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# Weeds and Their Control

BY R. H. PORTER



A spring tooth harrow in operation

IOWA STATE COLLEGE OF AGRICULTURE  
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# Weeds and Their Control

By R. H. PORTER

Weeds cause a loss of many millions of dollars to Iowa farmers annually. They crowd out desirable crops, rob them of plant food and moisture, act as hosts for insects and diseases, poison or injure livestock, depreciate land values and cause extra labor in cultivation; thus they increase the cost of crop production.

The primary cause of the serious weed problem in Iowa is the use of impure seed. Purity tests of clover, alfalfa, grass and grain seeds during the past 30 years, by the Botany Department Seed Laboratory, at Iowa State College, show that most of our bad weeds have been introduced and distributed by agricultural seed. Other factors which have made the weed problem more acute are as follows: (1) the area of distribution of many perennial weeds has been rapidly increasing; (2) mature weed seeds which live for years in the soil are commonly plowed under instead of burned; (3) the more extended sowing of legume crops with small grains for green manure and other purposes prevents the practice of early fall plowing; (4) on many farms soil erosion and depleted fertility have given weeds the advantage over hay and pasture crops. It is therefore imperative that communities as well as individuals take immediate steps to utilize all of the information available on weed control and to organize a comprehensive campaign for that purpose.

The object of this bulletin is to bring together in brief form available information on the control of weeds with special emphasis on the application of the principles of weed control and in addition suggest some methods whereby communities may develop and organize an effective campaign against weeds.

## KINDS OF WEEDS

One of the first steps in weed control is a knowledge of the habits and methods of reproduction of weeds. There are four main groups of weeds; namely, annuals, winter annuals, biennials and perennials.

**Annuals** complete their growth in one year, that is, the seed germinates in the spring or summer and the plants die in the fall. These weeds usually have either small, fibrous roots or a fleshy tap root somewhat branched. Most of the annuals pro-

duce a large quantity of seed, which in certain species retain their vitality in the soil for many years.

**Winter annuals** include a small group which behave like fall wheat or fall rye altho some of them may also act as true annuals. In all cases, however, the seeds usually germinate in the fall under favorable conditions and the plants complete their growth the following spring. Growth from the root starts early in the spring; hence, these weeds are often troublesome in small grain fields or in meadows where the stand of clover or grass is thin.

**Biennials** complete their growth in two seasons, behaving in the same manner as red clover and sweet clover. Seed is produced the second season after which the plants die. If biennials are cut too early the second year and several times again the same season, they sometimes remain alive a third season and thus become perennial in habit.

**Perennials** are plants that produce roots, rooting stems or rootstocks which remain alive for many years. In addition, seed production is usually abundant. Underground roots of perennials vary in depth and extent. Plantains produce clumps of short, shallow roots; quack grass produces long rooting stems which do not extend below the plow line, and Canada thistle and perennial sow thistle have long rootstocks extending to a depth of 1 foot or more in the soil.

### COMMON WEEDS OF IOWA

In this bulletin it is impossible to list and describe in detail all of the weeds which occur in the state or to give control measures for each one. For a description of many of our common Iowa weeds, the reader should consult Iowa Extension Service Bulletin No. 139, entitled "Handbook of Iowa Weeds."\* There are nearly 100 different weeds of general or local importance in the state. The following table classifies 92 of them giving a brief summary of the class, color, size and arrangement of their flowers, their methods of reproduction and dissemination and their habitation. The weeds are listed alphabetically according to their common names.

\* This bulletin can be purchased of the Agricultural Extension Service, Ames, Iowa, for 5 cents.

