Information Bulletin 216

Note: The insert described on page 25 is no longer available. Consult your county Cooperative Extension agent for up-to-date herbicide recommendations.

Weed Control for the Home Vegetable Garden

Robin R. Bellinder
Roger A. Kline
Donald T. Warholic

A Cornell Cooperative Extension Publication

This publication contains pesticide recommendations. Changes in pesticide regulations occur constantly and human errors are still possible. Some materials mentioned may no longer be available, and some uses may no longer be legal. All pesticides distributed, sold, or applied in New York State must be registered with the New York State Department of Environmental Conservation (DEC). Questions concerning the legality and/or registration status for pesticide use in New York State should be directed to the appropriate Cornell Cooperative Extension specialist or your regional DEC office. **Read the label before applying any pesticide.**

The information given herein is supplied with the understanding that no discrimination is intended and no endorsement by Cornell Cooperative Extension is implied.

ACKNOWLEDGMENTS

Reviewers:

Monika Roth Crispin, Program Leader, Cornell Cooperative Extension, Tompkins County

Joann Gruttadaurio, Extension Associate, Floriculture and Ornamental Horticulture

Shirley T. Kline, Agent, Cornell Cooperative Extension, Monroe County

Wesley L. Kline, Agent, Cornell Cooperative Extension, Genesee County

Robert E. Kozlowski, Extension Associate, Floriculture and Ornamental Horticulture

Robert D. Sweet, Professor Emeritus, Vegetable Crops

Leonard D. Topoleski, Professor, Vegetable Crops

Thomas W. Scott, Professor of Agronomy, assisted with the section on cover crops.

Editor:
Anita C. Stuever

The authors are deeply grateful to Anita Stuever, our editor in Media Services, who shepherded this publication through to its conclusion. Her editorial guidance gave meaning and worth to the bulletin.

Illustrator:
Kimberly Schrag

Weed Control for the Home Vegetable Garden

Robin R. Bellinder
Assistant Professor, Department of Vegetable Crops

Roger A. Kline
Senior Extension Associate, Department of Vegetable Crops

Donald T. Warholic
Research Associate, Department of Vegetable Crops

Cornell University

CONTENTS

Hoeing

I sometimes fear the younger generation will be deprived
of the pleasures of hoeing;
there is no knowing
how many souls have been formed by this simple exercise.

The dry earth like a great scab breaks, revealing
moist-dark loam—
the pea-root's home,
a fertile wound perpetually healing.

How neatly the green weeds go under!
The blade chops the earth new.
Ignorant the wise boy who
has never performed this simple, stupid, and useful wonder.

—John Updike

INTRODUCTION

HOME GARDENING is enjoyable and rewarding. Gardens provide opportunity for hours of exercise, communion with nature, and fresh vegetables for eating.

But the curse of every gardener is weeds. The purpose of this bulletin is to enable home gardeners to identify the most common weeds and to select the most suitable strategies for controlling them.

The first section discusses weed life cycles, which you'll need to know to select the best control method. Then the 18 weeds most troublesome in Northeast vegetable gardens are described, with photographs and descriptions to help you identify those weeds in your garden. In the final section, mechanical, cultural, and chemical strategies to control weeds are presented.

Correct identification and timely removal of weeds are essential to successful weed control. The term *weed* is somewhat controversial because, as the adage says, "beauty is in the eye of the beholder"; a weed to you may be a wildflower to your neighbor.

Some plants are easily recognized as harmful—for example, poison ivy, poison oak, and poison sumac. The negative impact of others is less obvious; the volunteer corn or potato plants from last year's garden that emerge in this year's plot for snap beans are weeds. A weed can be defined simply as a plant out of place.

The biggest problem with weeds is that they compete with garden plants for water, nutrients, and light—all essential for plant growth and development.

Where several plant species grow together, the most vigorous one usually dominates. Different species often have contrasting growth habits, and a plant with many large leaves or a rapidly growing root system has an advantage over one with sparse, narrow leaves or a slow growth habit (common lambsquarters dominates onions, for example).

The time weeds emerge in relation to vegetable emergence is also important. Weeds emerging prior to or simultaneously with garden plants decrease plant yields more than those emerging afterward. This is particularly true with small-seeded vegetables, such as lettuce or carrots.

Generally weed competition during the first 6 weeks after planting lowers yields. Competition late in the growing season interferes with harvesting and decreases the quality of the harvested product. For example, weed competition can reduce the size of potatoes, and quackgrass or nutsedge can actually puncture potatoes.

Knowing when weeds emerge is important in determining how to control them.

In addition to competing with crop plants, weeds harbor insects that attack crops. For example, weeds of the nightshade family host Colorado potato beetles, which attack potatoes, tomatoes, and eggplants. Aphids, frequent carriers of disease, commonly live on weeds and move easily from weedy borders into the garden.

Weeds also act as alternate hosts for numerous bacterial and viral diseases that are carried by feeding insects from weeds to crops. Therefore it is important to control weeds both within the garden and around it.

A single weed commonly produces thousands of seeds—both dormant and nondormant—which can live from 3 to more than 30 years. Table 1 lists a few common weed species and the number of seeds produced per plant per year.

Some weed seeds lie on the surface of the soil but others are buried deeply. The top inch of soil in 1 acre contains an estimated 3 million weed seeds.

New flushes of weeds appear shortly after every cultivation because stirring the soil exposes the seeds to light (triggering germination) and to environmental conditions that favor seedling emergence. Often more weed seedlings emerge when the soil surface is smooth and compact than when the surface is rough and loose because close seed-soil contact is essential for germination.

Failure to control weeds allows seed reserves to remain in the soil, which means weed problems may persist for years. Through careful use of cultural, mechanical, and occasionally chemical means, the number of weed seeds in cultivated soils can gradually be reduced. Timely control *before the plants set seed* is the best way to keep weed-seed reserves from building up.

Table 1. Number of seeds produced per plant in a year

Species	*Number*
Redroot pigweed	117,400
Common lambsquarters	72,450
Purslane	52,300
Shepherdspurse	38,500
Dodder	16,000

Source: Stevens, O. A. 1932. The number and weight of seeds produced by weeds. *Amer. J. Bot.* 19:784–94.

WEED TYPES AND LIFE CYCLES

You need to be familiar with weeds and understand their life cycles to select the stage most easily controlled. To begin with, you need to know whether a weed is a broadleaf or a grass and whether it is an annual, biennial, or perennial plant.

Weed life cycles are illustrated in figure 1.

Broadleaves. Broadleafed plants have broad leaves, with small veins radiating from larger veins like fingers. The flower parts are often in fours or fives. They may have taproots or fibrous roots that develop from a primary root. A taproot is a large primary root with branches growing from it; for example, a carrot has a taproot. In a fibrous root system, all roots are of about equal size.

Grasses. Grasses are characterized by long, narrow leaves with parallel veins. They have a fibrous root system, and flower parts are mostly in threes or multiples of three.

Annuals. Annuals germinate, grow, flower, and set seed in 1 year or less. The group can be divided into winter and summer annuals.

Winter annuals germinate in the fall or early winter and die the next summer; summer annuals germinate in the spring and die in the fall. Temperature and light are two important mechanisms that trigger germination of annuals.

Day length is also a critical trigger, causing the plant to shift from vegetative (leaf) to reproductive (flower) growth. Seedlings that emerge early (when days are longer) are likely to become large plants before flowering, and produce thousands of seeds. Seedlings that emerge later are soon exposed to shortening day lengths and

thus are quite small when flowering begins. Such plants produce fewer seeds.

A few annuals, such as purslane and galinsoga, are not sensitive to day length. They may produce 4 or 5 generations in a single growing season. Annuals are best controlled when they are very small seedlings but, at all costs, should be removed before they set seed.

Biennials. Biennials complete their life cycles in two growing seasons. During the first year, they germinate but form only a leafy rosette (a cluster of leaves radiating from one point and lying close to the ground). In the second year they form a leafy stem that matures and produces flowers and seeds.

Biennials may be found any time of year and are most easily controlled in the early growing stage of the first year. Yellow rocket is an example of a biennial.

Perennials. Perennials grow for many years and usually produce seeds each year. Many seeds are incapable of growing, however.

What makes the plants perennial are their underground reproductive organs—tubers, bulbs, stolons, or rhizomes—which live from year to year and produce new top growth annually.

At the start of the season, new plants sprout from buds on the underground parts often found deep in the soil. Few roots are found because initial plant nourishment comes from the parent rhizome, tuber, bulb, or stolon. First growth is rapid and neither mechanical nor chemical weed control early in the season does much to reduce the vigor of the underground reproductive structures.

Like annuals, perennials are influenced by day length. Day length also controls the transportation of food reserves as well as the vegetative growth of perennials. As days shorten in late summer, food reserves move to the underground reproductive organs for storage.

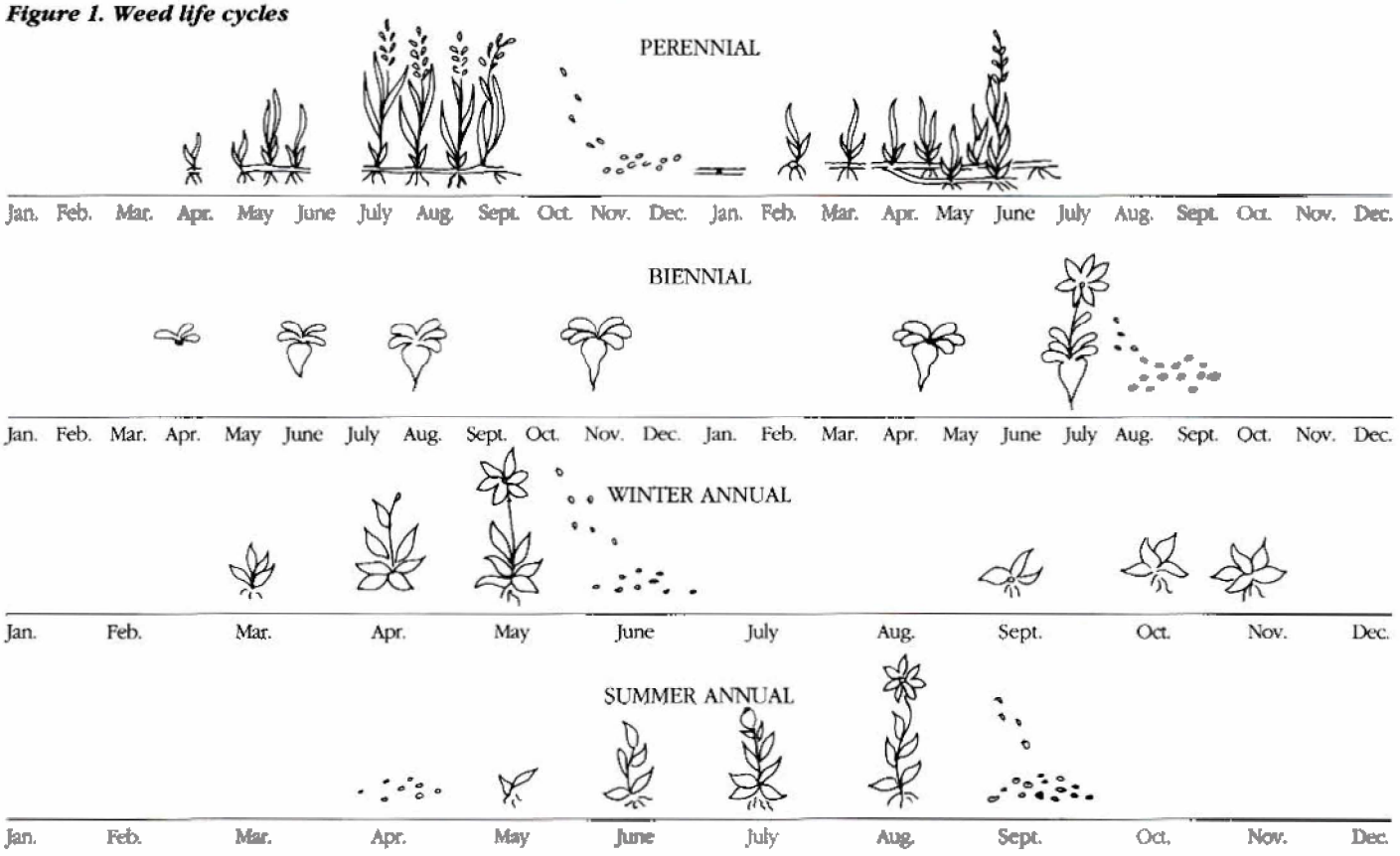
Control measures must take advantage of this flow of food reserves. Repeated top-kill or removal during the summer "starves" the reserve organs. Some chemicals penetrate the leaves and attach to the food reserves being stored. When the chemical moves to the underground reproductive structures it kills the plant.

Control of perennials, particularly chemical control, is often most successful in the fall or occasionally in the early spring following harvest and before planting. Quackgrass is a perennial weed.

