Herbicides and Weed Control

Weed control is the most persistent production problem which growers must solve to produce a quality plant in a reasonable period of time. Weeds not only compete for light, water and nutrients but also act as hosts of potentially injurious insects and diseases and shelter for rodents. A heavy weed population can increase handling and therefore cost, during shipping season and can reduce plant size and quality.

Weed Control

There are many methods that reduce a weed population. Cultivation, burying or hand pulling weeds prevents annual weeds from flowering and spreading seed, but must be done consistently to be effective. Chemical weed control is used by many growers as part of the program to reduce labour costs. However, it is necessary that the applicator understand the behaviour of the herbicide and the influences of water, irrigation or precipitation, temperature, sunlight and the state of growth of the crop to ensure that the application is effective for a reasonable period of time and the crop is not injured.

Types of Herbicides

Herbicides are applied either to the foliage of growing weeds (postemergence) or to the soil to prevent germination (preemergence). Post emergence foliar herbicides are either contact chemicals that weaken and disorganize the plant cell membranes causing leakage and subsequent localized death (e.g. GRAMOXONE), or translocated chemicals that move throughout the plant and slowly disrupt chemical processes that kill the entire plant (e.g. ROUNDUP).

Premergence herbicides (e.g. CASORON), are applied either to the soil or growing medium surface to prevent seed germination. These herbicides are usually absorbed by root systems, or by emerging shoot tips as they make their way through the soil surface during seed germination. Rainfall or irrigation water moves the herbicide into the top 5 cm of soil where most weed seeds germinate. The chemical must be dissolved in the soil/media solution in order to be effective. In the soil or media small negatively charged clay or humus particles called colloids adsorb, or hold onto, positively charged herbicides. There is a balance between the concentration of herbicide in the soil/media solution and the amount held by the colloids. As the concentration decreases in the soil solution, the herbicide held by the colloids is released to maintain this balance. This explains why some herbicides are retained in the top few centimetres at the soil/media surface and remain effective for long periods of time despite the heavy leaching activity from irrigation or rainfall. Porous soilless mixes and sandy soils may retain herbicide for a shorter period of time.

Many herbicides are selective. This means that the chemical can kill one plant or a group of plants without harming another (the crop). In some cases the selectivity is based on a physical separation. Soil applied herbicides stay in the surface layer of the soil or growing medium. The plants roots are below this layer. Obviously, there is a potential for crop injury if a large concentration of herbicide moves down to the crop root zone. Some herbicides are taken up by the plant, but a biochemical

Nursery Production

FACTSHEET

BRITISH COLUMBIA

Ministry of Agriculture, Fisheries and Food
Abbotsford Agriculture Centre
1767 Angus Campbell Road
Abbotsford, BC V3G 2M3
Phone: (604) 556-3044
Fax: (604) 556-3030

process detoxifies the chemical. In other cases herbicides, especially ones with postemergence control, can only be used when the crop is dormant. The cuticle layer is completely formed and thick enough at this time to reduce the amount of herbicide entering the plant.

Herbicide Entry Into Plants

Entrance of the herbicide into the plant is reduced by many physical factors. To be effective all foliar applied herbicides must cross a waxy water-repellent membrane called the cuticle which covers all of the non-woody above-ground surfaces of plants. A thick cuticle encourages the formation of large droplets that run off the foliage. A hairy leaf results in droplets sitting on top of the hairs and not reaching the leaf surface. Grass leaves are positioned at an angle that encourages runoff. Many herbicides must be applied to grasses before the 5 leaf stage in order to be effective.

Stomata, the tiny pores in leaves which allow $C0_2$ to enter and water vapour to exit the leaf, provide an entrance for a foliar applied herbicide. However, most stomata are on the underside of the leaf which is difficult to coat with herbicide and the chemical must still cross the cuticle covering the internal cells. The cuticle is thinner in younger leaves and stems which explains why control is much more effective on young weeds early in the season. However, translocated herbicide must be applied to leaves that are actively exporting carbohydrates, manufactured in the photosynthetic process, out of the leaf. The herbicide travels with this outward flow to the root. Very young leaves are net importers and the herbicide will stay in the leaf reducing the efffectiveness of the application.

