NOTE

This Label Book is intended to serve as a reference source to forest nursery tree managers in the Southeastern United States as to the herbicide options available to them, the nature and properties of those herbicides, recommended application procedures, and sources of further information. Hopefully, this Label Book will assist them in their nursery weed control programs.

Federal and state laws require anyone applying a pesticide to maintain a current label and Material Safety Data Sheet (MSDS) for any and all chemicals they are using on their premises. This book is not meant to be a substitute for applicator record keeping. Labels can change with little or no notice from the manufacturer. **It is the responsibility of the applicator to be sure they have the current label for the materials in use.**

Table of Contents

ORGANIZATION

The herbicides are listed in alphabetical order by their common name. For example, the product widely known as Roundup is listed under the common name of its principle active ingredient, which is glyphosate. While common names are sometimes not as well known as trade names, organizing by common names eliminates repetition. Furthermore, it is the active ingredient which has the greatest influence on product characteristics and behavior.

To facilitate locating information about a specific product, an "Index by Trade Name" is provided (pages II and III).

Several categories of information are provided for each chemical.

INFORMATION CATEGORIES

CLASSIFICATION

Most herbicides can be placed in one of several "families". This is often useful because herbicides within a specific family usually have the same characteristics in terms of activity, toxicity, movement in soil, and other important factors.

UTILIZATION

This provides a brief description of how the herbicide may be used (e.g. pre- or postemergence) and what types of weeds it can control (grasses, broadleaves, or sedges).

METHOD OF UPTAKE AND TRANSLOCATION

Herbicides are either foliar active, soil active, or both. This refers to how the chemical enters the plant. Foliar active chemicals require adequate leaf surface area to be absorbed by the plant. Soil active chemicals, on the other hand, are pulled into the plant through the roots as they take up water and transpire.

Chemicals are translocated in either the food transport system of the plant (the phloem) or in the water transport system (the xylem), or both. Chemicals transported in the xylem are characteristically soil active and move from the base of the plant towards the tips of branches and leaves with the transpiration flow. Chemicals transported in the phloem move both up and down the plant.

METHOD OF ACTION

This is a brief description of how the chemical actually causes plant mortality.

MOVEMENT IN SOILS

Chemicals vary as to their rate of movement in soils. The two largest influences on movement are water solubility and how tightly the chemical is bound to soil particles. A general description of the potential for movement (leaching) of each herbicide is provided based on available literature.

DECOMPOSITION

Half life

This indicates the expected time after application that one half of the chemical would naturally decompose in the environment. For example, if an application was made of 2 pounds of an active ingredient with a half life of 30 days, then one month after application 1 pound of the chemical would have decomposed and 1 pound would still be on the site.

Volatility

Refers to a chemical's tendency to go into a gaseous state after application.

Photodecomposition

Indicates whether a chemical is broken down or decomposed by sunlight.

TOXICITY

Toxicity is provided in reference to mammals and to fish. LD50 is the quantity of a chemical which is required for acute toxicity (a single dose) in 50% of a test animal population. It is expressed in milligrams of chemical for each kilogram of test animal (rat) weight. The following toxicities are provided for comparison.

Caffeine	LD50 = 200 mg/kg	(Extremely toxic)
Aspirin	LD50 = 1240 mg/kg	(Moderately toxic)
Table Salt	LD50 = 3000 mg/kg	(Moderately toxic)

LC50 is the concentration in water in which a chemical becomes toxic to 50% of a test population of fish.

PRODUCT FORMULATIONS

Manufacturers commonly sell the same active ingredient under more than one trade name or formulation. Each of these products will have their own distinct label. This section provides information for herbicides that, after careful review of the label, we believe are labeled for forest tree nurseries. The trade name, percentage active ingredient, formulation, and manufacturer are listed for each product. Also provided are some general observations about application.

WHEN USING ANY PESTICIDE;

ALWAYS READ THE LABEL

CLETHODIM

Classification: Cyclohexenone

Utilization: Selective postemergence control of both annual and perennial grasses. Does not control sedges or broadleaf weeds.

Method of Uptake and Translocation:
Little information is known about translocation, but it is hypothesized that it translocates in the phloem and accumulates at growing points.

Method of Action: Inhibits fatty acid synthesis that eventually results in blocking the production of new membranes required for cell growth.

Movement in Soils: Although clethodim is somewhat mobile (weakly bound to soils), it is very short-lived.

Decomposition: The half-life of clethodim is 3 days. It has minimal volatility and photodecomposition.

Toxicity:

LD50 – 1630 mg/kg	Low toxicity
LC50 – 33 mg/l	Slightly toxic to fish

Formulations Labeled for Nurseries:
Conifers, Ornamentals, and non-planted areas

Trade Name	Formulation	Manufacturer
1. Envoy	emulsifiable concentrate 12.6% active (0.94 lb/gal)	Valent

Application:

Timing	Any time of the year to actively growing grasses
Rate	17 fl. oz/ac (weeds 2 to 4 inches tall) to 34 fl. oz/ac (weeds 4 to 6 inches tall)
Precautions	Should be used early postemergence to grasses. A crop oil concentrate (containing at least 15% emulsifier) at 1% volume (essentially 1 liter of crop oil per 100 liters of product) will increase grass control. Do not apply more than 68 fl. oz/ac per year.