The best and simplest way to identify a weed is to look first at the leaves and flowers to determine whether it is a broadleaf or a grass. (See Weed Types and Life Cycles, page 5.) Next dig it up and look at the underground parts to determine whether it is an annual or a perennial (pages 5 and 6.)

The weeds in this bulletin are described by type: annual broadleaves, biennials, perennial grasses, perennial broadleaves, and annual grasses. Once you've determined the type of your weed, go to the corresponding section and find a picture that resembles it. Read the weed description for a positive identification.

Figure 1. Weed life cycles



WEED IDENTIFICATION

Annual Broadleaves

COMMON LAMBSQUARTERS

(Chenopodium album)
Fam. Chenopodiaceae

LAMBSQUARTERS grows rapidly and adapts to many soils and environments. It has a shallow, many-branched taproot system. The aboveground portion of the plant is erect and branching, ranging from 3 to 6 feet high. Stems are erect and sturdy with ascending branches. Leaves vary in shape, the lower leaves goosefoot shaped, and the upper leaves lance shaped (lanceolate). They are densely covered with white glands. Small, mealy, pale green flowers without petals form in clusters on spikes at the ends of stems and branches and in the axils. Flowering occurs from early summer to fall and does not depend on day length, although a 16-hour day will hasten flowering and maturity. Lambsquarters reproduces by seed. Germination begins in mid- to late May and continues through August but occurs more rapidly when temperatures are cool (32° to 41° F). The life cycle of the plant is completed in 4 months. As a summer annual broadleaf weed, lambsquarters is best controlled by mechanical means when the weeds are very small.

COMMON PURSLANE

(Portulaca oleracea)
Fam. Portulacaceae

PURSLANE is characterized by its fleshy, succulent foliage. It has a taproot system and fleshy, freely branching stems that lie on the ground and form mats up to 1 foot in diameter. Leaves are usually opposite or occasionally alternate, oval, juicy, smooth, and often reddish or maroon tinged with green. Flowers, which are found at the axils, are small, single, and yellow. Small oval capsules split to release the many small dustlike seeds that reproduce purslane. After the soil warms in the spring, purslane matures rapidly, flowering and fruiting from June until frost. The thick, juicy nature of this plant makes it relatively drought resistant and enables it to regrow from stem pieces. Those characteristics make purslane a particularly difficult weed to control. The easiest way to control summer annual broadleaf weeds such as common purslane is to remove them by mechanical means when the weeds are very small.

COMMON RAGWEED

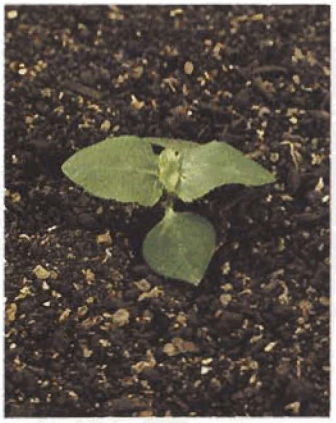
(Ambrosia artemisiifolia)
Fam. Compositae

COMMON RAGWEED, a member of the daisy family, has a shallow root system that is taprooted, but somewhat fibrous. The plant grows 2 to 4 feet tall and the stems may be unbranched or bushy, and hairless or covered with a dense mass of stiff, erect short hairs. Mature leaves, which resemble fern fronds, are deeply cleft, 6 to 12 inches long, and 4 to 6 inches wide. Male and female flowers develop separately on the same plant. Female flowers are green, stemless, and inconspicuous; they are borne singly or in clusters on leaf axils. The greenish white male flowers are clustered in 10 to 100 spikes at the ends of stems and branches. Ragweed flowers and produces seed during August and September. The optimal soil temperature for germination is between 50° and 80° F. It reproduces by seed; germination begins in May and is almost complete by late June. The easiest way to control summer annual broadleaf weeds such as common ragweed is to remove them mechanically when they are very small.

HAIRY GALINSOGA

(Galinsoga ciliata)
Fam. Compositae

HAIRY GALINSOGA is an annual weed with a taproot and it reproduces from seed. The stems are erect (1 to 2 feet tall), branching, and densely covered with coarse hairs. Leaves are opposite, with adjacent leaf pairs arranged at right angles. They are oval, nearly as wide as they are long, coarsely toothed, and hairy, with three major veins originating from a common point at the base. Flower heads are very small, numerous, and scattered at the ends of the branches. Individual flowers have white petals with a yellow center. Seeds are very small, densely haired, and brown to black; they have a white membrane with rough edges at the tip. Seeds germinate readily in the upper half inch of soil from May to September and are not dormant at maturity. Galinsoga is not responsive to photoperiod, which means that it flowers and sets seed throughout the growing season. Because of that, four or five generations can grow in 1 year in many areas of the northeastern United States. There is also some evidence that plants can reroot from stem pieces. You can control hairy galinsoga by mechanical means throughout the season. It is a summer annual broadleaf weed.

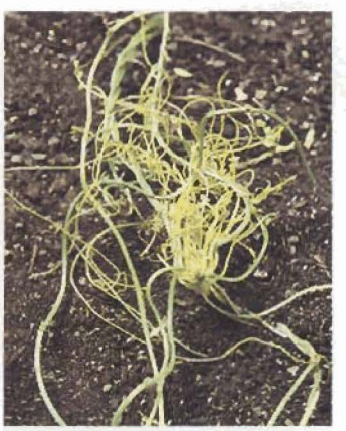


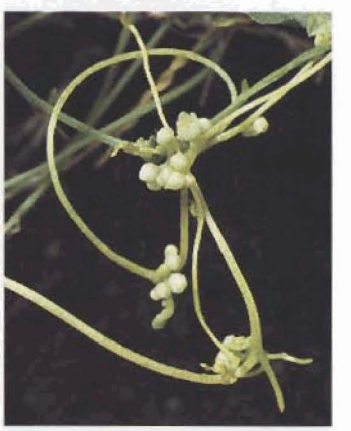
REDROOT PIGWEED
(Amaranthus retroflexus)
Fam. Amaranthaceae

REDROOT PIGWEED plants usually grow 2 to 3 feet tall but may grow as tall as 6 feet. They have a shallow taproot system, and the aerial portion consists of erect, many-branched stems that are green to slightly reddish. Leaves are lanceolate, dull, dark green, and alternate, with distinct veins and scattered hairs. Flowering begins in July and continues through September. Small green flowers are on dense, fingerlike spikes grouped in long clusters. It reproduces by seed; when seeds first mature, they are dormant. Germination is influenced by temperature, soil type, and day length but continues throughout the summer if moisture is adequate. The optimal soil temperature for germination is between 86° and 104° F. Because redroot pigweed germinates rapidly and the seeds have a shorter dormancy period in early and midsummer, two generations per year are common. Redroot pigweed is a summer annual broadleaf weed, controlled best by mechanical means when the plants are tiny.

FIELD DODDER
(Cascuta campestris)
Fam. Convolvulaceae

DODDER is a parasitic plant, which means it gets its nutrients from another plant. It reproduces by seed. After germination, each seedling emerges as a threadlike stem. The stem elongates rapidly until it encounters a host plant. It then coils tightly around the host's stem, sending root-like projections into its vascular tissues. It has no true roots. Dodder absorbs water and nutrients from the host, reducing its growth. Once attached to a host, the seedlings grow rapidly, branch extensively, and form dense mats. Competition from dodder in the early stages of vegetable growth reduces yield by an estimated 35 to 50 percent. It infests mostly broadleaf plants. Stems of dodder are leafless, slender, smooth, and pale orange to reddish. Flowers are inconspicuous and whitish; they grow in loose clusters on short stalks. Seeds are less than 1/16 inch in diameter—dustlike to the naked eye. They have the granular texture of pepper and are yellow to reddish brown. They are hard-seeded, which means they have impermeable seed coats and thus have long dormant periods. When dormancy is broken the seeds germinate readily from April to October. The parasitic plant must be controlled before it attaches to a host. It is also important to prevent dodder from forming seed. Control of this annual parasitic weed is extremely difficult once it is established. It is best controlled by *immediate* removal at its first appearance. If it becomes established, removal of the host plants may be required.



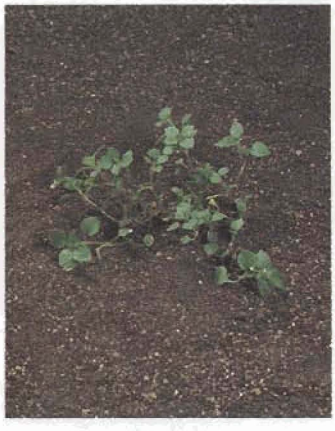


COMMON CHICKWEED

(Stellaria media)

Fam. Caryophyllaceae

CHICKWEED, a member of the carnation family, reproduces by seed. It is technically an annual, but it tolerates cold weather and often survives mild winters. The plants have shallow, fibrous root systems. Stems grow 3 to 15 inches long and are widely branched, forming thick, springy mats. Each stem has a single line of white hairs that shifts from one side of the stem to the other between nodes. When the branches are prostrate, they form roots at the nodes. Fully extended leaves are ½ inch long, opposite, and smooth, although the margins may have hairs. They are bright, light green, and nearly round with pointed tips. The leaf pairs close around the stem at night. Conspicuous but tiny flowers resembling starbursts form on long stalks, singly or in clusters, in leaf axils. The flower's five petals are deeply lobed, appearing as ten petals. The flowers open only on sunny days and last just 1 day. Their seeds are small—about 1/16 inch. Those that ripen during warm weather can germinate immediately; those that ripen in cold weather require alternating cold and warm temperatures for germination. Seeds mature 5 to 7 weeks after the parent plant germinates. During a single growing season, four or five generations of chickweed can be expected. You can control this annual (often winter annual) broadleaf weed by continuously removing it mechanically.



SHEPHERDSPURSE

(Capsella bursa-pastoris)

Fam. Cruciferae

SHEPHERDSPURSE is a member of the mustard family, which includes many weeds and several popular vegetable crops—cabbage, broccoli, cauliflower, collard, and radish. Shepherdspurse reproduces by seed. Growth from seed first produces a rosette of leaves that are 3 to 6 inches long and 1½ inches wide. The leaves are usually deeply lobed or coarsely toothed, similar to those of dandelion. The rosette form overwinters, and in the spring of the following year, the flower stalk emerges from it and bears flowers from spring until late fall. The flower stalk is unbranched or slightly branched, growing 6 to 18 inches tall. The stalk has mature seed pods on its lower portion and flowers on its upper portion. Individual flowers have 4 white petals and are less than ¼ inch in diameter. Leaves attached to the flower stalk are shaped like slender arrowheads with slightly toothed margins. The seed pods are flat, heart-shaped, and attached to the stalk at right angles on slender stems. Each pod contains 2 rows of tiny (1/32 inch) yellow-orange seeds. Germination occurs most readily in soils cooler than 60° F in the fall or early spring. Shepherdspurse is a broadleaf weed that may be a summer or winter annual. It is best controlled by early and timely mechanical removal.

WILD MUSTARD
(Sinapis arvensis)
Fam. Cruciferae

WILD MUSTARD reproduces by seed, germinating in the late summer and fall. In the first year it forms a rosette with leaves on short stalks called petioles. The rosette leaves are irregularly lobed or coarsely toothed with bristly hairs. During the following summer a flower stalk emerges from the rosette. The stalk is erect and branched near the top. Flower stalk leaves are smaller than rosette leaves, seldom lobed, and attached directly to the stem. Flowers, which grow in clusters at the ends of branches, are conspicuous, bright yellow, and have four petals. Seeds are borne in long pods. Each pod contains one to ten smooth black seeds in individual compartments. As a winter annual broadleaf weed, wild mustard is best controlled by removal during the rosette stage.

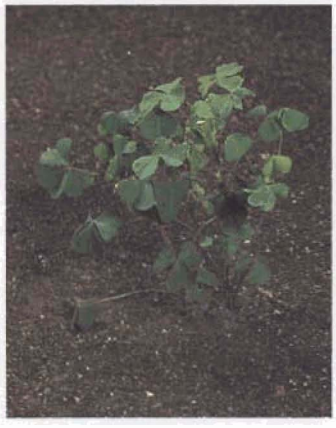
YELLOW ROCKET
(Tarbarea vulgaris)
Fam. Cruciferae

YELLOW ROCKET is a member of the mustard family. It is generally classified as a biennial; seeds germinate in the summer or fall and form an overwintering rosette with a yellow taproot. Rosette leaves are 2 to 8 inches long and have a large, round terminal lobe with 1 to 4 pairs of small, deeply indented, oval lobes near the leaf base. Three to eight stems grow from each rosette in the spring of the second growing season. The stems of yellow rocket are smooth and sturdy, growing 1 to 3 feet tall. Leaves are deep green and smooth. Leaf shape varies with position on the plant. Stem leaves are alternate and may resemble basal leaves or may be toothed, without basal lobes. It reproduces by seed. Flowers are bright yellow, ⅜ inch in diameter, with four petals formed in 5-inch-long clusters at the ends of branches. Flowering occurs during April and May. Dark green seed pods (1 inch long and ⅛ inch in diameter) develop from the flowers. Seeds are very small (1/32 inch in diameter) and light yellow to brown when mature. The whole plant normally dies in the fall but occasionally a rosette continues to send up flower stalks in the spring for several years. A biennial broadleaf or short-lived perennial weed, yellow rocket is best controlled by removal in the rosette stage or early in the flowering stage, before seeds are mature.