TABLE I — DESCRIPTIVE LIST OF IOWA WEEDS  
 A.—Annual WA.—Winter Annual B.—Biennial P.—Perennial

Common name ; botanical name and classification	Color, size and arrangement of flowers	Method of propagation; agency of seed distribution	Section of state commonly found	Habitat
Barnyard grass; <i>Panicum crus-galli</i> (A)	Green or purple; panicles	Seeds; animals, hay, grain and grass seed	Entire state	Cornfields, waste lots, river banks
Black bindweed; <i>Polygonum convol- vulus</i> (A)	Pink or white; 1/16 inch; racemes	Seed	Entire state	Corn and small grain fields
Black medick; <i>Medicago lupulina</i> (A)	Yellow, small; short spikes	Seed; clover and alfalfa seed	North central	Clover and alfalfa fields
Black nightshade; <i>Solanum nigrum</i> (A)	White; 3/4 inch; solitary	Seed; chicken feed and birds	Entire state	Shady grounds and fields
Braeted plantain <i>Plantago aristata</i> (A)	White; small spikes	Seed; clover, grass seed and hay	South- ern	Waste places, pastures and meadows
Bristly foxtail; <i>Setaria verticillata</i> (A)	Green; small spikes	Seed; clover seed and animals	South- eastern	Waste places and fields
Buckhorn or rib- grass; <i>Plantago lanceolata</i> (P)	White; small spikes	Seed and roots; clover seed and hay	South- ern	Lawns, clover fields and pastures
Buffalo bur; <i>Sola- num rostratum</i> (A)	Yellow; 1 inch; solitary	Seed; chicken- feed	Entire state	Cornfields and barnyards
Bull thistle; <i>Cirs- ium lanceolatum</i> (B)	Purple, 1 1/4 inches; heads	Seed and tap root; wind	Entire state	Pastures and roadsides
Bull nettle (see horse nettle)				
Burdock; <i>Arctium minus</i> (B)	Purple or white; 1 inch; heads	Seed and tap root; animals	Entire state	Waste places
Butter-print, but- tonweed, Indian mallow; <i>Abutilon Theophrasti</i> (A)	Yellow; 1 inch scattered on stem	Seed	Central and south- ern	Waste places and cornfields
Canada thistle; <i>Cirsium arvense</i> (P)	Purple or white; 3/4 inch; heads	Seed and root stocks; wind, grain and clover seed	Entire state	Pastures, fields and roadsides
Cheeses, common mallow; <i>Malva ro- tundifolia</i> (B)	White; 1 inch axillary	Seed and roots; animals	Entire state	Waste places and farm yards
Chess, cheat; <i>Bro- mus secalinus</i> (A)	Small; panicles	Seed; wheat seed and straw	South- ern	Winter wheat fields
Chicory; <i>Cichor- ium Intybus</i> (P)	Purple; 1 inch; heads	Seed and tap root; alfalfa, clover seed and hay	North- ern	Waste places and roadsides
Chickweed; <i>Stella- ria media</i> (A or WA)	White; 1/8 inch; axillary	Seed	Entire state	Lawns and waste lots
Cocklebur; <i>Xan- thum commune</i> (A)	Green; 3/4 inch; head	Seed; animals	Entire state	Cultivated fields waste places