CLOPYRALID

Classification: Picolinic acids

Utilization: Postemergence control of broadleaf weeds. Can be applied over-the-top (Stinger only) or as a directed spray (Stinger and Lontrel). Effective for clover, vetch, and sicklepod control.

Method of Uptake and Translocation:
Absorbed by the leaves and roots and is translocated rapidly in both the xylem and phloem systems.

Method of Action: It affects plant cell respiration and growth.

Movement in Soils: Since it is highly soluble in water and does not adsorb to soil particles it can leach from soils. It should be applied with great caution on loamy sand or sandy soils (especially when using no mulch or a chemical soil stabilizer).

Decomposition: The average half-life of clopyralid is 40 days. It has minimal volatility and photodegradation.

Toxicity: LD50 – >5000 mg/kg Low toxicity to mammals
LC50 – 125 mg/l Slightly toxic to fish

Formulations Labeled for Nurseries:

Trade Name	Formulation	Manufacturer
1. Lontrel	emulsifiable concentrate 40.9% active (3 lb/gal)	Dow AgroSciences

Labeled for conifers and non-leguminous tree species

Application:

Timing Any time after May 1 to actively growing broadleaf weeds

Rate 0.25 pt/ac in a spray volume of at least 20 gallons per acre. Multiple applications can be used but total chemical applied should not exceed 1.33 pt/ac per year (Except in Florida).

Precautions Clopyralid may cause some needle curling. Do not use a crop oil concentrate because needle curling maybe increased. Should not tank mix this chemical. Nurseries with less than 1% organic matter should not use this chemical due to increased risk of epinasty.

Do not use on crop legumes such as Redbud or Locust.

2. Stinger	emulsifiable concentrate 40.9% active (3 lb/gal)	Dow AgroSciences

Stinger is supplementally labeled for loblolly, slash, and longleaf pine only for the states of Alabama, Arkansas, Georgia, Lousiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia.

Application:

Timing	Any time after May 1 to actively growing broadleaf weeds
Rate	0.25 to 0.5 pt/ac in a spray volume of 20 or more gallons per acre.
Precautions	Clopyralid may cause some needle curling. Do not use a crop oil concentrate or a surfactant because needle curling maybe increased. Should not tank mix this chemical. Nurseries with less than 1% organic matter should not use this chemical due to increased risk of epinasty.

EPTC

Classification: Carbamothioate

Utilization: Selective preemergence control of grasses and broadleaves, some activity on sedges for up to 2 months. Puts nuts in a "coma" state.

Method of Uptake and Translocation:
EPTC is absorbed by roots and translocated upward to the stem and leaves through the xylem.

Method of Action: Inhibits cuticle formation at the early stages of seedling growth.

Movement in Soils: EPTC is moderately leachable, moving 9 to 15 inches when 8 inches of water is applied. Since EPTC has a low affinity for binding to soil and has high water solubility it has a potential to leach, but since it generally does not persist long in surface soils, the potential to leach is greatly reduced.

Decomposition: The half-life of EPTC in the soil is about 1 week. EPTC is readily lost from the soil surface by volatilization.

Toxicity:		
	LD50 – 1325 mg/kg	Slightly toxic to mammals
	LC50 – 17 mg/l	Slightly toxic to fish and moderately toxic to aquatic invertebrates

Formulations Labeled for Nurseries:
Loblolly, slash, longleaf, and shortleaf pine

Trade Name	Formulation	Manufacturer
1. Eptam 7-E	Emulsifiable concentrate 87.8% active ingredient (7 lbs/gal)	Syngenta

Application:

Pre-sowing

Timing	Apply prior to bed shaping and at least 14 days before sowing
Rate	7 pts/ac
Precautions	EPTC must be mechanically incorporated. In some nurseries stunting has been observed when soil is cool and wet during the spring.

Postemergence — Does not have activity on established plants.

FLUAZIFOP-P-BUTYL

Classification: Aryloxyphenoxy propionate

Utilization: Postemergence control of annual and perennial grasses. Not effective on sedges or broadleaf weeds.

Method of Uptake and Translocation:
Absorbed only through green leaves. After foliar absorption it is translocated in both the xylem and phloem systems.

Method of Action: Fluazifop inhibits the formation of lipids, an essential component of cell membranes.

Movement in Soils: Generally considered to have low soil mobility

Decomposition: The half-life of fluazifop-P-butyl is 15 days. It has minimal volatility and photodecomposition.

Toxicity: LD50 – >5000 mg/kg Very low toxicity to mammals
LC50 – 0.53 mg/l Toxic to fish

Formulations Labeled for Nurseries:
Labeled for conifers and ornamentals

Trade Name	Formulation	Manufacturer
1. Fusilade II Turf and Ornamental	emulsifiable concentrate 24.5% active ingredient (2 lb/gal)	Syngenta

Application:

Timing Any time of the year to actively growing grasses

Rate 16 to 24 fl. oz/ac
0.5% solution for directed sprays

Precautions A 0.25% addition of nonionic surfactant is recommended when applying over the top of pine. Do not use a crop oil concentrate.

FOMESAFEN

Classification: Diphenylether

Utilization: It is labeled for control of yellow nutsedge in pine nurseries**.** Also provides preemergence and postemergence (to the weeds) control of annual broadleaf weeds.