COMMON YELLOW WOODSORREL

(Oxalis stricta)
Fam. Oxalidaceae

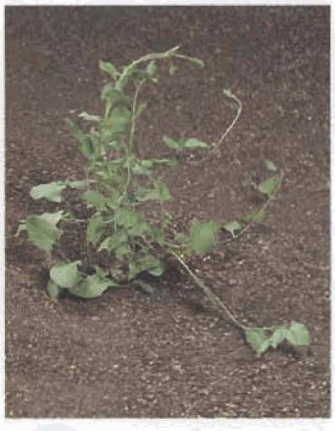
COMMON YELLOW WOODSORREL, a very familiar pest in home gardens, reproduces by seed. It is hypothesized that the plant overwinters as buds on underground roots. It is frequently confused with clover. The mature plant can be bushy or can form extensive mats. The plants have taproots and the stems are only weakly erect, often lying on the ground and forming roots at the nodes. Upper stems branch freely. Leaves are alternate and consist of three heart-shaped leaflets on long leaf stems (petioles). Flowers are typically yellow, have five petals, and are clustered in groups of three on long stalks. Seeds are enclosed in long, cylindrical, hairy capsules with pointed tips. When mature, the numerous seeds are ejected explosively; because of their small size they can be propelled many feet. This broadleaf weed, which may be perennial or summer annual produced from seed, can be controlled by clean cultivation. Remove the young weeds before seeds form.



FIELD BINDWEED

(Convolvulus arvensis)
Fam. Convolvulaceae

FIELD BINDWEED, a vine-like perennial that is a member of the morningglory family, reproduces by seed and by creeping roots. Stems are smooth or occasionally hairy, slender, and twining and can grow to form densely tangled mats. Leaves are alternate and smooth. Although they vary in shape, they frequently resemble arrowheads. Flowering occurs from spring to late summer but peaks in June. Blossoms occur singly in leaf axils and are shaped like trumpets or funnels, with five fused white or pink petals. One to four seeds are enclosed in each egg-shaped capsule. Most of the seeds are viable; about ¼ of them germinate immediately; the remainder have an impermeable seed coat and require an overwintering period before they germinate. The weed is perennial because of the reproductive ability of the extensive rhizome-producing root system. A 6-week-old plant can produce new shoots from root buds. Until mid-summer, top growth draws on root reserves for food. In the early fall, nutrients return to the roots for storage. New shoots that emerge from the rhizome buds are more vigorous than plants arising from seed. This perennial broadleaf weed may be controlled by removal of the seedling forms, but if the weed has become established, chemical removal may be necessary.



YELLOW NUTSEDGE
(Cyperus esculentus)
Fam. Cyperaceae

YELLOW NUTSEDGE is a grasslike member of the sedge family that reproduces by underground tubers called nutlets. It has a fibrous root system and an erect stem that grows 1 to 3 feet tall. Viewed in cross section, the stem is triangular. The leaves are very narrow, pale green, smooth, and shiny on the upper surface. The leaf blade bends up along its middle vein, making its cross section V-shaped. Flower clusters appear from early to late summer when days are 12 to 14 hours long. A flattened yellow flower cluster forms on a stalk arising from the center of the base of the plant. Yellow nutsedge is perennial because small underground tubers form on the tips of rhizomes. The nutlets overwinter, surviving soil temperatures as cold as 20° F, and sprout from May to late July. Leaves, stems, and roots of new plants grow until the shortening days of late summer trigger nutlet formation. In a single year the outward growth of rhizomes from one nutlet can produce 1,900 new plants and 7,000 new nutlets. Although frost kills the aboveground portion, nutlets remain viable for one to three years. Nutsedge should be controlled before it begins to form nutlets. You can control this perennial sedge by mechanical removal, particularly before nutlet formation begins early in the season.

QUACKGRASS
(Elytrigia repens, formerly *Agropyron repens)*
Fam. Gramineae

QUACKGRASS OR COUCHGRASS is an aggressive perennial cool-season grass that reproduces by seed and by rhizomes. Stems are 15 to 30 inches tall and have several tillers. Leaves are smooth on top but rough underneath and are distinguished by clasping, claw-like auricles at the base of the leaf blade. The flower spikes are 4 to 10 inches long, resembling slender heads of wheat. Seedling quackgrass has a fibrous root system, but by the time the plant has five leaves, rhizomes begin to develop. The rhizomes grow rapidly and extensively, often up to 3 feet long. Buds on nodes of the rhizomes give rise to new plants. The rhizome tips are so sharply pointed that they can penetrate potato tubers. Quackgrass is best controlled when the plants are in the seedling stage, before rhizomes develop. Once established, this perennial grassy weed may be controlled by chemical means.

YELLOW FOXTAIL

(Setaria glauca)
Fam. Gramineae

YELLOW FOXTAIL is a shallow, fibrous-rooted annual grass that reproduces by seed. Smooth, flat stems branch at the base and grow 1 to 2 feet tall. They often become prostrate, with roots forming at the nodes. Leaves are 4 to 12 inches long and ¼ inch wide at the base. There are no auricles. The base of the leaf has a fringe of hairs (1/16 inch long) that are fused together at the bottom. The easiest way to identify yellow foxtail is by the long, scraggly white hairs clustered near the base of the upper leaf surface. The remainder of the leaf is smooth. The seed head is a compact, slightly tapered cylinder covered with soft yellow bristles. The head grows 1 to 5 inches long and has small seeds densely packed along it. Yellow foxtail seeds are not dormant when shed so they can germinate immediately. The optimal temperature for germination is 68° to 95° F. Emergence occurs when seeds are in the top ¾ to 1¼ inch of soil. Seedlings reach maturity and produce new seeds in 40 days or less. This summer annual grassy weed is controlled by mechanical removal before seeds are shed.

LARGE CRABGRASS

(Digitaria sanguinalis)
Fam. Gramineae

LARGE CRABGRASS has a fibrous root system. The plant is generally prostrate, branching and spreading extensively, forming roots at the leaf nodes. Stems are often purplish or green. Stems, leaf sheaths, and leaf blades are densely hairy. Leaves are narrow and 2 to 6 inches long. The flower is a 2- to 7-inch spike with 3 to 13 fingerlike projections on which the seeds are borne. This characteristic is the basis for the genus name, Digitaria. Large crabgrass produces many tillers, each containing a flower. Seeds germinate from midspring to late summer and are dormant when shed. Because of its prostrate growth habit, large crabgrass is not conspicuous but always competitive. It is an alternate host for several plant viruses. This summer annual grassy weed is controlled by mechanical means.

FALL PANICUM
(Panicum dichotomiflorum)
Fam. Gramineae

FALL PANICUM is a fibrous-rooted grass that reproduces by seed. The plant grows up to 3 feet high and the stems bend at the joints, creating an upright but branching form. Outer stems, lying on the soil, form roots at the nodes. Leaves are lanceolate, ½ to 1 inch wide and 6 to 18 inches long, with a prominent, pale green center vein. Leaf blades are dull green on top and glossy on the lower surface. The upper surface may be sparsely hairy but usually is smooth. Fall panicum flowers from late June until October. The seed head is distinctive, being delicate with long, wispy flower stalks borne on a single stem. Newly shed seeds are dormant and require a 4-month cold period before germinating. The optimal soil temperature for germination is 80° F. As a summer annual grassy weed, fall panicum is best controlled by mechanical means.



WITCHGRASS
(Panicum capillare)
Fam. Gramineae

WITCHGRASS, a close relative of fall panicum, has a shallow, fibrous root system and reproduces by seed. It grows 10 to 30 inches tall, often in bunches because the stems branch at the base. Stems, leaf sheaths, and leaf blades are extremely hairy, distinguishing witchgrass from fall panicum. Leaf blades are 6 to 12 inches long and covered on both sides with soft, erect hairs. The flower opens to form a large, spreading, branched head with hundreds of tiny seeds on purple or green threadlike stalks. Summer annual grassy weeds such as witchgrass are best controlled by early and timely mechanical removal.



Now 'tis the spring, and weeds are shallow-rooted;
Suffer them now and they'll o'ergrow the garden.

—*Shakespeare,* King Henry VI

I will go root away
The noisome weeds, that without profit suck
The soil's fertility from wholesome flowers.

—*Shakespeare,* King Richard II

Bowed by the weight of centuries he leans
Upon his hoe and gazes on the ground,
The emptiness of ages in his face,
And on his back the burden of the world.

—*Edwin Markham,* The Man with the Hoe

WEED CONTROL STRATEGIES

CONTROLLING WEEDS is not simple. They have evolved complex mechanisms that enable them to survive in a wide range of conditions. Weeds have great adaptive abilities, therefore multiple techniques are needed to control them.

Four basic weed control strategies can be used by the home gardener: prevention, mechanical control, cultural control, and chemical control. Careful use of the first three often provides adequate weed control for the garden without resorting to the use of chemicals.

Prevention is simply good housekeeping. Use clean seed that is not contaminated by weed seed. Fresh manure may contain many weed seeds. When fertilizing with manure or compost, make sure it has been either stockpiled for 6 to 12 months or heat-treated; both practices kill the weed seeds.

Keeping the garden perimeter close cut prevents weed plants from producing seeds and reduces the spread of weeds into the garden as well as insect and disease infestations. Perennial weeds, in particular, should be kept from spreading into the garden because they are extremely difficult to control during the growing season.

Mechanical weed control is used most commonly. It includes hand weeding, plowing, tilling, and hoeing. Although often considered the most burdensome part of gardening, mechanical control is highly effective.

Numerous techniques fall into the category of cultural control. They include mulching, planting early, minimum tillage, and planting competitive crops. Cultural techniques used in conjunction with mechanical operations control most garden weeds effectively.

As a last resort, you may choose chemical control. Only a few herbicides are registered for home garden use, and with good reason. There are few advantages and numerous disadvantages of using herbicides in small areas.

The remainder of this bulletin describes in detail the three major weed control strategies—mechanical, cultural, and chemical.

STRATEGY 1.
Mechanical Control

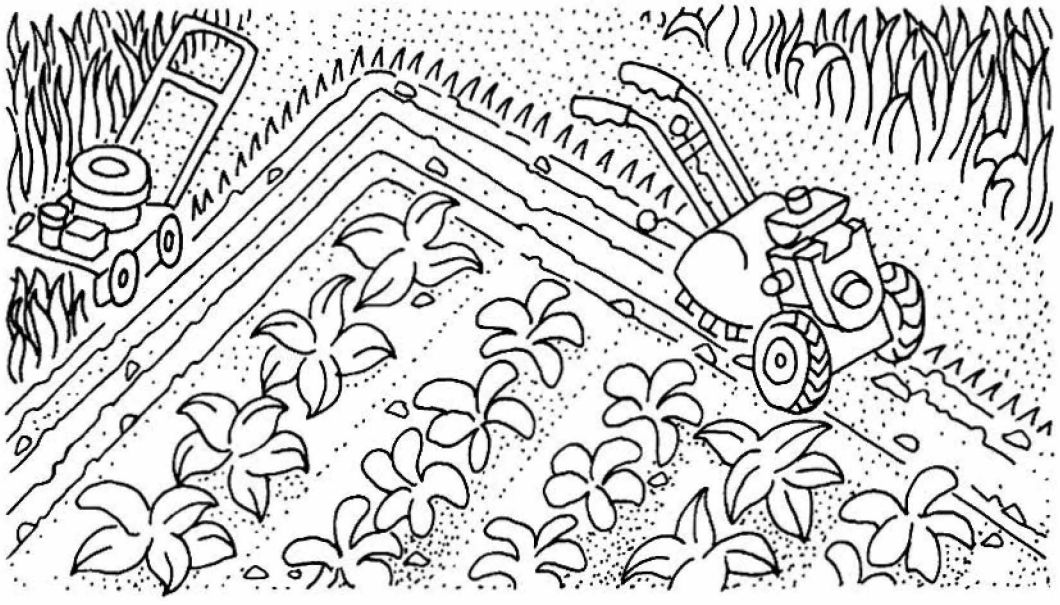
Home gardeners can control weeds successfully throughout the season with mechanical techniques. A considerable amount of hand labor is necessary, however. A period of neglect (for example, a 2- or 3-week vacation) in the midst of summer usually spells disaster if other controls are not used.

Weed control practices should begin when a garden site is chosen. Many new gardens are situated on abandoned land or grassy areas that have not been cultivated for many years. Such land very likely has a heavy infestation of quackgrass and possibly other perennial weeds.