## DESCRIPTIVE LIST OF IQWA WEEDS (Continued)

Common plantain; <i>Plantago major</i> (P)	White; small; spike	Seed and root; grass and clover seed	Entire state	Lawns, meadows and waste lots
Corn cockle; <i>Agrostemma Githago</i> (A)	Purple; $\frac{3}{4}$ inch; solitary and axillary	Seed; small grain seed	Eastern and southern	Small grain fields
Crab grass; <i>Digitaria sanguinalis</i> (A)	Green; spikes	Seed; clover and grass seed, hay, animals	Entire state	Lawns, gardens meadows
Creeping Jennie (see European bindweed)				
Curled dock (see sour dock)				
Dandelion; <i>Taraxacum officinale</i> (P)	Yellow; $1\frac{1}{4}$ inches; head	Seed and tap root; wind	Entire state	Lawns, gardens meadows
Devil's shoe-string, Tanweed; <i>Polygonum Muhlbergii</i> (P)	Pink or white; small; racemes	Few seed, mostly roots; plows and cultivators	Entire state	Low, rich, heavy land
Dodder; ( <i>Cuscuta sp</i> ) (A)	Yellow; $\frac{1}{8}$ inch; clusters	Seed; clover and alfalfa seed	Entire state	Clover and alfalfa fields
Dog fennel, mayweed; <i>Anthemis cotula</i> (A or WA)	White; 1 inch; heads	Seed; clover and grass seed	Entire state	Barnlots, pastures and meadows
Dooryard knotweed; <i>Polygonum aviculare</i> (A)	Greenish pink; small; racemes	Seed; clover and timothy seed	Entire state	Dooryards, orchards, and lawns
Downy brome grass; <i>Bromus tectorum</i> (A)	Green; panicles	Seed; wind, animals and hay	Central and southern	Roadsides, pastures and waste places
European morning-glory, field bindweed, creeping Jennie; <i>Convolvulus arvensis</i> (P)	White or pink; $1\frac{1}{4}$ inches; solitary	Seed and creeping rootstocks; grain and flax seed	Northwestern	Fields, pastures and waste places
Evening primrose; <i>Oenothera biennis</i> (B)	Yellow; $\frac{3}{4}$ inch; clusters	Seed and tap root; hay and animals	Entire state	Pastures and roadsides
Five finger, false strawberry; <i>Potentilla monspeliensis</i> (P)	White; $\frac{1}{2}$ inch; close cymes	Seed and tap root; clover and grass seed	Entire state	Pasture, meadows and gardens
Flowering spurge (see spurge)				
Four o'clock, umbrella plant; <i>Oxybaphus nyctagineus</i> (P)	Pinkish; $\frac{1}{2}$ inch; axillary or terminal clusters	Seed and tap root; grain seed and hay	Entire state	Cultivated fields and waste lands
Foxtail (green); <i>Setaria viridis</i> (A)	Green; spike	Seed; clover and grass seed, hay and grain	Entire state	Cultivated fields and waste lands
Foxtail (yellow); <i>Setaria glauca</i> (A)	Green; spike	Seed; clover and grass seed, hay and grain	Entire state	Cultivated fields and waste lands
Goat's beard; <i>Tragopogon pratensis</i> (P)	Yellow; $1\frac{1}{2}$ inches; heads	Seed and tap root; wind	Entire state	Meadows, pastures and roadsides
Hare's ear mustard <i>Conringia orientalis</i> (A)	Yellow; $\frac{1}{2}$ inch; racemes	Seed; clover; grass and small grain seed	Northern	Cultivated fields

## DESCRIPTIVE LIST OF IOWA WEEDS (Continued)

Hedge bindweed, wild morning-glory; <i>Convolvulus sepium</i> (P)	White or pink; 2 inches; solitary	Seed and rootstocks; grain and flax seeds	Entire state	Cultivated fields
Hemp; <i>Cannabis sativa</i> (A)	Green; axillary; clusters	Seed; water and animals	Entire state	Roadsides and waste places
Hoary alyssum; <i>Berteroa incanna</i> (A or B)	White; small; racemes	Seed; timothy seed and hay	Scattered	Roadsides and fields
Hoary cress, perennial pepper grass <i>Lepidium Draba</i> (P)	White; small; racemes	Seed and rootstocks; clover and grain seed	Ida, Crawford, and Carroll counties	Fields, meadows and waste lots
Horse nettle, bull nettle; <i>Solanum carolinense</i> (P)	Purple or white; 1 inch; solitary	Seed and rootstocks; clover seed and hay	Central and Southern	Cultivated fields and meadows
Horsetail; <i>Equisetum arvense</i> (P)	No flowers	Spores and rhizomes (roots); wind and water	Entire state	Partially drained fields and waste land
Horseweed, mule-tail; <i>Erigeron canadensis</i> (A)	White; inconspicuous; heads	Seed; hay and wind	Entire state	Roadsides; pastures and meadows
Indian mallow (see butter-print)				
Indian mustard; <i>Brassica juncea</i> (A)	Yellow; 1/2 inch; racemes	Seed; clover and grain seed	Scattered	Grain fields
Jimson weed, thorn apple; <i>Datura Stramonium</i> (A)	White; 2 1/2 inches; solitary	Seed; water	Entire state	Hog lots and waste lands
Kinghead, giant ragweed; <i>Ambrosia trifida</i> (A)	Yellow; 1/4 inch; small heads or spikes	Seed; hay and water	Entire state	Roadsides and fence lines
Lady's thumb, smartweed; <i>Polygonum persicaria</i> (A)	Pink; 1/16 inch; spikes	Seed; clover seed and hay	Entire state	Cornfields and gardens
Lamb's quarters; <i>Chenopodium album</i> (A)	Green; small; panicles	Seed; clover and grass seed	Entire state	Fields, gardens and roadsides
Leafy spurge; <i>Euphorbia Esula</i> (P)	Yellow; small; terminal clusters	Seed and rootstocks; clover and alfalfa seed	Northwestern	Cultivated fields, meadows and pastures
Marsh cress; <i>Radicula palustris</i> (WA)	Yellow; 1/2 inch; racemes	Seed; grain seed	Northern	Corn and small grain fields
Marsh elder, false ragweed; <i>Iva xanthifolia</i> (A)	Dark; small; compound panicle	Seed; clover and alfalfa seed	Scattered	Rich land around buildings
Mayweed (see dog fennel)				
Mexican dropseed grass; <i>Muhlenbergia mexicana</i> (P)	Green; dense panicles along stem	Seed and short scaly rootstocks; clover and grass seed	Entire state	Grain fields, roadsides and waste lots
Milkweed; <i>Asclepias syriaca</i> (P)	Purple; small dense umbels	Seed and rootstocks; wind	Entire state	Corn and grain fields, roadsides