Method of Uptake and Translocation:
Rapidly absorbed in leaves. Fomesafen may be absorbed by roots. It is transported in the xylem.

Method of Action: Disrupts cell membranes.

Movement in Soils: Has a moderate rating for leaching, especially on permeable soils that have a shallow water table. It is considered more mobile in sandy soils than in silt loam soils.

Decomposition: The half-life of fomesafen is approximately 4 months. While volatility losses are low, it readily decomposes in sunlight.

Toxicity: LD50 – >6500 mg/kg Slightly toxic - 1858 mg/kg for Reflex
LC50 – >6030 mg/l Very low toxicity to fish

Formulations Labeled for Nurseries:
Labeled (24-C) for longleaf, slash and loblolly pine in the states of Alabama, Arkansas, Georgia, Mississippi, North Carolina, South Carolina, and Texas.

Trade Name	Formulation	Manufacturer
1. Reflex	Soluble concentrate 22.8% active ingredient (2 lb/gal)	Syngenta

Application:

Timing Apply immediately after seeding.

Rate 1.5 pts/ac in 30 to 40 gallons of water.

Precautions Apply mulch for seed cover. Irrigate with 0.5 to 2 inches of water immediately following application. Injury has occurred when a preemergence application was applied on silt loam soils. Do not apply more than 1.5 pts/ac per year.

GLYPHOSATE

Classification: Unique chemistry

Utilization: Non-selective broad spectrum postemergence weed control. Should not be applied over-the-top and do not directly apply to seedlings. Has no residual soil activity.

Method of Uptake and Translocation:
Glyphosate is absorbed only by green leaves and tissue. It is translocated in both the xylem and phloem.

Method of Action: Inhibits the formation of essential amino acids. This reduces protein production that inhibits plant growth.

Movement in Soils: Tightly bound to soil particles, particularly organic matter. It is virtually non-leachable.

Decomposition: The average half-life of glyphosate is 47 days. It has negligible volatility and photodecomposition.

Toxicity:

LD50 – >5000 mg/kg	Very low mammalian toxicity
LC50 – 120 mg/l	Slightly toxic to fish and practically non-toxic to aquatic invertebrates

Formulations Labeled for Nurseries:
Ornamentals and plant nurseries

Trade Name	Formulation	Manufacturer
1. Roundup Pro	Water soluble liquid 41% a.i. plus a surfactant (4 lb/gal)	Monsanto

Application:

Timing Can be applied any time of the year to physiologically active green tissue.

Rate 6 to 48 fl. oz/ac
1% to 2% solution may be used for directed applications

Precautions It is only absorbed through green foliage. Similarly, it is non-selective and must be used with caution. Effectiveness can be affected by dirty or muddy water. Total application of this chemical cannot exceed 10.6 qts/ac per year. Use as a post-directed spray. May also be used in a wick applicator.

2. Other glyphosate labels include:

Roundup PRO Concentrate
Roundup PRODry
Roundup DRYpak

HALOSULFURON-METHYL

Classification: Sulfonylurea

Utilization: Postemergence control of sedges (namely purple and yellow nutsedge) and for one broadleaf weed (*Kyllinga* spp.)

Method of Uptake and Translocation:

Method of Action: Meristematic inhibitors.

Movement in Soils: Can be mobile in the soil and has low to moderate leachability.

Decomposition: The half-life is 6-12 days. Photodegradation and volatility are minimal.

Toxicity: LD50 – 1287 mg/kg for the Manage formulation Slightly toxic
LC50 – >118 mg/l Slightly toxic to fish

Formulations Labeled for Nurseries:
Halosulfuron-methyl is **NOT** labeled for pine and hardwood seedling nursery beds. It may be used, however, for nutsedge control in fallow ground, corn, and grain sorghum. Two formulations are available for these uses.

Trade Name	Formulation	Manufacturer
1. Permit	Water Dispersable Granule 75.0% active ingredient	Monsanto

Application: Used primarily for sedge control

Preemergence - not used for preemergence control

Postemergence - Over-the-top application

Timing Apply prior to weed emergence
Rate 0.67 to 1.33 fl. oz/ac (0.031 to 0.062 lbs/ac ai)
Precautions May need sequential treatment in 6 to 10 weeks. Use 0.25-0.5% v/v of non-ionic surfactant (1-2 qts per 100 gallons of spray solution). Do not exceed 1 qt of surfactant per acre when using high volume applications. Total annual use cannot exceed 2.66 oz/ac.

2. Manage (Fallow areas)	Water Dispersable Granule 75.0% active ingredient	Monsanto

Application: Used primarily for sedge control

Preemergence - not used for preemergence control

Postemergence - Over-the-top application

Timing	Apply prior to weed emergence
Rate	0.67 to 1.33 fl. oz/ac (0.031 to 0.062 lbs/ac ai)
Precautions	May need sequential treatment in 6 to 10 weeks. Use 0.25-0.5% v/v of non-ionic surfactant (1-2 qts/100 gallons of spray solution). Do not exceed 1 qt of surfactant per acre when using high volume applications. Total annual use cannot exceed 5.33 oz/ac.

LACTOFEN

Classification: Diphenylether

Utilization: Primarily for selective postemergence broadleaf control in pine nurseries.