If you must plant a garden plot following sod, it should be treated with a herbicide that is both nonselective and systemic before plowing or hand-turning the soil. (Nonselective herbicides kill all types of plants; systemic herbicides are absorbed by one part of a plant and distributed internally to other parts.) The herbicide should be applied in early to mid-fall well before a hard killing frost and when the weeds are green and actively growing. The herbicide will be translocated to the underground portions of most plants, where it will destroy their root and rhizome systems. The nonselective, systemic herbicide may be applied 1 to 2 weeks before plowing in the spring, but systemic herbicides work less effectively when plants are beginning their spring growth.

Hand weeding. Hand pulling weeds as they appear gives good temporary results and is good exercise. It is effective for controlling all seedlings and annual and biennial weed species. It is less effective in controlling established perennials because it is nearly impossible to pull out all the underground reproductive structures. Weeds pull out more easily after heavy rain or watering.

Plowing. Plowing alone provides good control of perennial weeds whereas rototilling generally does not. In most soils one cannot rototill deeply enough to destroy the deep perennial root systems. In the case of quackgrass, a



Keeping the garden perimeter weed-free reduces the spread of weeds into the garden.

rototiller cuts the underground rhizomes into small pieces, which encourages sprouting. Hand forking or spading of old sod is also effective but very strenuous. In small (such as 100 square feet) gardens, however, spading would be adequate.

Tilling. Rototilling does an excellent job of preparing a seedbed in a garden that has been established for several years, but it should be kept to a minimum.

Although a tiller chops up the previous year's vegetable and weed residue and incorporates it into the soil, its shearing action compacts and destroys the soil structure, especially when wet. Adding compost, manure, or other organic matter to the soil minimizes the compacting effects of rototilling.

Many people misuse the tiller by running the machine either too deeply (2 inches is sufficient) or too fast. A tiller should not be run at a speed that controls the operator; the operator should always be in full control of the machine. You can maintain control by operating the tiller at a low rpm and by adjusting the depth so the tiller digs into the soil rather than walking over the surface.

To cultivate a growing garden, set the rototiller at a shallow depth—about 1 inch—and till when weeds are tiny. Otherwise the tiller will transplant rather than eliminate weeds.

Hoeing. Lightly scraping the soil surface is the most effective way to control small weeds (less than ½ inch tall). Weeds are cut off just below the surface and no new weed seeds are brought up. In addition, vegetable roots are not damaged or severed.

Another reason for hoeing is to create a shallow (¼ inch to ½ inch) surface layer of dry soil mulch. Keeping that layer dry prevents weeds in the layer from sprouting and conserves moisture by slowing evaporation of surface water.

Hoeing should be done when weeds are tiny. Always hoe 3 to 4 days after a rain. By then, many weed seeds have swelled and are ready to germinate or have already germinated. A shallow hoeing at this time dries out the soil surface and prevents seedlings from becoming established.

Many people misuse a hoe by treating it as if it were a shovel. It is important to choose an appropriate hoe design and understand hoeing techniques.

Many shapes and designs of hoes are available, but gardeners should avoid a few that are poorly designed. Look for a hoe with a blade that is in one piece rather than two welded pieces; repeated use will break the hoe at the weld point.

Several types of hoes are illustrated in figure 2.

Scraping is most readily accomplished with a wheel hoe, scuffle hoe, or onion hoe.

The blades of chopping hoes tend to dig holes or craters rather than scrape the soil surface. Soil builds up behind the blade and is deposited unevenly in small piles. The chopping hoe is more appropriate in rocky soils or for thinning crops.

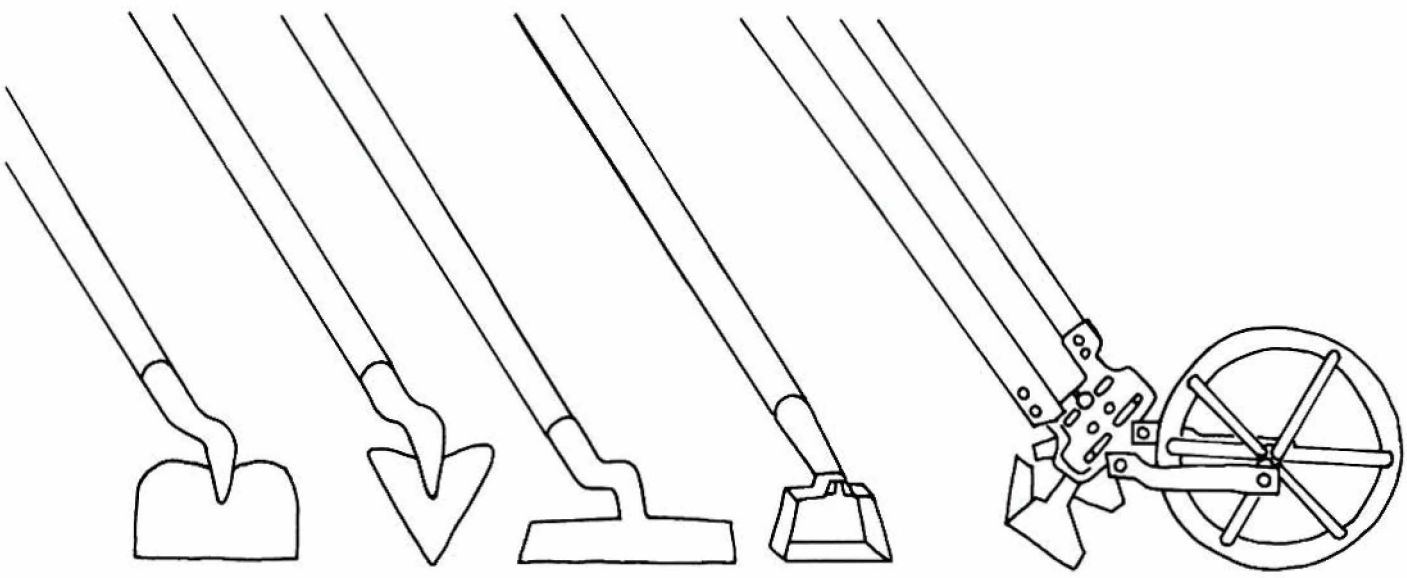
The warren hoe is an excellent tool for making rows and shallow ditches but poorly designed for severing weeds.

A rectangular hoe called an onion or tobacco-thinning hoe is shaped best for weeding. This hoe allows you to scrape the soil and, if it is held at the correct angle, the soil flows over it rather than builds up behind it.

Where rocks are not common, the well-designed scuffle hoe and wheel hoe are also effective.

Gently scratching the soil surface a few days before your crops emerge controls weed seedlings on or just below the soil surface. A bamboo or metal leaf rake is the best choice for this purpose. This technique is very effective on slowly emerging, small-seeded vegetables such as carrots, parsley, New Zealand spinach, and parsnips. Be sure, though, that your vegetable plants are seeded deeply enough so they aren't disturbed.

Figure 2. Hoes



STRATEGY 2.
Cultural Control

Cultural methods of weed control use practices common to good soil management and moisture conservation. Several are effective in home gardens. These include using organic or inorganic mulch, using the stale seedbed method, planting competitive varieties, planting early, using successive planting and intercropping, using good crop management techniques, planting cover crops or living mulch, no-tillage, and minimum tillage systems.

Mulch. Mulch spread over garden soil suppresses weed growth by blocking light. Used correctly, mulch not only controls weeds but also conserves soil moisture by reducing water evaporation.

Before laying any mulch, allow the soil to warm in the spring sun. Mulch should not normally be applied in the Northeast before May. Very early vegetables can be mulched after they have grown.

The area must be well watered before mulch is laid, especially if black plastic is to be used. That initial watering will supply the young plants with moisture until their roots grow far enough to find other water.

Using mulch to control weeds in the home garden saves labor and time during the growing season but requires an expenditure of labor and time early in the season. Laying plastic may take one minute per foot; laying straw or grass clippings takes less time.

After that initial investment, however, you need only monitor the weeds. If some escape, pull them out or put on another layer of mulch.

Because of its cost, mulch is usually laid over the planted garden row; other weed control methods can be used to control weeds between the rows. If aisles are left uncovered, weed them by hand or cultivate them. Hoeing or tilling complement the use of mulch.

Various materials are used as mulch. Some are organic, meaning they are degradable and can be incorporated into the soil at the end of the season. Others are inorganic, thus nondegradable, and must be removed.

Degradable plastics are being developed to break down by the end of the growing season. Because they are activated by sunlight, the degree of deterioration varies depending on the amount of sunlight and on the shade cast by the vegetable and weed plants. Some types are further degraded by microorganisms after being partially broken down by the sun and then plowed or tilled into the soil.

Materials used as mulch include straw, grass clippings, plastic, newspaper, leaves, shredded bark, and seed hulls. Selection depends on the availability, effectiveness, cost, and even the appearance of the mulching material.

Clear and white plastic are not recommended for home gardens. They promote the growth of many vegetables, but also accelerate weed growth because they allow light to pass through.

The type of weeds to be controlled is also important. Annual weeds, which reproduce by seed, can be controlled by almost all mulches. Control of perennials, which reproduce by roots or other vigorous plant structures, requires thicker, less penetrable mulches.

If weeds are too tall to be covered by a mulch, first mow or hoe them, then cover the area with a dense mulch—for example, sawdust, cardboard, tarpaper, or black plastic.

Other considerations are important when choosing mulching material. Grass clippings from lawns treated with herbicides may damage vegetables. The hulls of buckwheat and some other seeds may contain plant-growth inhibitors that could retard the growth of young plants. Manure frequently contains live weed seeds. Hay contains unwanted grass seed. Almost all mulches harbor and encourage a population of slugs and rodents. Too much organic mulch may absorb rain and overhead irrigation water, causing the vegetables to suffer from water stress (lack of water).

Because mulch works by blocking light to the germinating weed seed, it must be dense. The density depends on the thickness and type of mulching material.

A layer of grass clippings, for example, needs to be only 1 to 2 inches thick to exclude the same amount of light as 4 to 6 inches of straw. Black plastic is normally 1 or 1½ mils (thousandths of an inch) thick. Thinner plastic allows light to penetrate and weeds to grow beneath it.

Black plastic raises the temperature of the topsoil by up to 10° F at certain times of the day. Organic mulches such as straw or grass clippings insulate the soil and hold the temperature lower and more uniform than that of bare soil.

At the end of the season, black plastic mulch should be lifted carefully out of the ground, leaving no remnants, and either saved for a second year or, if damaged, thrown away. It is not biodegradable.

Incorporate organic mulches into the soil so they have the winter to decompose. If mulch is removed before the end of the season, however, a new flush of weeds may grow where the mulch had been.

Black plastic mulch is a very effective deterrent to both annual and perennial weeds. It is available in garden supply stores, usually in 3- or 4-foot wide rolls.

Black plastic, 1 mil thick, may cost about one cent per square foot when purchased by the roll. By comparison, a 4-sheet thick mulch made of the Sunday *New York Times* costs about two cents per square foot, although this is a secondary use.

Steps in laying black plastic mulch are shown in figure 3.

Stale seedbed. The stale seedbed technique promotes early germination of the seed in the upper 1 to 2 inches of soil so the weeds may sprout and be eradicated before vegetables are planted.

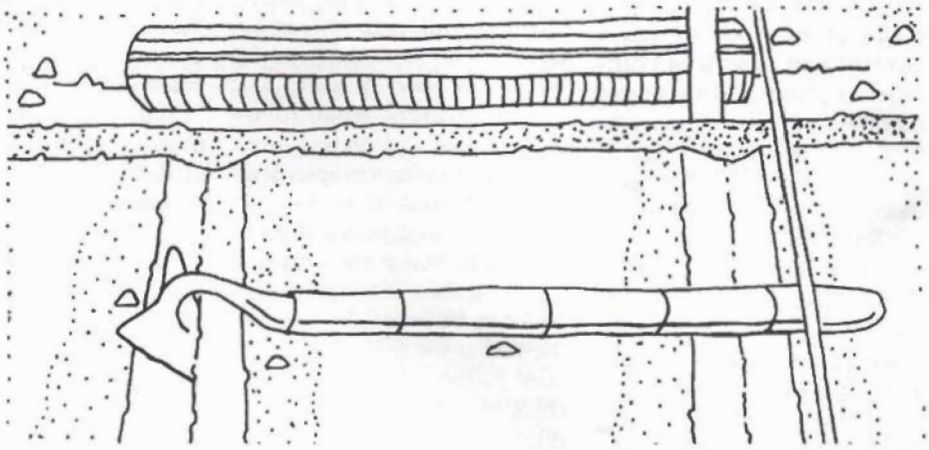
To use the stale seedbed method, prepare the garden for planting, including adding compost, manure, lime (if needed), fertilizer, or other materials, and till or plow it as deeply as you can (6 inches or more is good). After that, do not disturb the soil again before planting, as most deep-lying weed seeds do not germinate without light.

Mechanically or chemically destroy the first flush of young weed seedlings and plant your vegetables with as little disturbance to the soil as possible. When a second flush of weeds occurs, it will be much less dense and thus easier to control manually.

