gloves, protective clothing, eye protection, and respirators as indicated in the label. One should always remain attentive during pesticide application. Proper ventilation management is also important during pesticide application in greenhouses. Do not apply chemicals over the top of your ornamentals. Follow label instructions. For some chemicals, greenhouse ventilation systems or circulation fans may need to be turned off temporarily during application to prevent drift or uneven distribution of the spray solution. After application, ventilation should be restored as directed by the label. The REI on the product should be strictly followed, and a record should be maintained. PPE should be handled and disposed carefully according to the manufacturer guidelines. Clothing worn during pesticide application should be washed separately from other household laundry to avoid contamination.

Conclusion:

Since greenhouses offer a conducive environment to promote rapid growth and the spread of pests and pathogens a comprehensive weed and pest management package is fundamental for successful crop production. Effective pest control relies on a combination of preventive cultural practices, careful use of herbicides, and regular sanitation of greenhouse structures and equipment. Herbicides are widely used in controlling weeds in non-crop areas such as floors, walkways, and under benches.

However, the use of herbicides must be carefully managed to avoid crop injury in the greenhouse. Likewise, disinfectants play an important role in maintaining clean production areas and reducing the algae, pathogens, and other pests. The applicator must follow label directions, REI, and use appropriate PPE during application. Overall, integrating chemical pesticides with proper sanitation and safe application practices can help maintain a healthy greenhouse environment and support crop production and profitability.

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