Method of Uptake and Translocation:
Similar in properties to oxyfluorfen, lactofen is basically a contact herbicide that is readily absorbed into plant leaves but not readily taken up by roots. It is most active as a postemergence foliar application. Lactofen has limited translocation after absorption.

Method of Action: Is a membrane and chlorophyll production disruptor.

Movement in Soils: Tightly adsorbed to soil particles and has negligible leaching.

Decomposition: The half-life is 3 days. Photodecomposes minimally in soils. Insignificant volatility.

Toxicity: LD50 – > 5000 mg/kg 2600 mg/kg for Cobra
LC50 – 1.1 to 3.7 mg/l for the Cobra formulation
Cobra is highly toxic to freshwater aquatic plants and animals including fish, invertebrates, and clams.

Formulations Labeled for Nurseries:
Post-emergent applications are labeled for conifer nurseries on a Cobra supplemental label.

Trade Name	Formulation	Manufacturer
1. Cobra	Emulsifiable concentrate 23.2% active ingredient (2 lb/gal)	Valent

Application:
Postemergence:

Timing Should be applied postemergence 4-6 weeks after germination and seedlings have grown out of the cotyledon stage; i.e. having a tuft of primary needles.

Rate 6.5 fl. oz/ac weekly or 13% fl. oz/ac every other week (in at least 20 to 40 gallons of water/ac) for a maximum of 26 fl. oz./ac in one season.

Precautions A 0.25% addition of a nonionic surfactant or a 0.125% crop oil concentrate is recommended when applying over the top of pine. Apply to small actively growing weeds. Works primarily through contact, so good coverage of weeds is essential. Do not exceed 26 fl. oz/ac per year.

NAPROPAMIDE

Classification: Amides

Utilization: Selective preemergence (to weeds) for control of annual grasses and broadleaves.

Method of Uptake and Translocation:
Absorbed primarily by the roots with subsequent translocation to the shoots.

Method of Action: Seedling root growth stopped by blocking cell division**.**

Movement in Soils: Napropamide shows moderate leachability, moving 8 inches through a loamy sand when 8 inches of water is applied.

Decomposition: Generally considered to be somewhat persistant, the half-life is 8 to 12 weeks in soil. Although very little is lost to volatilization, strong summer sunlight can photodecompose 50% of the soil surface applied material in 4 days.

Toxicity: LD50 – >5000 mg/kg Very low mammalian toxicity
LC50 – 30 mg/l Slightly toxic to fish

Formulations Labeled for Nurseries:
Woody ornamentals

Trade Name	Formulation	Manufacturer
1. Devrinol 50-DF Ornamental Selective	Dry flowable powder 50% active ingredient (0.5 lb/lb)	United Phosphorus, Inc.

Application:
Postemergence to crop

Timing Maybe applied year round as a broadcast treatment over young hardwood stock (after germination is complete and seedlings have true leaves) or a directed application to weed-free soil. Subsequent applications may be made on a monthly basis. Weeds should be removed before applying Devrinol.

Rate 3 lbs/ac product (1.5 lb/ac ai)

Precautions Because of photodecomposition, napropamide does best when incorporated. One to two inches of water maybe used to incorporate. Not all hardwoods are listed on the Devrinol 50-DF label.

OXADIAZON

Classification: Oxadiazole

Utilization: Selective preemergence (to weeds) for control of annual grasses and broadleaves.

Method of Uptake and Translocation:

Readily absorbed by shoots of emerging weed seedlings, but less so by roots. Controls weeds by killing the young weed seedlings as they come in contact with the herbicide during germination. If the soil is disturbed after application, weed control activity of oxadiazon may be reduced.

Method of Action:

Movement in Soils: Tightly adsorbed to soil particles and has negligible leaching.

Decomposition: The average half-life is 60 days. Photodecomposes minimally in soils. Insignificant volatility.

Toxicity: LD50 – >5000 mg/kg Very low mammalian toxicity
LC50 – 1.76 mg/l Toxic to fish (carp)

Formulations Labeled for Nurseries:
Conifers

Trade Name	Formulation	Manufacturer
1. Ronstar 50 WSP	Water soluble packets (powder) 50% active ingredient (0.5 lb/lb)	Chipco

Application:
Postemergence to crop

Timing Prior to weed seed germination, as a directed spray or as an over the top spray.

Rate 4 to 8 WS packets per acre (2 to 4 lb/ac ai) for ground application

Precautions An irrigation of 0.5-inch of water immediately after application will improve weed control activity. Irrigation is required after over the top applications to move oxadiazon to the soil surface. Do not apply during bud break or during the 4 weeks after bud break. All weed growth should be removed prior to application.

OXYFLUORFEN

Classification: Diphenylether

Utilization: Selective preemergence and early postemergence herbicide. More effective on broadleaves than annual grasses.

Method of Uptake and Translocation:
Oxyfluorfen is basically a contact herbicide. Leaf surfaces more readily absorb this chemical than roots. There is very little movement within the plant after uptake. Preemergence applications work when the germinating plant contacts herbicide treated soil. If the soil is disturbed after application, the herbicide barrier might be broken/removed and germinating plants may therefore escape treatment.

Method of Action: Cell membrane disruptor. Requires light for herbicidal activity.