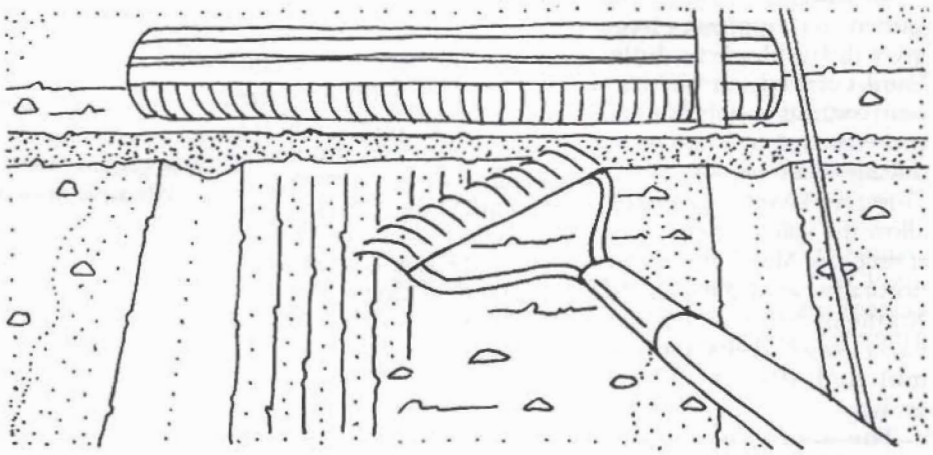
If you wish to plant early, lay clear plastic over the area of the stale seedbed. The temperature under the plastic will rise, enhancing early germination of weed seed.

Figure 3. Steps in laying black plastic mulch

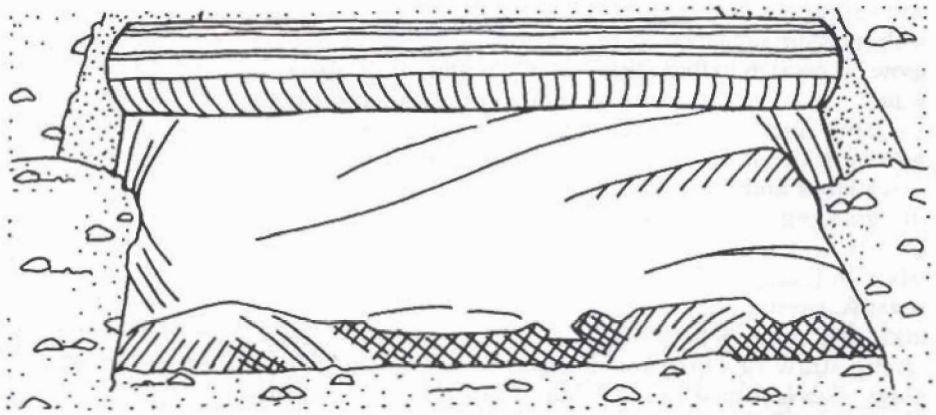
1. *The width of the area to be mulched should be 6 inches narrower than the width of the plastic. (The hoe may be marked in 6-inch increments and used as a measuring tool.) Dig a trench 3 inches deep all the way around the mulching area. You can keep the trenches straight by running a string from corner to corner along each edge.*



2. *Smooth the center of the area with a rake and remove any large stones or debris that might tear the plastic.*



3. *Beginning at the end trench, roll out the plastic over the prepared area 3 to 4 feet at a time, tucking first the end and then the side edges into the trenches. With a hoe, pull in soil to bury the edges of the plastic. To secure it, you may need to step on the opposite edge, pressing it into the furrow as you bury it. If the plastic is too loose, it will billow in the wind and may pull out or tear.*



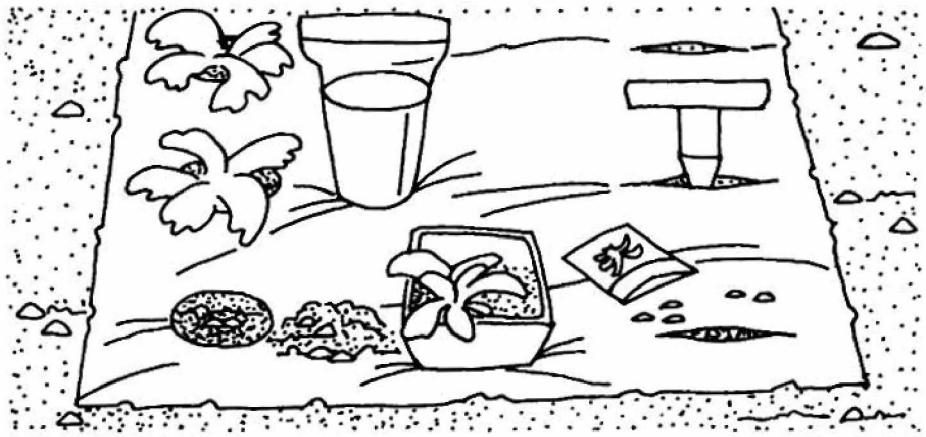
NOTES:

- *Leave plastic a bit loose if laying it on a very warm day. It will tighten as the temperature cools.*

  Do not lay plastic mulch tightly over perennial weeds; it might be punctured by such vigorous plants.

Figure 3 (continued)

4. Seeds may be planted or plants transplanted into the black plastic through holes made by a bulb setter or dibble.



When the flush of weeds is growing but still young, remove the plastic and destroy the weeds by hoeing or raking, by carefully burning them with an open flame from a propane or kerosene torch, or by applying a nonselective herbicide that leaves no residue.

The stale seedbed method, because it delays planting of vegetables, should be used for warm-weather vegetables in half the garden. In the other half use other weed control practices so early spring vegetables can be planted. Next year reverse the two sections.

Planting competitive varieties. Some vegetable crops and specific varieties are much better adapted to compete with weeds than are others.

Plants that emerge quickly and have dense foliage have a competitive advantage over most weeds. Vegetables that outgrow and shade surrounding weeds have a major advantage. Rapidly growing vegetables compete well for nutrients and water.

Beans compete successfully because of their large seeds, rapid early growth, dense leaf canopy, and general vigor. Peas also have an advantage against weeds because of their large seeds, fast emergence at low temperatures, and general adaptability to spring conditions.

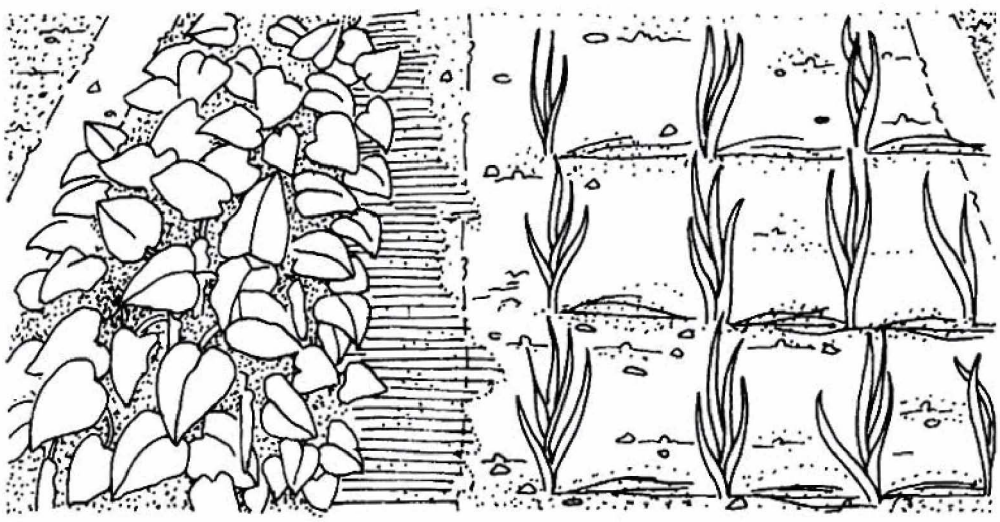
Compare these traits to those of onions, which have small seeds, come up relatively slowly, have thin and sparse foliage, and are easily choked by weeds.

For a particular vegetable, the choice of variety can be very important. The leaf canopy and growth habit of the Hudson potato is effective in suppressing weeds, for example. But the Katahdin potato more readily allows broadleaf weeds to grow, reducing potato yields.

The vegetables, and especially the varieties, you choose for your garden should be well adapted to local growing conditions. If the vegetables do not have that basic advantage, they will not compete successfully against weeds or other environmental factors.

Planting early. You can give a vegetable crop competitive advantage by planting it early enough to permit good growth before weeds emerge. Peas and spinach, for example, can be planted early because they can tolerate the cool soils of early spring, although they may take several extra days to germinate and emerge.

Because a plant with rapid early growth has a competitive advantage, transplants compete better with weeds than plants that are seeded directly into the garden. In the spring you can transplant such vegetables as lettuce, onions, cabbage, and broccoli. Later you can transplant squash, melons, cucumbers, celery, tomatoes, eggplants, and peppers.



Vegetables with dense foliage (left) have competitive advantage over weeds. Vegetables with thin, sparse foliage (right) are easily choked by weeds.

Successive planting and intercropping. Keeping the garden soil occupied by vegetables reduces the chance for weeds to grow. We recommend that you plant one vegetable crop after another (successive planting) and that you plant a variety of vegetables for the best cover and utilization of garden soil.

The principle behind successive planting is this: when the soil is alternately utilized and worked often, individual weed species have little chance to become established or grow to produce seeds.

For example, spinach followed by sweet corn or beans offers a diversity of competition against weeds. Early radishes might permit weeds to grow, but a dense foliage cover of potatoes following that will suppress later weed growth.

Intercropping—growing one crop between rows or interspersed with another vegetable—also helps protect the soil from erosion, offers multiple crops, crowds out weeds, and makes the most efficient use of garden space.

In vegetables that grow slowly or are in widely spaced rows, such as squash or pumpkins, rapidly growing crops are ideal for intercropping. The second crop can be planted in the aisles or in the rows between the main crop plants, depending on the spacing of the primary crop. They should be harvested before the main crop begins to mature.

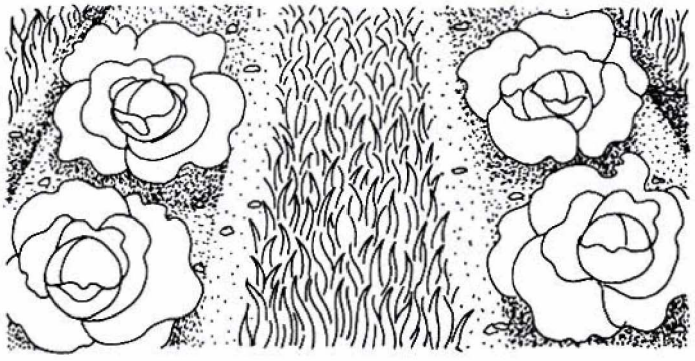
Good crop management. In addition to selecting the best plant variety for your area and planting at the appropriate time, you can give vegetables competitive advantage by using good growing practices. Any practice that favors good vegetable production helps the vegetable compete with weeds.

Proper fertilizer types and amounts should be applied, soil pH should be adjusted if necessary, water should be in good supply, and vegetables should be rotated from year to year.

Generally, use standard planting and density rates that are recommended in gardening books. Large vegetables, which demand a lot of space, permit weed growth when they are young and small because of the open ground around them.

To give competitive advantage you could plant a vine crop in a smaller area than recommended, such as a 3-by-4-foot plot instead of a 4-by-10-foot plot. Tomatoes can be planted in a 1-by-4-foot area instead of a 2-by-4-foot plot. Denser plantings require extra water and nutrients, but they are more effective in competing with weeds.

Trickle irrigation, which applies water specifically to the crop and not to the weeds, enhances vegetable growth without encouraging weed growth.



The grassy cover crop between rows of cabbage is an example of living mulch.

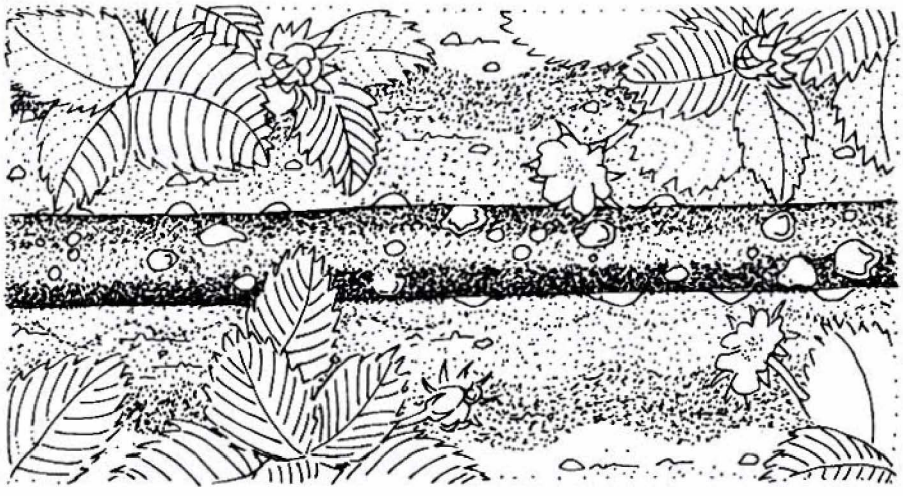
Keep newly planted areas of the garden weed-free for at least the first month and remove any large weeds after that. Research with beans and peas indicates that keeping the garden free of broadleaf weeds for the first four weeks and letting all weeds grow after that time did not significantly reduce yields.