Loss of Applied Herbicides

The amount of herbicide that is required for effective control is small which is good as losses are usually quite high. Volatilization or the evaporation of the chemical into the atmosphere is one type of loss. As a result, certain herbicides must be applied when temperatures are cool and incorporated mechanically or via irrigation immediately after application in order to prevent excessive losses (e.g. CASORON). Sunlight can also break down some chemcials in a process called photodecomposition (e.g. TREFLAN).

A major area of herbicide loss is the activity of microorganisms, such as bacteria, algae, fungi and actinomycetes, inhabiting any soil or container growing medium. The microbes use the herbicide as a carbon-rich food source, multiplying rapidly after application. Soil temperature, moisture, pH, aeration and high organic matter content favourable for plant growth also favours microbe activity. Multiple applications of the same chemical can result in high populations of microbes and subsequent high decomposition rate of the herbicide.

Herbicide Injury

Herbicides are designed to kill undesirable plants. Unfortunately, nursery plants can be damaged or injured too. Premergence herbicides, which are usually absorbed by the roots, or emerging shoots may cause injury due to:

1. too concentrated a mixture
2. application at an inappropriate stage of plant growth
3. heavy rainfall immediately after application
4. application when plants are stressed due to poor growing conditions
5. application to a sensitive species
6. herbicide build-up
7. application of the wrong chemical
8. contaminated irrigation water
9. application adjacent to the root system of sensitive crops.

Post emergence herbicides, which are absorbed by the leaves and stems, not by the roots, may cause injury due to:

1. too concentrated a mixture
2. spray drift
3. vapour drift
4. chemical residues in the spray tank

Some herbicides cause injury symptoms similar to an over application of growth regulators, such as twisted and distorted growth. Others inhibit photosynthesis and the formation of chlorophyll, producing chlorosis or yellowing of the leaves. In general if many plants in an area are injured, herbicide misuse may be the culprit. Carefully examine the crop, because plant stress due to drought, insect feeding, diseases, air pollution, nutrient deficiences or excesses, and cold damage cause injury symptoms that may mimic injury from herbicides. A good understanding of the injury symptoms caused by a particular chemical combined with a thorough investigation will help in pinpointing the sources of injury. (See Table 1).