Movement in Soils: Strongly adsorbed onto soil particles with virtually no leaching. Maybe slightly mobile on extremely sandy soils.

Decomposition: Half-life is 30 to 40 days. Will photodecompose rapidly in water but slow in soil.

Toxicity:

LD50 –	>5000 mg/kg	Very low mammalian toxicity.
LC50 –	0.2 mg/l	Oxyfluorfen is highly toxic to freshwater aquatic plants and animals including fish, invertebrates, and clams.

Formulations Labeled for Nurseries:
Conifer seedbeds

Trade Name	Formulation	Manufacturer
1. Goal 1.6E	emulsifiable concentrate 19.4% active ingredient (1.6 lb/gal)	Dow AgroSciences
2. Goal 2XL	emulsifiable concentrate 23% active ingredient (2 lb/gal)	Dow AgroSciences

Application:
Preemergence

Timing	Over the top of sown and mulched seedbeds before pine germination.
Rate	1 to 2 pts (0.25 lbs. To 0.5 lb. active) per acre (minimum of 20 gallons of water per treated acre).
Precautions	An irrigation of 0.25" to 0.75" of water should be applied following the preemergence treatment prior to seedling emergence.

Postemergence

Timing Over-the-top postemergence applications should be delayed until at least 5 weeks after germination (7-8 weeks after sowing).

Rate 1 to 2 pts (0.25 lb to 0.5 lb. active) for Goal 2XL and 1.25 to 2.5 pints (0.25 to 0.5 lb. Active) for Goal 1.6E per acre for each postemergence application (minimum of 20 gallons of water per treated acre). Repeated applications maybe needed for control.

Precautions Succulent seedlings may be damaged. Apply to seedling weeds less than 4 inches in height. The maximum annual application amount of Goal 2XL that can be applied per acre is 8 pts. The addition of a 0.25% (2 pts per 100 gallons of spray solution) nonionic surfactant will enhance the herbicide activity. Use of crop-oil can enhance herbicidal activity but may increase phytotoxicity to pines. To avoid increasing the risk of injury apply oxyfluorfen 1 or 2 days before N fertilization (as opposed to 1 or 2 days after fertilization) of young seedlings.

3. Galigan 2E — emulsifiable concentrate, 23% active ingredient = 2 lb/gal — Makhteshim-Agan of North America, Inc.

Preemergence

Timing Over the top of sown and mulched seedbeds before pine germination.

Rate 1 to 4 pts (0.25 lbs. To 1 lb. active) per acre (minimum of 20 gallons of water per treated acre). If grasses are present, application should be 2 to 4 pts per acre.

Precautions All debris should be removed before application. An irrigation of 0.5 to 0.75-inch of water should be applied following the preemergence treatment prior to seedling emergence.

Postemergence

Timing Over-the-top postemergence applications should be delayed until at least 5 weeks after germination (7-8 weeks after sowing).

Rate 1 to 2 pts (0.25 lbs. To 0.5 lb. active) per acre for each postemergence application (minimum of 20 gallons of water per treated acre). Repeated applications maybe needed for control.

Precautions Succulent seedlings may be damaged. Apply to seedling weeds less than 4 inches in height. The maximum annual

application amount of Galigan 2E that can be applied per acre is 8 pts. The addition of a 0.25% (2 pints per 100 gallons of spray solution) nonionic surfactant will enhance the herbicide activity. Use of crop-oil can enhance herbicidal activity but may increase phytotoxicity to pines. To avoid increasing the risk of injury apply oxyfluorfen 1 or 2 days before N fertilization (as opposed to 1 or 2 days after fertilization) of young seedlings.

PENDIMETHALIN

Classification: Dinitroanaline

Utilization: Selective preemergence herbicide for control of broadleaves and annual grasses.

Method of Uptake and Translocation:
Taken up both by roots and shoots. Foliar absorption is probably more effective for broadleaves. Pendimethalin is not absorbed by the leaves of grasses. Translocation is minimal.

Method of Action: Inhibits cell division and elongation.

Movement in Soils: Pendimethalin is strongly adsorbed to soil organic matter and clay and has virtually no movement in soils.

Decomposition: Half-life of 44 to 90 days. Photodecomposition is minimal but pendimethalin has moderate volatilization losses.

Toxicity: LD50 – >5000 mg/kg Very low mammalian toxicity
LC50 – 0.199 mg/l Highly toxic to fish and aquatic invertebrates

Formulations Labeled for Nurseries:
Hardwood nurseries

Trade Name	Formulation	Manufacturer
1. Pendulum WDG	Water dispersable granule 60% active ingredient	BASF

Application:

Timing Applied preemergence to established hardwood seedbeds after seedlings have been well rooted.

Rate 1.6 lbs/ac of product (1 lb/ac ai)

Precautions Irrigation of at least 0.5-inch is necessary for maximum efficacy. Hardwood seedlings should have true leaves for over-the-top application. Weeds should be hand-weeded before applying Pendulum.

2. Pendulum 3.3 EC	emulsifiable concentrate 37.4% active ingredient	BASF

Application:

Timing Applied preemergence to established hardwood seedbeds after seedlings have been well rooted.