Studies have shown that large weeds reduce vegetable yields and that the large weeds have to start early to reach their size. Any weed that goes to seed will cause many more weeds in future growing seasons.

Cover crops. Vegetable gardens are commonly used only 5 months per year in the Northeast. If gardens are left unprotected during the off-season, weeds can become established, leaving their seeds or perennial roots to plague the garden in future growing seasons.

In addition, insects and disease organisms often overwinter in the weeds and complete their life cycles on vegetables during the following spring.

Weeds can be reduced or eliminated by growing a cover crop during the off-season. A cover crop is a dense living blanket of plants that compete with weeds for light and nutrients. Tradi-



Trickle irrigation applies water to the crop, not the weeds.

tional cover crops are ryegrass, winter rye, winter wheat, oats, white clover, sweet clover, and buckwheat.

Cover crops do more than control weeds. They retard soil erosion, prevent minerals from leaching, and reduce soil compaction. The lush top growth, called green manure when it is tilled into the soil in the spring, adds organic matter.

The cover crop's root system is as valuable as its top growth, providing organic matter and improving soil structure as the roots grow. The roots improve soil aeration and drainage and the tops capture light energy from the sun.

Table 2 lists useful and popular cover crops and their characteristics.

Success in growing cover crops requires proper crop selection, correct timing of planting, and good managerial techniques.

Grasses are much easier to establish as cover crops than legumes are. Small-seeded grasses such as fescue grow slowly and are more difficult to establish than large-seeded grasses such as oats.

Winter rye and ryegrass become very dense and are much more effective at shading out weeds than are oats and small-seeded legumes such as clover and trefoil. Oats quickly produces a lush growth in the fall to smother weeds, but oats freezes, leaving open spaces where winter and spring weeds may grow. Unfortunately oats does not improve soil structure.

Availability and cost of seed are also important considerations.

In Northeastern conditions, the ryegrasses should be considered first for garden cover crops. They are vigorous and have extensive root systems that occupy the same root zone as vegetables. Winter rye is an excellent second choice and is best for late planting. Mowing stops its growth in the spring. All the ryegrasses are excellent competitors with weeds.

Time of planting the cover crop dictates the types that may be used. As late as October, only rye and winter wheat can be started successfully. If the land is available in August, the choice broadens to include ryegrass, oats, and clover.

Good managerial techniques for growing cover crops are basically the same techniques that are good for growing vegetable crops. These include keeping weeds out of the cover crops, irrigating, and, if you add organic matter, planting soon thereafter, before nutrients are lost.

Living mulch. Cover crops, when interplanted with vegetable crops during the growing season, are called living mulch. They are not a "crop" meant to be harvested but help suppress weeds, prevent soil compaction, and prevent erosion. They also improve soil structure by their root growth and by serving as green manure.

Using living mulch as a cultural strategy for weed control requires careful attention and gardening experience. A well-established living mulch reduces weed growth. If, however, it is not well chosen or controlled, it interferes with vegetable growth just as weeds do. Easiest to manage are living mulches, which are short and slow to spread.

Living mulch is more effective when used for large-seeded, vigorous vegetables such as corn and beans than for small-seeded, slow-growing ones such as carrots and onions.

Just as with cover crops, grasses are easier than legumes to establish as living mulch. Grasses allow a wide range of planting dates. Those that have shown success in tests include Chewing's fescue, Kentucky bluegrass, bent grass, red fescue, and tall fescue. Legumes that have proved successful are dwarf white clover, which spreads very slowly, and wild white clover (the Kent variety).

To reduce competition, plant living mulch at the same time as or any time after planting the vegetables. The primary concern is to prevent the mulch crop from competing for light and water. The more vigorous and spreading it is, the later it should be seeded.

Usually the seed chosen for the living mulch plants is broadcast between vegetable

Table 2. Characteristics of various cover crops

Cover crop	*Vigor of germination and establishment*	*Seed cost to plant 1000 sq ft*	*Time of planting*	*Overwintering ability*	*Amount of growth*	*Effort needed to incorporate*	*Benefit to soil structure*
Highly recommended							
Perennial ryegrass †	••	••	Aug.–mid-Sept.	•••	••	•••	••
Winter rye	•••	••	Aug.–Oct.	•••	•••	•••	••
Winter wheat	•••	••	Aug.–Oct.	•••	•••	•••	••
Oats	•••	••	Aug.–Sept.	No	•	•	•
Others							
Annual ryegrass †	•••	•	Aug.–Sept.	No	••	••	•••
Buckwheat	•••	••	Summer	No	••	•	•
Fescue		•••	Spring	•••	•	••	••
Hairy vetch	•••	••	Aug.–Sept.	••	•••	••	••
Sweet clover		•	Summer	•••	•••	••	••
White clover		•(•)	Summer	•••	•	•	••

Source: Adapted from R. D. Sweet and R. A. Kline, *Weed Control in Specialty Crops*, Cornell University Vegetable Crops Report #333, 1985.

Key: ••• relatively high •• moderate • relatively low

† Packaged ryegrass seed usually contains a mixture of annual and perennial types.

rows. Restrict fertilization to the vegetable row. Once they are growing, keep living mulch plants 6 to 8 inches away from the vegetable row by hoeing or pulling. If the living mulch plants grow too vigorously, suppress them by mowing.

The living mulch should be allowed to grow after the food crop is harvested and through the winter, then tilled when the garden is readied next season. Some mulches, especially the legumes, may be retained several years, creating more permanent garden walkways.

Minimum tillage and no-till systems. In minimum tillage systems, soil preparation tasks are combined to reduce soil compaction due to traffic, labor, and loss of soil moisture.

The no-tillage system uses no seedbed preparation other than opening the soil to receive the seed or transplant. Little, if any, cultivation is done after planting. Cover vegetation is killed with chemical herbicides. The dead plant debris holds the soil, preventing erosion and reducing evaporation of water. The crop is planted among the debris with as little disturbance to the soil as possible.

There are problems with the no-tillage method, however. By not tilling, you are not incorporating organic matter into the soil. In heavy (clay) soils, without adding humus, the organic matter content can decline and soil improvement can't be managed easily.

The no-till technique leaves plant residue on the surface of the soil, providing a refuge for slugs and rodents that may damage vegetables. And planting into crop residue is difficult.

Minimum tillage may be used best in plantings of large-seeded vegetables such as beans and corn and for transplants.

Minimum tillage and cover cropping can be combined for effective weed control. Cover crops that usually die in the winter—such as oats and buckwheat—readily lend themselves to no-till planting in the spring. Narrow tilling or hoeing opens the planting row.

Perennial ryegrass and winter rye—which don't die in the winter—produce massive top growth during the spring, which is effective for shading weeds. Cover crops that grow in the new planting season should be cut back once with a mower, weed whacker, or scythe. Fertilizer should be broadcast, then the grass can be covered with strips of black plastic. The absence of light will kill the cover crop within 2 to 3 weeks.

Transplants or large-seeded vegetable crops can be planted through the plastic, or the plastic can be removed and the planting strips cultivated. These no-till techniques control weeds and maintain good soil condition.

STRATEGY 3.
Chemical Control

Herbicides are chemical pesticides developed to control unwanted plants. Herbicide use in commercial agricultural production requires the skill of trained applicators. Using herbicides is an even greater risk in home gardens in the hands of untrained applicators.

Herbicides may seem to offer the ultimate work-free approach to weed control, but they are expensive and difficult to apply accurately. They also can drift from the intended site and damage nearby desirable plants. In addition, proper storage and disposal are burdensome.

Home gardeners should consider the use of chemical herbicides as the last choice for weed control. There are only a few exceptions. Herbicides can reduce hand work in perennial plants such as asparagus, rhubarb, strawberries, and brambles, and they can control perennial weeds, primarily quackgrass, in the home garden. Judicious and timely herbicide applications on those plants will give you more time to spend on the annual plants for which no chemicals are available.

Safety and responsibility. Herbicides available to the public are generally considered safe, but precautions and general directions for safe use are printed on every label and must be read carefully and followed strictly.

All statements on a herbicide label have been approved by the Environmental Protection Agency (EPA). The label includes everything you need to know to apply the herbicide safely and effectively. By deciding to use chemical herbicides you are legally obligated to follow instructions on the herbicide label.

It is illegal to use any pesticides on a plant not listed on the label or to apply them in a way contradictory to the label, such as increasing the rate. *To protect yourself and the environment, do not deviate from label directions.*

Check the label for the safest, most effective time to apply herbicides. When used according to the label directions, herbicides should not be a hazard to people, pets, or desirable plants.

Be sure to minimize exposure to herbicides by wearing protective clothing. Rubber boots, pants, gloves, long-sleeved shirts, and goggles are recommended. Apparel contaminated with herbicides must be laundered separately according to the instructions included in the center of this publication.

How herbicides work. Plants, either vegetables or weeds, that survive exposure to a herbicide are classified as tolerant; those that die are called susceptible. Herbicides that have no effect on a particular plant are said to be selective for that plant.

Most herbicides have been developed because they are selective on one or two major commercial crops such as corn or soybeans. Some herbicides are classified as nonselective herbicides, which means they are toxic to almost all plants. Nonselective materials must be handled with great care to avoid exposure to nontarget plants.

Most herbicides available to homeowners are applied to the soil, where they inhibit or prevent weed emergence. Such herbicides are said to have soil activity and are referred to as preemergence compounds (because they are applied before the weeds emerge). These herbicides are most successful in controlling either broadleaf or grassy weeds—seldom both. Germinating seeds or seedlings absorb the herbicide, which interferes with biochemical functions and causes death.

Most herbicides that have soil activity have little, if any, effect on weeds if they are applied after the weeds have emerged. Timing of application is especially important with herbicides that can be applied to garden plants after they have been transplanted or after they emerge (postemergence) but before weeds emerge. If such an application is delayed, weeds will have already emerged and the herbicide will be ineffective.

Several preemergence herbicides are available for home gardeners to purchase. Herbicides provide 4 to 8 weeks of control depending on the amount of rainfall and the severity of the weed infestation. Herbicides are not a miracle cure and do not eliminate the need for hand weeding, hoeing, and cultivation.

See the insert to this publication for a list of herbicides approved for use in home gardens in New York State. Be sure you have an up-to-date copy of that publication (ask for the insert to Information Bulletin 216). Herbicide registrations and recommendations change constantly, and the publication is revised annually.

In other states, contact your cooperative extension office concerning the legality and registration status of herbicides in your state.

Sometimes herbicides fail, usually when soil moisture is insufficient. If the soil is dry, the newly germinating weeds escape close contact and absorption of the herbicide and they emerge without injury.

With sufficient moisture it is much more difficult for the weeds to escape. As a rule of thumb, if a ¼- to ½-inch rainfall does not occur within 2 to 3 days of applying a preemergence herbicide, you should irrigate the garden.

Controlling perennial weeds. Perennial weeds such as quackgrass, bindweed, milkweed, marsh mallow, goldenrod, and curly dock tend to creep slowly into the garden. If there are few they can be uprooted easily with a garden fork and removed to a compost heap.

If there are many, you may choose to apply a nonselective herbicide after all the vegetables have been harvested. Fall is the ideal time to control perennials, because plants are actively transporting food produced above ground to storage organs below ground. Applying a nonselective herbicide at this time enables the chemical to be transported to the root system where it destroys the plant.

Quackgrass has probably dampened the spirits of gardeners more than any other weed. Most land that has not been plowed for several years has at least some quackgrass on it. Many grass sods are pure quackgrass.

One week before plowing and disking a garden plot in which you have quackgrass, you could apply a nonselective, systemic herbicide to the area. A single application should eliminate most severe quackgrass problems but retreatment may be necessary in the fall or the following spring.

Herbicides are available in several forms. Granules and dust formulations are applied dry and don't require expensive application equipment. Wettable powders and liquid

BEFORE YOU DECIDE TO USE HERBICIDES

Consider everything written in this publication.

Use chemicals only as the last resort and be prepared to follow safe application procedures.

Cautions for Using Herbicides

- Purchase only what you need for one season. Some herbicides lose effectiveness from one season to the next.
- Post the phone number of your local poison control center near your telephone. (See the back cover of this publication for a list of New York State poison control centers.)
- Read the entire label and follow the directions exactly. Observe precautions, especially to *keep out of reach of children*, and the information in *days before planting*.
- Prepare the materials in a well-ventilated area.