## DESCRIPTIVE LIST OF IGWA WEEDS (Continued)

Motherwort; <i>Leonurus cardiaca</i> (P)	Pale purple; ¼ inch; axillary	Seed and creeping roots; animals	Central and southern	Pastures, woods and roadsides
Night-flowering catchfly; <i>Silene noctiflora</i> (A or WA)	Pinkish; 1 inch; solitary	Seed; alsike and red clover	Eastern and southern	Grain and clover fields
Ox-eye daisy; <i>Chrysanthemum Leucanthemum</i> (P)	White with yellow center; 1½-2 inches; solitary	Seed and rootstocks; clover and grass seed	North-eastern	Meadows, pastures and roadsides
Penny cress; <i>Thlaspi arvense</i> (A or WA)	White; 1/8 inch; terminal and lateral clusters	Seed; clover and grass seed, also floods	Entire state	Grain fields, meadows and pastures
Perennial peppergrass (see hoary cress)				
Perennial ryegrass <i>Lolium perenne</i> (P)	Green; terminal spikes	Seed and roots; wheat and grass seed	Entire state	Meadows and waste lands
Peppergrass; <i>Lepidium apetalum</i> (A or WA)	Greenish; minute; clusters	Seed; clover and timothy seed	Entire state	meadows
Pigweed, redroot; <i>Amaranthus retroflexus</i> (A)	Inconspicuous; in dense axillary and terminal spikes	Seed; clover seed	Entire state	Cornfields, meadows and waste lots
Prickly lettuce; <i>Lactuca scariola</i> (WA)	Pale yellow; ½ inch; solitary	Seed; wind	Entire state	Meadows, gardens and waste lands
Purslane, pusly; <i>Portulaca oleracea</i> (A)	Yellow; ¼ inch; solitary	Seed and fleshy stems; water	Entire state	Field and gardens
Quack grass <i>Agropyron repens</i> (P)	Green; spikes	Seed and rooting stems; grain and clover seed, farm tools	Entire state	Fields, roadsides, gardens and lawns
Ragweed (small) <i>Ambrosia artemisiifolia</i> (A)	Yellow; inconspicuous; small heads or spikes	Seed; hay, water, and grass seed	Entire state	Fields and permanent pastures
ed sorrel (see sheep sorrel)				
Ribgrass (see buckhorn)				
Russian thistle; <i>Salsola Kali var. tenuifolia</i> (A)	Purplish; ¼ inch; solitary in leaf axils	Seed; wind and clover seed	Central and northern	Roadsides and meadows
Sandbur; <i>Cenchrus tribuloides</i> (A)	Small; burs contain spikelets	Seed; animals and hay	Scattered	Sandy lands
Sheep sorrel, red sorrel; <i>Rumex acetosella</i> (P)	Red; 1/8 inch; racemes	Seed and rootstocks; clover, grass seed and hay	Southern	Thin, sour soils
Shepherd's purse; <i>Capsella bursa-pastoris</i> (A or WA)	White; small; racemes	Seed; clover seed	Entire state	Meadows; pastures and roadsides
Shoo-fly, bladder ketmia; <i>Hibiscus trionum</i> (A)	Yellow with dark center; ¾ inch; solitary	Seed; hay, fodder and water	Central and southern	Fields and barn lots