Rate 1.2 qts/ac of Pendulum 3.3 EC (1 lb/ac ai)

Precautions	Irrigation of at least 0.5-inch is necessary for maximum efficacy. Hardwood seedlings should have true leaves for over-the-top application. Weeds should be hand-weeded before applying Pendulum.

PRODIAMINE

Classification: Dinitroaniline

Utilization: Selective preemergence control of grasses and broadleaves.

Method of Uptake and Translocation:
Taken up by roots of germinating seeds with very limited translocation to shoots.

Method of Action: Prevents seed germination and inhibits root growth.

Movement in Soils: Strongly adsorbed to soil with very low leachability.

Decomposition: Half-life of 120 days in the soil. Photodecomposition and volatilization can be a problem if not incorporated.

Toxicity:

LD50 – >5000 mg/kg	Very low mammalian toxicity
LC50 – 13 mg/l	Not toxic to fish at the limit of solubility. However, prodiamine is moderately toxic to fish at concentrations above this point.

Formulations Labeled for Nurseries:
Conifer and hardwood nurseries

Trade Name	Formulation	Manufacturer
1. Factor	Water dispersible granule	Syngenta
2. Endurance	65% active ingredient	
3. Barricade		

Application:
Preemergence

Timing For pine, over the top applications may be made 5 weeks after the time most pine seedlings have shed their seedcoat.

Rate 0.75 lbs/ac (0.49 lb/ac ai) for pine and 0.75 to 1.5 lbs/ac (0.49 to 0.98 lb/ac ai) for hardwoods mixed with at least 20 gallons of water per acre.

Precautions Activate Prodiamine with at least 0.5-inch of irrigation and/or with shallow incorporation (1 to 2 inches) prior to weed seed germination and within 14 days of the application. Do not use on pines when organic matter levels are less than 1.5%.

All three chemicals should not be applied until oak, sweetgum, and green ash seedlings are at least 6 weeks old (from time of 50% germination). Repeat applications can be conducted as long as

they do not exceed the annual maximum allowed application rate of 2.3 lbs/ac.

SETHOXYDIM

Classification: Cyclohexenone

Utilization: Postemergence control of both annual and perennial grasses. Is not effective against sedges or broadleaf weeds.

Method of Uptake and Translocation:
Sethoxydim is taken up by green leaves and is translocated through the phloem and xylem systems of the plant.

Method of Action: Stops the biosynthesis of lipids, particularly in growing shoots and leaves.

Movement in Soils: Has a weak tendency to adsorb to soil particles. Therefore, it has slight mobility.

Decomposition: Half-life is 5-11 days. While volatilization is minimal, it can photodecompose rapidly.

Toxicity: LD50 – >2200 mg/kg Very low mammalian toxicity
LC50 – 100 mg/L Slightly toxic to fish

Formulations Labeled for Nurseries:
Ornamental, nursery plantings, and fallow land

Trade Name	Formulation	Manufacturer
1. Vantage	Water soluble liquid 13% active ingredient (1 lb/gal)	BASF

Application: labeled for "nursery plantings" for both conifers and hardwoods.

Preemergence — Sethoxydim is not effective for preemergance application.

Postemergence

- **Timing** — Maybe applied any time grasses are physiologically active and growing.
- **Rate** — 2.25 pts/ac for grass up to 6 inches in height, 3.75 pts/ac for grass up to 12 inches in height.
- **Precautions** — Thorough coverage of foliage is essential. Vantage has a surfactant as part of the formulation. Crop oil or nonionic surfactants are not recommended. Repeat application if new grass regrowth occurs.

TRIFLURALIN

Classification: Dinitroaniline

Utilization: Preemergence control of annual grasses and broadleaf weeds.

Method of Uptake and Translocation:
Absorbed primarily by emerging plant shoots and to a lesser extent by roots. Trifluralin works when the germinating radicle contacts herbicide treated soil.

Method of Action: Inhibits root growth as it is absorbed by newly germinating weed plants.

Movement in Soils: Very low water solubility and strong adsorption to soil results in very little leaching.

Decomposition: Half-life is 45-60 days. While volatilization is minimal, it can photodecompose.

Toxicity: LD50 – >5000 mg/kg for Trifluralin. >2900 mg/kg for Treflan E.C. (Slightly toxic to mammals)
LC50 – 0.058 Highly toxic to fish and aquatic invertebrate animals

Formulations Labeled for Nurseries:
Conifer and hardwood nurseries

Trade Name	Formulation	Manufacturer
1. Treflan E.C.	Emulsifiable concentrate 43% active ingredient (4 lbs/gal)	Monterey Chemical Co.

Application:
Preemergence

Timing Apply after sowing but before germination of target weeds.

Rate Coarse soils (sand and sandy loam) – 1 pt/ac (1/2 lb./ac ai), Medium soils (loam, silt loam, and silt) – 1 1/2 pts/ac (3/4 lb/ac ai), Fine soils (clay loam, silty clay, and clay) – 2 pts/ac (1 lb/ac ai)

Precautions Apply in 5 to 40 gallons of water per acre. Trifluralin must be incorporated into the soil after application to prevent loss of its activity. A 1/2-inch rain or its equivalent in sprinkler irrigation must be received within 24 hours or poor weed control will result.

Postemergence – does not provide control of emerged weeds.