  Have soap, water, and a towel available when mixing and applying herbicides. Should you spill herbicide on yourself, wash immediately and thoroughly. Wash thoroughly after handling herbicides. Remove contaminated clothing immediately and shower for at least 15 minutes.
- Wear rubber boots, pants, long-sleeved shirts, gloves, and goggles to protect yourself and your clothing.
- Never smoke, drink, or chew gum or tobacco while handling herbicides.
- Avoid inhaling herbicide sprays, dusts, or vapors.
- Measure the material accurately. Overdoses may kill the vegetables or leave soil residues that will injure succeeding crops.
- Use a sprayer separate from that used for insecticide or fungicide applications to avoid injuring sensitive plants with herbicide residue.
- Never spray when children are nearby.

Disposal Recommendations

- Rinse sprayers three times with water after use and dispose of rinse water by spraying on noncrop areas, such as paths or borders.
- Do not reuse empty containers.
- Wrap empty containers and surplus herbicide in thick layers of newspaper and place them in a trash can just before the trash is collected. Federal regulations allow you to dispose of less than 1 gallon of liquid formulations in the trash. Less than 10 pounds of dry materials may be disposed in the trash. Check your state, regional, or local pesticide regulations for herbicide disposal requirements, however. These regulations may be more stringent than federal laws.

Storage Recommendations

- Always keep herbicides in their original containers. Make sure they are tightly closed and clearly labeled.
- Do not contaminate food and water containers that will be used by people or pets or immersed in ponds or streams.

  Never leave herbicides where children or other innocent persons can reach them.
- Store herbicides only in a locked cabinet or room. A cool, dry, well-ventilated storage area is best.
- Never store herbicides near food, medicine, cleaning supplies, animal feed, or fertilizers.
- Do not store the herbicide 2,4-D with other pesticides because 2,4-D vapors may be absorbed by other pesticides and injure sensitive plants. Volatile herbicides such as 2,4-D should be stored outside the house if you have sensitive houseplants.

formulations must be mixed with water and applied with a sprayer.

Use a sprayer separate from that used for insecticides or fungicides to apply herbicides safely and effectively. Most garden insecticides and fungicides are applied directly to plant foliage, and even very dilute amounts of some herbicides left in sprayers can kill plants. Using a separate sprayer rules out any possibility of unintentionally exposing your vegetables to herbicides.

Most of the sprayers available in hardware stores and garden centers come fitted with a cone nozzle designed for applying insecticides and fungicides, not herbicides. Cone nozzle tips are designed to wet leaf surfaces quickly and thoroughly. The cone nozzle does not produce a desirable and precise spray pattern for herbicide application. Flat-fan nozzles, developed specifically for herbicide application, must be purchased separately.

Many good sprayers are available, both metal and plastic, which with proper care and storage should provide many years of service. Plastic is not susceptible to rust, but plastic threaded fittings on the sprayer are easily stripped by cross-threading or overtightening. If you cross-thread a plastic thread once, the joint will always leak.

Metal sprayer fittings are strong and durable. The least expensive are made of galvanized steel, which will eventually rust. Galvanized steel sprayers have a reasonably long life, however, if they are allowed to dry after each use, cleaned thoroughly after a season's use, and sprayed with penetrating oil on the plunger and interior of the tank before storage. The most expensive, but longest lasting, metal sprayers are made of stainless steel.

Perhaps the best sprayers available for herbicide application are the knapsack-type sprayers such as those manufactured by the companies Solo and Hardi. They can easily be equipped with flat-fan nozzles and a pressure gauge; pressure is maintained by a convenient waist-level pumping lever.

Spray pressure during application must be kept constant to maintain a uniform nozzle pattern and application rate. Unless a tank sprayer is fitted with an in-line pressure gauge, it is useless for herbicide application.

Applicator calibration. Application rates have been approved by the EPA to ensure that food produced in herbicide-treated gardens is safe to consume and the environment is protected. Correct rates can be applied only through practice and calibration. *Before applying herbicides, take the time to check application rates and calibrate the applicator according to the formulation of the herbicide you are using.*

Granules. Granular formulations are identified as such on the label, sometimes with the letter G. Do not use any dry formulation of a pesticide until you identify it as either 1) a granular formulation or 2) a wettable powder (WP).

Granular formulations are intended to be used directly from the container and ***should not*** be mixed with water. Many granular formulations are sold in containers with perforated tops that serve as shaker-applicators.

For herbicides not available in shaker cans, homemade applicators can be made easily by punching holes in a jar lid. Be sure the jar chosen does not bear a food label. Clearly label the jar indicating that it is for pesticide application only. The new label should contain the trade name of the herbicide and the word "poison" on it.

Return any unused material (dust or granules) to the original container for storage. Remember, all pesticides should be stored in locked storage compartments that children or pets cannot open.

All herbicide labels have specific directions for rates of application. They may include a diagram showing the proper granule distribution.

To check your application rate you will need a scale (a dietetic or inexpensive postal scale will work) and a piece of plastic 4 feet by 5 feet (20 square feet). Black plastic is best because you can easily see the granule distribution on it.

Wettable powders and liquid concentrates. Wettable powders and liquids are diluted with water and applied by using a sprayer. Water is used as a carrier to evenly apply a minute amount of herbicide over a large area.

Herbicide application with hand-held garden sprayers differs somewhat from application of other pesticides. When applying many fungicides or insecticides the main objective is to spray until the solution begins to run off the leaves. This is necessary to cover the plant completely so all parts are well protected or the target pest is fully exposed to the pesticide. It may take more than one pass with a hand sprayer to achieve this coverage.

The main objective of most herbicide applications, however, is to apply just the correct dosage uniformly to the soil or the plant surface. This is best accomplished with a single pass of the sprayer.

Improper application or overlap of sprayed areas results in an increased rate of application. Applying more than the label rate of herbicide is illegal, may injure the garden vegetables, and may leave a chemical residue on the soil that will injure succeeding vegetables.

Calibrating a sprayer takes considerable time and effort but accuracy must not be compromised. The rate of application is controlled by spray volume and is usually expressed as gallons per acre (gpa). Spray volume is governed by three factors: sprayer nozzle size, walking pace, and spray pressure.

Start with a sprayer fitted with a flat-fan nozzle. Flat-fan nozzles (figure 4) differ from cone nozzles (figure 5) in that their spray pattern is confined to a single plane.

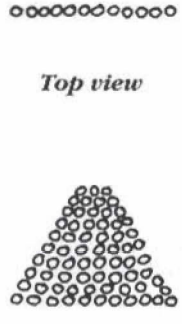
There are two types of flat-fan nozzles. The *even* type produces a pattern that is uniformly dense from edge to edge. This type is preferred where sprayer overlap is not desired, as when applying herbicides in a band over the vegetable row.

With a *tapered* nozzle tip the spray distribution is slightly less dense at the edges than at the middle of the pattern. To apply herbicides in the home garden, use a tapered nozzle tip and overlap the edges of the pattern to cover the entire garden.

We recommend using a nozzle tip that delivers 30 to 40 gallons of liquid per acre. To minimize spray drift, which can harm nontarget plants, pets, people, or the water supply, avoid nozzles that deliver 10 gallons or less per acre.

When you buy a nozzle, be sure to get the correct size and find out whether the tip is even or tapered—informa-

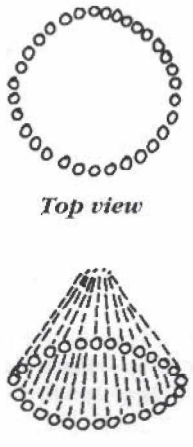
Figure 4. Flat-fan spray pattern



Top view

Side view

Figure 5. Hollow cone spray pattern



Top view

Side view

tion that is necessary for correct sprayer calibration.

To keep your application rate uniform, it is very important to maintain a measured, comfortable stride or cadence as you spray. The length of your stride is not as important as the consistency of your step.

Practice your pace along a line of string 16½ feet long. Develop a cadence by counting your steps. Walk at that cadence until you consistently come out with the same number of steps per 16½ feet. This exact length is important.

Maintaining consistent pressure while spraying is as important as maintaining an accurate and consistent pace. If spray pressure is allowed to fluctuate, the application rate changes.

You must have an in-line pressure gauge on your sprayer to apply herbicides accurately. Maintain pressure between 35 and 40 pounds per square inch (psi). That insures that your nozzle delivers the proper pattern consistently.

It is easier to control pressure with a knapsack sprayer than with a tank sprayer (figure 6). A knapsack sprayer frees your hands, enabling you to keep pumping while spraying, but it is a challenge to keep cadence, maintain pressure, and watch where you're going all at the same time. It takes a great deal of practice.

With a tank sprayer, you need to keep close watch of the tank pressure. Every time the tank loses pressure, stop, set down the sprayer, and recharge the tank. You should be able to spray a reasonable area, however, before recharge is necessary. For accuracy, repressurize at the beginning or end of a spray pass, not during; otherwise you will lose your cadence.

Once you have acquired a suitable sprayer, familiarized yourself with its operation, and mastered a measured walking pace, you can calibrate your sprayer.

All sprayers are calibrated by determining their output at the nozzle end, expressed as gallons per acre (or gpa). To determine the amount of herbicide to add to the water carrier you must first calibrate spray volume.

STEPS IN CALIBRATING A GRANULAR HERBICIDE APPLICATOR

1. Read the label and observe all safety precautions. Wear protective clothing.
2. On a windless day spread out the plastic.
3. Using your shaker, distribute the granules as uniformly as possible over the plastic.
4. Collect the herbicide in a small plastic bag and weigh it.
5. Use the following formula to calculate your actual rate of application:

$$\frac{\text{Area } (ft^2) \text{ from label}}{\text{Area of plastic } (ft^2)} \times \text{weight of herbicide collected} = \text{rate of application}$$

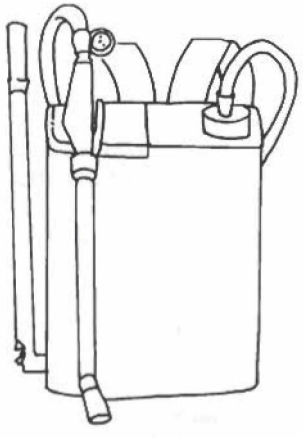
Divide the square footage called for on the label by the area covered in your test. Multiply the answer by the weight of the herbicide collected on your plastic.

$$\frac{200\ ft^2}{20\ ft^2} \times 1\ oz = 10\ oz/200\ ft^2$$

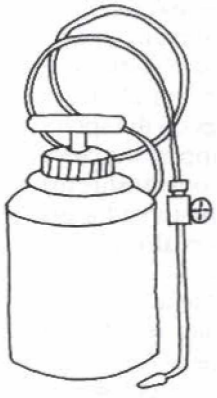
For example, if the label rate is 1 pound (16 ounces) per 200 square feet and you collected 1 ounce on 20 square feet of plastic, you would have applied 10 ounces per 200 square feet. Your test application rate is too light.

6. Repeat the calibration exercise until you achieve the correct density and you are confident that you can reproduce the results in your garden.

Figure 6. Sprayer types



Knapsack sprayer



Tank sprayer

STEPS IN CALIBRATING A SINGLE-NOZZLE SPRAYER

1. Read the label and observe all safety precautions. Wear protective clothing.
2. Stake out an area 16 ½ feet by 16 ½ feet. This area (about 272 square feet) is 1 square rod, chosen because it is easily divisible into the number of square feet per acre (43,560).
3. Next to the sprayer nozzle tie a piece of twine 18 inches long. Secure to the free end a small weight, such as a washer. Make sure the washer and string do not interfere with the spray pattern.
4. Load your sprayer with 1 gallon of water and pressurize your tank to 40 psi. Hold the spray tip 18 inches above the ground by allowing the suspended washer to barely touch the ground. Measure the width of the spray pattern on the ground. It will vary depending on the height of the wand, the spray pressure, and the nozzle size used. Let us say your pattern is 18 inches wide.
5. If you have an even-fan nozzle, mark off your square rod block into strips the width of the spray pattern (18 inches). If you have a tapered nozzle, your spray pattern has to overlap about 30 percent so mark off your block in 13-inch strips. Use string lines to guide your spray wand along a straight line. (See figure 7)
6. This step is very important. Walk the block with your sprayer, tracing the path of your guide lines with your nozzle tip. Record the time it takes to complete the route. Repeat this step until you consistently come out with the same time.
7. Repressurize the sprayer to 40 psi. Spray into a plastic milk container for the same period of time it took you to walk your practice block. Measure the fluid ounces of water collected. Use the following formula to calculate your sprayer's application rate.