## DESCRIPTIVE LIST OF IOWA WEEDS (Continued)

Smartweed, heart's ease; <i>Polygonum pennsylvanicum</i> (A)	Light rose; 1/16 inch; racemes	Seed; hay, fodder and grain	Entire state	Fields and lots
Smartweed (see lady's thumb)				
Smooth dock, peach leaved dock; <i>Rumex altissimus</i> (P)	Green; 1/4 inch; panicle	Seed; hay and clover seed	Entire state	Meadows, pastures and roadsides
Sour, curled or yellow dock; <i>Rumex crispus</i> (P)	Green; 1/4 inch; panicle	Seed and fleshy root; hay, clover seed	Entire state	Meadows pastures roadsides
Sow thistle (perennial); <i>Sonchus arvensis</i> (P)	Yellow; 1 1/2 inches; terminal clusters	Seed and rootstocks; wind	Scattered in northern section	Fields, meadows and roadsides
Squirrel tail (see wild barley)				
Tanweed (see devil's shoe-string)				
Thorn apple (see jimson weed)				
Tumbling mustard; <i>Sisymbrium altissimum</i> (A)	Yellow; 1/3 inch; terminal clusters	Seed; grain, seed and wind	Entire state	Grain fields and waste lots
Western wheat grass; <i>Agropyron smithii</i> (P)	Green; terminal spikes	Seed and short rootstocks; hay and grain seed	Scattered	Railways and roadsides
White cockle, white campion; <i>Lychnis alba</i> (B or P)	White; 3/4 inch; axillary and solitary	Seed; clover and grass seed	Scattered	Grain fields and meadows
Whorled milkweed; <i>Asclepias verticillata</i> (P)	White; small; loose clusters	Seed and running rootstocks; wind	Scattered	Pastures, meadows and waste lands
Wild barley, squirrel tail; <i>Hordeum jubatum</i> (A or B)	Green; loose spikes	Seed; wind and hay	Entire state	Roadsides and permanent pastures
Wild buckwheat (see black bindweed)				
Wild carrot; <i>Daucus Carota</i> (B)	White; small; clusters	Seed; clover seed and hay	Central and eastern	Meadows and roadsides
Wild licorice; <i>Glycyrrhiza lepidota</i> (P)	White; small; spikes	Seed and roots; animals hay and seed	Western	Meadows and roadsides
Wild morning-glory (see hedge bindweed)				
Wild mustard <i>Brassica arvensis</i> (A)	Yellow; 1/2 inch; terminal clusters	Seed; grain and clover seed	Entire state	Small grain fields and meadows
Wild oats; <i>Avena fatua</i> (A)	Green; panicles	Seed; small grain seed	Northern	Grain fields
Wild parsnip; <i>Pastinaca sativa</i> (B)	Yellow; small; large clusters	Seed; water and hay	Central and eastern	Roadsides and waste lots
Wild sunflower; <i>Helianthus annuus</i> (A)	Yellow; 1 1/2 to 3 inches; heads	Seed; hay and water	Western	Roadsides