GRANULAR FORMULATIONS

A granular is a dry formulation consisting of discrete particles generally less than 10 cubic millimeters and designed to be applied without a liquid carrier (Weed Science Society of America WSSA). Granular herbicides are often used in horticultural nurseries and a number of granular herbicides are on the market. We have selected 12 granular herbicides that have potential for use in hardwood nurseries. Although some have potential for use in pine nurseries, the cost is greater than liquid formulations. The cost to treat an acre with granular herbicides could exceed $120. This may be 8 to 10 times the cost of applying the same active ingredient sold as a liquid formulation.

An advantage of granular herbicides is that when hardwood leaves are dry, the granules drop to the ground and do not affect the foliage. In cases where granules are lodged in the foliage, a sufficient amount of irrigation soon after treatment will reduce the chance of phototoxicity. For this reason, a wide variety of species are listed on granular herbicide labels. Granules of oxyfluorfen and oxadiazon could cause some necrosis if they are allowed to remain on leaves.

WARNING: Unfortunately, "water dispersable granules" (WDG) do not fit the WSSA definition even though they are called "granules." DO not treat WDG formulations as though they were true granular formulations. WDG formulations should be mixed with water and applied as a liquid spray. Do not apply WDG formulations without following the label directions.

Product	**Active Ingredients**
1. Devrinol 5-G	napropamide – 5%
2. Devrinol 10-G	napropamide – 10%
3. Ornamental Herbicide II	oxyfluorfen – 2%, pendimethalin 1%
4. Pendulum 2G	pendimethalin – 2%
5. PrePair Ornamental Herbicide	napropamide – 4%, oxadiazon – 2%
6. RegalO-OHerbicide	oxyfluorfen – 2%, oxadiazon – 1%
7. RegalKade G	prodiamine – 0.5%
8. Regal Ronstar AC	oxadiazon – 2%
9. RegalStarII	oxadiazon – 1%, prodiamine - 0.2%
10. Ronstar G	oxadiazon – 2%
11. Rout	oxyfluorfen – 2%, oryzalin – 1%
12. Treflan 5G	trifluralin – 5%

Trade Name	Formulation	Manufacturer
1. Devrinol 5-G	napropamide - 5% a.i. (lbs/Lbs)	Syngenta

Application:

Timing	Apply to established seedlings (i.e. seedlings have true leaves) and to freshly weeded soil before weeds germinate.
Rate	80 lbs/ac (when weeds are lighter) to 120 lbs/ac (when weeds are heavy or when primarily broadleaves) of Devrinol (4 to 6 lbs/ac of napropamide).
Precautions	Should remove existing weed/grass growth before application. Irrigation of 1 to 2 inches is required for optimum weed control activity.

Trade Name	Formulation	Manufacturer
2. Devrinol 10-G	napropamide - 10% a.i. (lbs/Lbs)	United Phosphorus, Inc.

Application:

Timing	Apply to established seedlings (i.e. seedlings have true leaves) and to freshly weeded soil before weeds germinate.
Rate	40 lbs/ac (when weeds are lighter) to 60 lbs/ac (when weeds are heavy or when primarily broadleaves) of Devrinol (4 to 6 lbs/ac of napropamide).
Precautions	Should remove existing weed/grass growth before application. Irrigation of 1 to 2 inches (within 2-3 days) is required for optimum weed control activity.

Trade Name	Formulation	Manufacturer
3. Ornamental Herbicide II	oxyfluorfen - 2% a.i. (lbs/Lbs) pendimethalin – 1% a.i. (lbs/Lbs)	The Scotts Co.

Application:

Preemergence

Timing	Apply to established seedlings (i.e. seedlings have true leaves) and to freshly weeded soil before weeds germinate.
Rate	100 lbs/ac of Ornamental Herbicide II (2 lbs/ac of oxyfluorfen and 1 lb/ac of pendimethalin)
Precautions	Should remove existing weed/grass growth before application. Irrigation of 0.5-1 inch immediately after application is needed to activate the product. Repeat applications should be made every 3 months.

Trade Name	Formulation	Manufacturer
4. Pendulum 2G	pendimethalin – 2% a.i. (lbs/Lbs)	BASF

Application:

Timing Apply to established seedlings (i.e. seedlings have true leaves) and to freshly weeded soil before weeds germinate.

Rate 100 lbs/ac of Pendulum 2G (2 lbs/ac of pendimethalin).

Precautions Should remove existing weed/grass growth before application. Irrigation of 0.5-inch after application will improve the control of weeds.

Trade Name	Formulation	Manufacturer
5. PrePair Ornamental Herbicide	napropamide - 4% a.i. (lbs/Lbs) oxadiazon – 2% a.i. (lbs/Lbs)	Platte Chemical Co.

Application:

Timing Apply to established seedlings (i.e. seedlings have true leaves) and to freshly weeded soil before weeds germinate.

Rate 100 lbs/ac (for easier-to-control weeds) to 150 lbs/ac (for harder-to-control weeds) of PrePair (4 to 6 lbs/ac of napropamide and 2 to 3 lbs/ac of oxadiazon)

Precautions Should remove existing weed/grass growth before application. Irrigation will improve weed control activity. Repeat applications should be made every 3 months. Cultivating or disturbing the soil may reduce weed control activity. Can only apply 240 lbs/ac of this product annually.