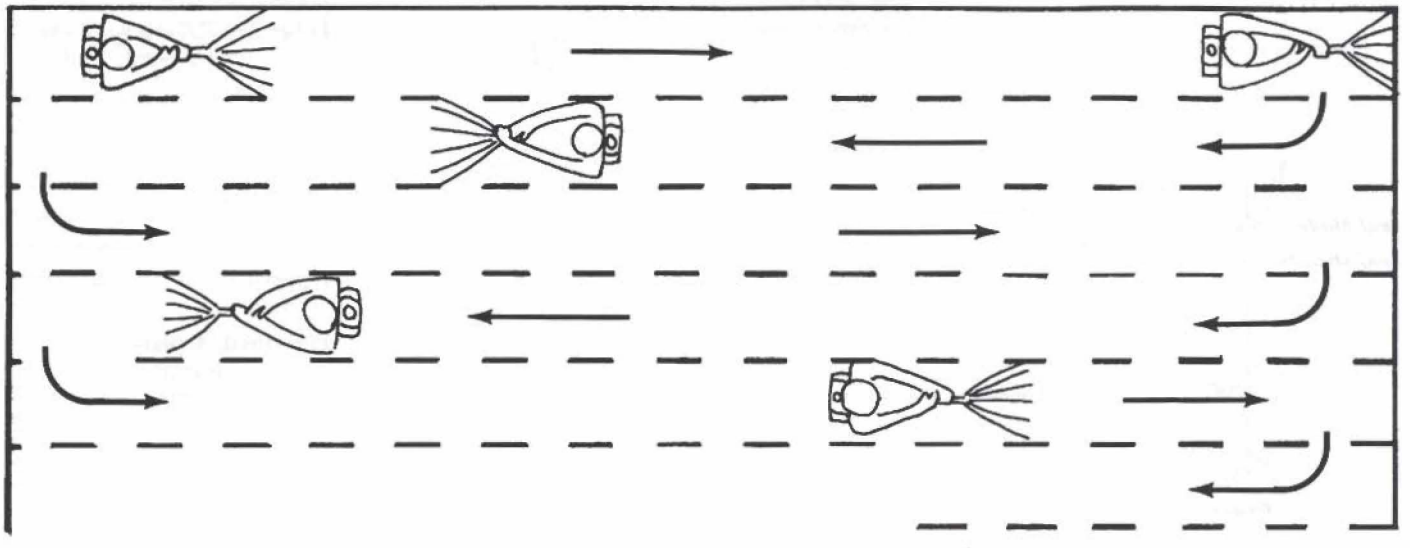
$$\frac{\textit{oz water collected} \times 160}{128\ \textit{oz}} = \frac{\textit{gal}}{\textit{acre}}$$

EXAMPLE

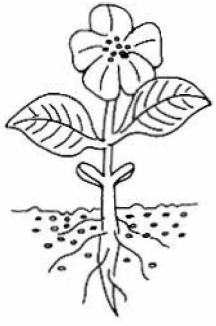
$$\frac{10\ \text{oz} \times 160}{128\ \text{oz}} = \frac{12.5\ \text{gal}}{\text{acre}}$$

8. Congratulations, you have finished calibrating your sprayer. You now know the rate of delivery in gallons per acre. Using the guidelines on the herbicide label, you can now calculate the gallonage on any fraction of an acre in your garden.

Figure 7. Mark off your test block into strips the width of the spray pattern.

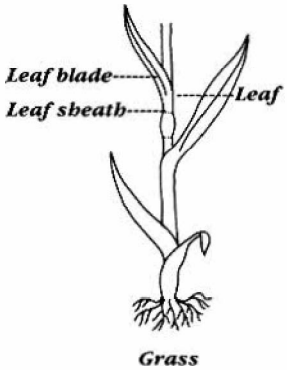


GLOSSARY



Broadleaf

Bulb



Grass

Alternate. *See Leaf arrangement.*

Annual. A plant that goes through its complete life cycle and dies in one year or less.

Summer annual. Plant that germinates in the spring and dies in the fall.

Winter annual. Plant that germinates in the fall or early winter and dies the next summer.

Auricle. *See Grass.*

Axil. The angle formed by the stem and leaf intersection.

Biennial. A plant that completes its life cycle in two growing seasons.

Broadleaf. A plant characterized by broad leaves with branched veins, a taproot, and flower parts (petals and sepals) often in fours or fives.

Bulb. A thick, rounded mass of overlapping scalelike leaves from which a stem grows up and roots grow down.

Capsule. A receptacle that contains two or more seeds and that dries and splits open at maturity.

Crown. The part of the plant, usually at ground level, where stem and root meet.

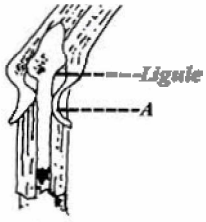
Dormant. Not actively growing, but alive and protected from the environment. Seeds cannot sprout until dormancy (the dormant stage) is broken.

Fibrous root system. *See Root system.*

Germinate. To sprout and begin to grow.

Germination. Sprouting; the process a seed goes through when it begins to grow.

Grass. A plant characterized by long, narrow leaves with parallel veins, a fibrous root system, and flower parts (petals and sepals) mostly in threes or multiples of three. Some parts of a grass plant are:



Lanceolate leaf

Alternate

Opposite

Whorled

Lobed leaf

Nodes

Auricle. In grasses, a clawlike appendage at the base of a leaf.

Leaf base. The part of the leaf attached to the stem.

Leaf blade. The flattened portion of the leaf, in both and broadleaves.

Leaf sheath. In grasses, the lower part of the leaf that surrounds the stem.

Ligule. The thin appendage at the top of the leaf sheath in most grasses.

Lanceolate. Spear shaped, slightly broader at the center and tapered to a point at the tip.

Leaf arrangement. The way leaves are arranged on the plant. Common broadleaf arrangements are:

Alternate. Leaves are attached singly at regular intervals on opposite sides of the stem.

Opposite. Leaf pairs are attached on opposite sides of a stem.

Whorled. Three or more leaves radiate from a single point.

Leaf base. *See Grass.*

Leaf blade. *See Grass.*

Leaf sheath. *See Grass.*

Ligule. *See Grass.*

Lobe. A rounded segment of a leaf or a petal.

Lobed. Describing a leaf or petal with rounded indentations.

Node. A point where one or more leaves originate or a stem or bud branches off.

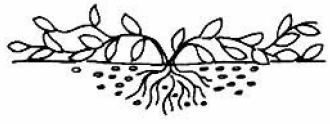
Opposite. *See Leaf arrangement.*

Perennial. A plant that grows three or more years without replanting. Has underground reproductive organs (tubers, bulbs, stolons, or rhizomes) that live from year to year,

sprouting new plants from buds on the underground parts each year.

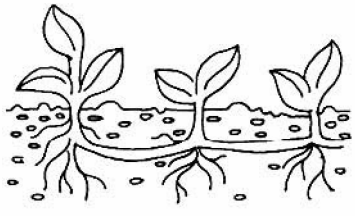
Photoperiod. The period of darkness required to trigger a shift from vegetative (leaf, stem, and root) growth to reproductive (flower and seed) growth; a long-day plant requires a short dark period; a short-day plant requires a long dark period.

Prostrate. Lying horizontally on the ground.



Prostrate

Rhizome. An underground horizontal stem modified for food storage and reproduction. It grows parallel with the soil surface and sends shoots up from its nodes.

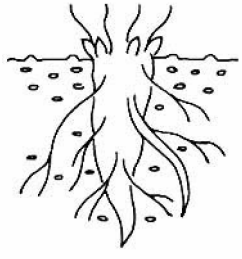


Rhizomes

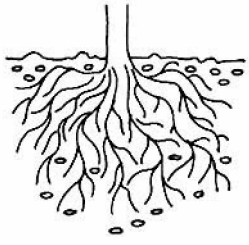
Root system. The structure of a plant's roots, usually either fibrous or a taproot.

Fibrous root system. A root system with many small, spreading roots but no large single root.

Taproot. A large central root with smaller roots branching from it.



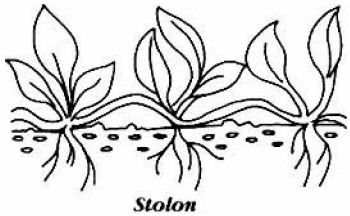
Taproot



Fibrous root system

Rosette. A cluster of leaves radiating from one point at the top of a root system and lying close to the ground.

Rosette



Stolon

Spike. A shaft with stalkless flowers arranged along it.

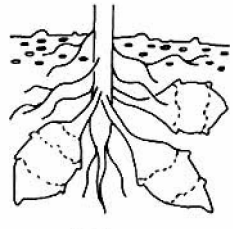
Stolon. A horizontal stem running on the surface of the soil, usually rooting at the nodes. Also called a runner

Summer annual. *See Annual.*

Taproot. *See Root system.*

Tiller. A shoot that sprouts at the base of the mother plant in grasses.

Tuber. A fleshy, thickened part of a root or underground stem that stores food and produces buds from which new plants will grow.



Tubers

Winter annual. *See Annual.*

ADDITIONAL READING

Brown, L. *Grasses—An Identification Guide*. Boston: Houghton Mifflin, 1979.

Guide to Safe Pest Management around the Home. Cornell Misc. Bulletin #74. Ithaca, N.Y.: Cornell University, 1988.

Lanini, T. W., and Wertz, B. A. *Weed Identification Series.* University Park, Pa.: Pennsylvania State University, College of Agriculture, Cooperative Extension Service, 1986 and 1987. At press time the series included: Barnyardgrass (# 12), Canada Thistle (# 7), Coltsfoot (# 20), Common Burdock (# 26), Common Chickweed (# 28), Common Cocklebur (# 25), Common Dandelion (# 11), Common Lambsquarters (# 2), Common Milkweed (# 19), Common Ragweed (# 8), Fall Panicum (# 10), Field Bindweed (# 17), Giant Foxtail (# 15), Green Foxtail (# 13), Hemp Dogbane (# 23), Horsenettle (# 24), Jimsonweed (# 1), Johnsongrass (# 6), Large Crabgrass (# 4), Mouse-ear Chickweed (# 18), Poison Ivy (# 21), Pokeweed (# 22), Redroot Pigweed (# 5), Shepherd's Purse (# 32), Teasel (# 27), Velvetleaf (# 3), Wild Buckwheat (# 29), Wild Carrot (# 30), Witchgrass (# 16), Yellow Foxtail (# 14), Yellow Nutsedge (# 9), and Yellow Rocket (# 31). Available from Publications, Pennsylvania State University, 112 Agricultural Administration Building, University Park, Pa. 16802 or Media Services Distribution Center, 7 Research Park, Cornell University, Ithaca, N.Y. 14850.

Lorenzi, H., and Jeffery, L. S. *Weeds of the United States and Their Control.* New York: Van Nostrand Reinhold, 1984.

An Organic Gardener's Guide to Weeding. Pamphlet. Emmaus, Pa.: Rodale Press, 1980.

Phillips, C. E., and Fisher, V. J. *Weeds of the Northeast.* Newark, Del.: University of Delaware, 1970.

Phillips, C. E. *Some Grasses of the Northeast.* Newark, Del.: University of Delaware, 1962.

United States Department of Agriculture. *Common Weeds of the United States.* New York: Dover Publications, 1971.

Smith, M., and Carr, A. *Garden Insect, Disease, and Weed Identification Guide.* Emmaus, Pa.: Rodale Press, 1988.

Weed Control in the Home Garden. Handbook. Brooklyn, N.Y.: Brooklyn Botanic Garden, 1975.

Weed Control Manual and Herbicide Guide. Willoughby, Ohio: Meister Publishing, 1987.

This publication is issued to further Cooperative Extension work mandated by acts of Congress of May 8 and June 30, 1914. It was produced with the cooperation of the U.S. Department of Agriculture, Cornell Cooperative Extension, New York State College of Agriculture and Life Sciences, New York State College of Human Ecology, and New York State College of Veterinary Medicine, at Cornell University. Cornell Cooperative Extension provides equal program and employment opportunities. Lucinda A. Noble, Director.

Would you like our free catalog of extension publications? It is available from any Cornell Cooperative Extension county office or by writing to:

Distribution Center
Cornell University
7 Research Park
Ithaca, NY 14850

PESTICIDE EMERGENCY NUMBERS

Pesticide Spills and Accidents
CHEMTREC

1-800-424-9300

Pesticide/Information Emergencies
National Pesticide Telecommunications Network

1-800-858-7378

Report Oil and Hazardous Material Spills
NYS Department of Environmental Control

1-800-457-7362

Information on Symptoms and Treatment
You can obtain prompt and up-to-date information about the symptoms and treatment of cases resulting from exposure to toxic agricultural chemicals by telephoning any of the centers listed below and asking for "Poison Control Center."

When you are unable to reach a Poison Control Center or obtain the information your doctor needs, the office of the N.Y.S. Pesticide Coordinator at Cornell University, 607-255-1866, may be able to assist you in obtaining such information.

Poison Control Centers

Buffalo 716-878-7654
Central New York 1-800-252-5655
Hudson Valley 914-353-1000
Long Island 516-542-2323
New York City 212-340-4494
Rochester 716-275-5151
Schenectady 518-382-4124
Southern Tier 607-723-8929

Cornell Cooperative Extension

422/650 11/89 6M ML E8802150101G