## DESCRIPTIVE LIST OF IOWA WEEDS (Continued)

Woolly thistle; <i>Cirsium canescens</i> (P)	Purple; 1½ inches; terminal	Seed and root- stocks; wind	North- western and western	Pastures and meadows
Wormwood; <i>Arte- misia biennis</i> (A or B)	Green; incon- spicuous; axillary spikes	Seed; hay	Entire state	Roadsides and woody pastures
Yarrow; <i>Achillea millefolium</i> (P)	White; small; large clusters	Seed and roots; hay and seed	Entire state	Meadows and pastures
Spurge (flowering) <i>Euphorbia corollata</i> (P)	White; ½ inch; heads	Seed and roots; clover and grass seed	Scatter- ed	Meadows and grain fields

## NOXIOUS WEEDS OF IOWA\*

There are 17 weeds classed as noxious in the Iowa weed law. Six of them are annuals, three are biennials and eight are perennials. Methods of eradication, naturally, are not the same for each class or for each member of a class. One of the first steps in dealing with all of them, however, is to prevent seed production, which can be accomplished by cutting them at the proper time. The time of cutting varies somewhat for each section of the state and from one year to the next. Many of the noxious weeds may need a second or even a third cutting. The list which follows gives the common and scientific name, the class and the approximate cutting dates for each of the noxious weeds.

Common Name	Scientific Name	Class	Cutting Date
Buckhorn	<i>Plantago lanceolata</i>	Perennial	June 15-30
Burdock	<i>Arctium minus</i>	Biennial	July 20-30
Butter-print	<i>Abutilon Theophrasti</i>	Annual	July 20-30
Canada thistle	<i>Cirsium arvense</i>	Perennial	June 15-25 and Sept. 1
Cocklebur	<i>Xanthium commune</i>	Annual	July 15-30
European bindweed	<i>Convolvulus arvensis</i>	Perennial	July 15-30 and Aug. 15
Horse nettle	<i>Solanum carolinense</i>	Perennial	July 15-30 and Aug. 15

\* Information regarding the weed law may be secured from the State Secretary of Agriculture at Des Moines.

Perennial sow thistle	<i>Sonchus arvensis</i>	Perennial	June 10-20 and Aug. 20
Quack grass	<i>Agropyron repens</i>	Perennial	June 10-25 and Sept. 1
Russian thistle	<i>Salsola Kali var. tenuifolia</i>	Annual	July 1-15
Shoo-fly	<i>Hibiscus trionum</i>	Annual	July 20-30
Smooth dock	<i>Rumex altissimus</i>	Perennial	June 10-20
Sour dock	<i>Rumex crispus</i>	Perennial	June 1-10
Wild carrot	<i>Daucus Carota</i>	Biennial	July 1-15 and Aug. 20
Wild mustard	<i>Brassica arvensis</i>	Annual	June 10-20
Wild parsnip	<i>Pastinaca sativa</i>	Biennial	July 1-15 and Aug. 20
Wild sunflower	<i>Helianthus annuus</i>	Annual	Aug. 15

### WHAT MAKES A WEED NOXIOUS OR UNLAWFUL?

All weeds are harmful in one or more ways, but some of them are unquestionably more harmful than others. It is impracticable to place all weeds in the unlawful list, in fact, it is highly desirable to make the list as small as possible. The noxious weeds of Iowa are designated by the State Legislature, based largely on information secured regarding their habits. It is probable that some of the weeds listed as noxious are not as serious as they were considered to be when first introduced. The conditions which should determine whether a weed is noxious or not are as follows:

1. Ability to crowd out or lower the quality of a crop.
2. Persistence in cultivated land.
  - a. Longevity of seeds in the soil.
  - b. Development of running rootstocks which produce new plants.
3. Amount of seed produced and methods of its dissemination.
4. Method of eradication required.
5. Poisonous properties.

It is possible that a weed which fulfilled any one of the conditions listed might be considered noxious, but in most cases it is probable that more than one condition should be fulfilled before a weed is placed on the unlawful list. Of the 17 weeds listed there are at least 5 perennials which are among our worst enemies, namely Canada thistle, European bindweed or creeping Jennie, horse nettle, perennial sow thistle and quack grass.