Table 1. Herbicide Injury

TRADE NAME(S)	SYMPTOMS AND DESCRIPTION	HERBICIDE PERSISTENCE
Amitrole-T (amitrole)	Causes bleaching of plant foliage. All leaf pigments, including chlorophyll, are destroyed. Leaf looks bleached with a white colour. In some cases the leaves may look more yellowish than white, making symptoms difficult to distinguish from herbicides which cause leaf chlorosis. Injury is usually the result of spray drift. Injury first appears on the new growth. Plants may outgrow injury depending on the quantity of herbicide absorbed.	The chemical is deactivated in the soil. There is little breakdown in sunlight.
Casoron (dichlobenil)	Causes leaf chlorosis or yellowing - veinal, interveinal, marginal or overall leaf chlorosis. At low concentrations, a halo effect or marginal chlorosis is evident. Injury appears on the new growth. Plants may outgrow injury caused by low doses. At high rates, entire leaf becomes chlorotic. Chlorotic areas may turn brown and die. Injury on broad leaf plants is sometimes more severe on leaves oriented toward the afternoon sun. Herbicide carryover may be a problem when replanting a field crop. Liners may be susceptible to injury.	Slow, is tied up by organic matter and slowly decomposed by soil microbes. The chemical will remain active for 2-12 months. Rapid loss from the soil surface due to volatilization at high temperatures.
Devrinol (napropamide)	Causes stunting. The chemical inhibits both root and shoot development. Woody ornamentals are quite tolerant, but injury may result from over-application to young plants.	The chemical is broken down by soil microorganisms or sunlight. Will remain active for one growing season.
Fusilade II (fluazifop-p-butyl)	Causes spotting of foliage and tip dieback. May cause spotting of flower petals. Injury usually results from spray drift. Injury to ornamentals is often temporary, and plants are able to quickly outgrow damage.	At high rates may have pre-emergence activity on light soil.
Gramoxone (paraquat)	Causes contact burn of plant foliage. Brown leaf spots on the leaves results from spray drift. Overall leaf death will result if the entire plant is sprayed. Injury appears within several hours when sprays occur on hot, humid days. Gramoxone causes contact, not systemic injury, new growth will not be damaged. Plants may outgrow injury if only a few branches affected.	The chemical is strongly absorbed by clay and organic matter in the soil. Is biologically unavailable. No residual activity.
Princep, Simazine (simazine)	Causes yellowing or leaf chlorosis, veinal, interveinal, marginal or overall chlorosis. Injury appears first in the new growth, since the chemical is translocated to the growing point. Plants may outgrow injury which is the result of low concentrations. New leaves will eventually become greener. The whole leaf may become chlorotic at high concentrations. Leaves may turn brown and die. Excessive root absorption of the chemical is the major cause of plant injury. Repeated applications over several years will cause soil buildup. Plants transplanted may be damaged by the carry-over.	The chemical is decomposed by soil microbes. Will remain active for up to a year in soil.
Reglone (diquat)	Causes leaf spotting. Symptoms and comments as for Paraquat. Both chemicals are from the same herbicide family.	Is strongly absorbed to clay and organic matter in soil.
Roundup, Laredo, Wrangler (glyphosate)	Causes tip chlorosis, tip dieback and abnormal leaf development. After absorption the chemical is translocated to the growing point, new growth appears chlorotic, stunted, narrow or distorted and tightly spaced together, with a switches-broom appearance. There may be a purplish cast to foliage of broadleaf plants. Injury is usually the result of spray drift onto green foliage, green or thin bark. The chemical is not absorbed by the roots. If overspray occurs in the fall, damage may not appear until the new growth begins the following spring.	Strongly adsorbed onto soil particles, rapid deactivation, no residual activity.
Treflan, Trifluralin, Rival (trifluralin)	Causes roots to become shortened, thick and swollen at the tip. The chemical inhibits the development of new roots. Root damage is usually limited to the top 5 cm of the soil since the chemical has limited water soluability. Other symptoms include stem swelling at the soil line and stunting. A callous-like growth may develop at soil line, become brittle and cause stem breakage. Leaves may appear darker green. Shoots may look normal but the plant wilts when conditions are dry. When roots are unearthed, they are stunted with few laterals. Over application to young nursery stock, especially tightly rooted liners ,may cause injury. Healthy established plants show considerable tolerance to the chemical.	Degraded by soil microbes and broken down by sunlight if not incorporated. The chemical can remain active for one year in soil. The chemical is adsorbed so greatly that it is not effective in soils with more than 5% organic matter.

Each nursery has its own unique soil types, container growing media, crop mix, planting techniques, soil cultivation practices and grower preferences. Herbicides are usually only a part of a full weed control program. If used correctly, production costs can be reduced; if used incorrectly, the costs can be quite high. A chemical weed control program deserves some thought and planning each year. There are many books published on this subject and the Nursery Crop Production Guide outlines many of the facts needed to make good decisions. However, the pesticide label is really the most valuable source of information. Very few problems arise when label directions are adhered to. **READ THE LABEL!**

REFERENCES:

Adams, R.W. Ed. 1990. Handbook for Pesticide Applicators and Dispensers. 5th Ed. British Columbia Ministry of Environment and Parks.

Derr, J.F. and B.L. Appleton. 1988. Herbicide Injury to Trees and Shrubs: A Pictorial Guide to Symptom Diagnosis. Blue Crab Press, Virginia Beach, VA

Derr, J.F. and B.L. Appleton. 1989. "Behind Herbicide Injury." American Nurseryman. Vol. 169 Number 10, May 15, 1989, pp 56-59.

Gwynne, D.C. and R.B. Murray. 1985. Weed Biology and Control in Agriculture and Horticulture. Batsford Academic and Educational, London, UK .

Harris, R.M. 1992. Arboriculture Integrated Management of Trees, Shrubs, and Vines. Prentice-Hall, Inc. Englewood Cliffs, N.J.

Maleike, Ray. Herbicides in Landscape Plantings. Washington State University, Puyallup, Wash.

Rice, R.P. Jr. 1986. Nursery and Landscape Weed Control Manual. Thomson Publications, P.O. Box 9335, Fresno,CA 93791.