Trade Name	Formulation	Manufacturer
6. RegalO-O Herbicide	oxyfluorfen - 2% a.i. (lbs/Lbs) oxadiazon – 1% a.i. (lbs/Lbs)	Regal Chemical Co.

Application:

Timing Do not apply over seedlings that are producing flush new growth because injury may result. Any time of the year prior to susceptible weed seed germination.

Rate 100 lbs/ac of RegalO-O (2 lbs/ac of oxyfluorfen and 1 lb/ac of oxadiazon)

Precautions Remove existing weed growth before application. A 0.5-inch irrigation after treatment will result in maximum weed control activity. Cultivating or disturbing the soil may reduce weed control activity. Repeat applications should be made every 3-4 months.

Trade Name	Formulation	Manufacturer
7. RegalKade G	prodiamine – 0.5% a.i. (lbs/Lbs)	Regal Chemical Co.

Application:

Timing Can be applied anytime in established seedlings prior to weed seed germination.

Rate 132 to 300 lbs/ac of RegalKade (0.66 to 15 lbs/ac of prodiamine). Higher rates can be used for longer periods of control.

Precautions For best results, 0.5-inch irrigation should be conducted prior to weed seed germination and within 14 days after application to activate the chemical. Repeat applications can be made so long as the total amount of product applied does not exceed 300 lbs. per acre per year.

Trade Name	Formulation	Manufacturer
8. Regal Ronstar AC	2% oxadiazon a.i. (lb/Lbs)	Regal Chemical Co.

Application:

Timing Apply to established seedlings (i.e. seedlings have true leaves) and to freshly weeded soil before weeds germinate.

Rate 100 to 200 lbs/ac of Regal Ronstar AC (2 to 4 lbs/ac of oxadiazon) depending on the weed species to be controlled.

Precautions Irrigation immediately after application will improve weed control activity. Remove existing weed growth before application. Cultivating or disturbing the soil after application may reduce weed control activity.

Trade Name	Formulation	Manufacturer
9. RegalStarII	oxadiazon - 1% a.i. (lbs/Lbs) prodiamine – 0.2% a.i. (lbs/Lbs)	Regal Chemical Co.

Application:

Timing Apply to established seedlings (i.e. seedlings have true leaves) and to freshly weeded soil before weeds germinate.

Rate 200 lbs/ac of RegalStarII (2 lbs/ac of oxadiazon and 0.4 lbs/ac of prodiamine)

Precautions For best results, irrigation should be conducted within 14 days after application to wash the herbicide into the soil. Cultivating or disturbing the soil after application may reduce chemical effectiveness.

Trade Name	Formulation	Manufacturer
10. Ronstar G	2% oxadiazon a.i. (lbs/Lbs)	Chipco

Application:

Timing Apply to established seedlings (i.e. seedlings have true leaves) and to freshly weeded soil before weeds germinate.

Rate 100 to 200 lbs/ac of Ronstar G (2 to 4 lbs/ac of oxadiazon) depending on the weed species to be controlled.

Precautions An irrigation of 0.5-inch of water immediately after application will improve weed control activity. Remove existing weed growth before application. Cultivating or disturbing the soil after application may reduce weed control activity.

ORYZALIN

Classification: Dinitroaniline

Utilization: Selective preemergence herbicide.

Method of Uptake and Translocation:
Readily absorbed by roots of weed seedlings.

Method of Action: Inhibits cell division in plants and coleoptile growth resulting in the plant not being able to emerge.

Movement in Soils: Moderately adsorbed onto soil particles and may leach. Maybe slightly mobile on extremely sandy soils.

Decomposition: Half-life is an average of 20 days. May photodecompose slightly. Volatilization is minimal.

Toxicity: LD50 – >5000 mg/kg Very low mammalian toxicity.
LC50 – 2.88 mg/l Toxic to fish.

Formulations Labeled for Nurseries:

Trade Name	Formulation	Manufacturer
11. Rout	2% oxyfluorfen a.i.(lbs/Lbs) 1% oryzalin a.i.(lbs/Lbs)	The Scotts Co.

Application:

Timing Apply to established seedlings (i.e. seedlings have true leaves) and to freshly weeded soil before weeds germinate.

Rate Apply at 50 lbs/ac (1 lb/ac of oxyfluorfen and 0.5 lb/ac of oryzalin) for a maximum of two applications per growing season or at 100 lbs/ac (2 lbs/ac of oxyfluorfen and 1 lb/ac of oryzalin) maximum once a year.

Precautions Do not reapply at less than a 3 month interval. The soil should not be disturbed after application because the herbicide barrier will be broken. For maximum efficacy an irrigation of 0.5-inch/ac should be conducted immediately following application to activate the product.

Trade Name	Formulation	Manufacturer
12. Treflan 5G	trifluralin - 5% a.i. (lbs/Lbs)	United Horticultural Supply

Application:

Timing	Can be applied before planting or after planting before weed germination or immediately after cultivation.
Rate	80 lbs. per acre of Treflan 5G (4 lbs/ac of trifluralin)
Precautions	Repeat applications should not be made sooner than 60 days after a previous application. Can only apply 240 lbs/ac of this product annually. Irrigation of 0.5-inch or more is required to activate this product (should be within a few hours but not longer than 3 days after surface application).