Four other weeds which are not listed as noxious but are persistent and difficult to eradicate are wild morning-glory, devil's shoe-string, leafy spurge and hoary cress.

### **VITALITY OF WEED SEEDS IN THE SOIL**

One of the factors which makes it difficult to destroy weeds permanently is the prolonged life of many weed seeds in the soil. Their longevity is in striking contrast to that of most of our cultivated crop seeds and may be of more value in some localities than is commonly realized. The ability of seeds of wild plants to retain their vitality for many years makes it possible for non-tilled land to have a continuous cover, thus avoiding soil washing and blowing. Numerous experiments have been conducted with many different kinds of weed seeds which were buried in the soil. The following table presents a brief summary of the information now available on this subject.

It is evident from the data presented that it is folly to allow weeds to go to seed on cultivated land. In no case should mature weed seeds be plowed under; they should be burned.

### **PRINCIPLES OF WEED CONTROL**

In the control of weeds there are certain fundamental principles involved which, if followed carefully, will greatly aid in the success of the program. These principles are as follows:

1. Sow clean seed of strong vitality.
2. Prevent weed seed production.
3. Do not plow land covered with weeds having mature seeds until weeds have been burned.
4. Encourage germination of weed seeds and kill them in the seedling stage.
5. Destroy rootstocks of perennials whenever possible.
6. Prevent storage of organic food reserves in the roots of perennials.
7. Maintain or increase soil fertility.
8. Learn to classify weeds and start eradication measures as soon as the nature of a new weed is determined.
9. Develop community cooperation by education.

### **METHODS OF CONTROLLING WEEDS**

The control or eradication of weeds consists primarily of applying the principles outlined above. The degree of success in control achieved by a farmer or a group of farmers will be determined by their ability to apply these fundamental principles at the proper time and in the most feasible way. It is obvious that good farming practices are an essential part of a weed control program, but it is often necessary to depart from the customary routine of crop rotation in order to cope with a special weed problem. Detailed recommendations for the control of each weed listed in table I are unnecessary because many

of them yield to the same method. It is essential, first, to outline those methods which apply to most weeds, and, second, to discuss in detail specific practices for the eradication of a few of the more persistent ones.

TABLE II. VITALITY OF WEED SEEDS IN THE SOIL

Common Name	Scientific Name	Known Year of Life
Pigweed	<i>Amaranthus rethoflexus</i>	40 or more
Ragweed	<i>Ambrosia artemisiifolia</i>	40 or more
Black mustard	<i>Brassica nigra</i>	40 or more
Shepherd's purse	<i>Capsella bursa-pastoris</i>	35
Peppergrass	<i>Lepidium virginicum</i>	40 or more
Dog fennel	<i>Anthemis cotula</i>	25
Evening primrose	<i>Oenothera biennis</i>	40 or more
Common plantain	<i>Plantago major</i>	40 or more
Common smartweed	<i>Polygonum hydropiper</i>	25
Purslane	<i>Portulaca oleracea</i>	40 or more
Curled or sour dock	<i>Rumex crispus</i>	40 or more
Common chickweed	<i>Stellaria media</i>	30
Common mullin	<i>Verbascum thapsus</i>	35
Tumble weed	<i>Amaranthus graecizans</i>	40
Lamb's quarters	<i>Chenopodium album</i>	40
Green foxtail	<i>Setaria viridis</i>	20 or more
Yellow foxtail	<i>Setaria glauca</i>	20 or more
Bristly foxtail	<i>Setaria verticillata</i>	20 or more
Smartweed	<i>Polygonum persicaria</i>	20 or more
Penny cress	<i>Thlaspi arvense</i>	20 or more
Cinquefoil, five-finger	<i>Potentilla monspeliensis</i>	20 or more
Hedge bindweed	<i>Convolvulus sepium</i>	20 or more
*Button weed	<i>Abutilon Theophrasti</i>	20 or more
Dodder	<i>Cuscuta polygonorum</i>	20 or more
Blue vervain	<i>Verbena hastata</i>	20 or more
Jimson weed	<i>Datura stramonium</i>	20 or more
Black nightshade	<i>Solanum nigrum</i>	20 or more
Rugel's plantain	<i>Plantago rugellii</i>	20 or more
*Shoo-fly	<i>Hibiscus trionum</i>	20 or more
Horse nettle	<i>Solanum carolinense</i>	11
Quack grass	<i>Apropyron repens</i>	4

\*Seed of Shoo-fly and butter-print kept in a dry place retained their vitality for over 57 years, as shown by Ewart.

### CLEAN AND TEST ALL SEED BEFORE PLANTING

The primary cause of the weed problem in Iowa is the presence of weed seeds in agricultural seed which is sown on the land. A few seeds of a noxious weed may produce enough plants to start a center of distribution either by means of seed harvested in grain, clover and grass seed, or by the agencies of wind, water and animals. As long as seed companies are allowed to sell impure seed and farmers continue to sow it, new weeds will be introduced, local weeds will be more widely scattered and the weed problem will increase in severity.

The weed seeds which are commonly carried in agricultural seed are listed here:

Black medick	European bindweed	Shoo-fly
Bracted plantain	Horse nettle	Small ragweed
Buckhorn	Horse sorrel	Smooth dock
Butter-print	Night-flowering catch-	Sour dock
Canada thistle	fly	Wild buckwheat
Chicory	Ox-eye daisy	Wild carrot
Corn cockle	Perennial sow thistle	Wild morning-glory
Crabgrass	Pigweed	Wild mustard
Dog fennel	Quack grass	Wild oats
Dodder	Russian thistle	Wild sunflower
Dragonhead	Smartweed	

Other weed seeds carried by crop seeds may be found by reference to the third column in table I. The presence of weed seeds in crop seeds has been determined over a period of years by the Botany and Plant Pathology Section of the Iowa Agricultural Experiment Station. During the years 1913 to 1921, it was found that 227 different species of plant seeds occurred as impurities in the samples tested. Most of the impurities were weed seeds. Canada thistle seed was found in 50 samples of red clover, four of alfalfa, 50 of alsike, 6 of sweet clover, 7 of timothy and 37 of timothy and clover mixtures. Canada thistle seeds were found in 2 percent of the number of samples tested. Quack grass seeds occurred in 1.2 percent of the samples tested.

A summary of the results secured from July, 1926, to June, 1927, are given in table III.

Further evidence regarding the dissemination of weed seeds by the agency of crop seeds was secured in the tests carried on from July, 1929, to June, 1930. It was found that foxtail occurred in 564 samples of red clover, 128 samples of sweet clover and 129 samples of alfalfa. Sour dock was found in 138 samples of red clover, 20 samples of sweet clover, 17 samples of alsike and 29 samples of alfalfa. Smartweed was found in 183 samples of red clover, 22 of sweet clover and 16 of alfalfa. These records clearly show that more attention should be given by farmers to the kind of seed they sow in order to prevent the initial spread of weeds.

TABLE III. PERCENTAGE OF SAMPLES OF CROP SEEDS HAVING WEED SEEDS

Kind of Weed	Red Clover 411 Samples	Alfalfa 273 Samples	Alsike 90 Samples	Timothy 270 Samples	Sweet Clover 350 Samples
Buckhorn	14.59	2.93	3.33	9.62	3.71
Canada thistle	1.21	—	4.44	0.69	2.28
Dodders	2.67	14.28	—	—	0.28
Dragonhead	12.16	0.37	2.22	1.11	13.17
Quack grass	0.97	2.19	—	1.85	5.60
Russian thistle	8.51	65.20	—	—	10.83
Sheep sorrel	12.18	1.08	50.0	14.07	4.85
Sour dock	47.20	24.82	27.7	25.92	32.28
Wild carrot	3.40	—	—	0.69	0.56

The first step in weed control is to clean and test all seed before it is sown. Certain weed seeds cannot be readily removed from clover and grass seeds by cleaning, hence, cleaned seed should be submitted for a purity test. Seed containing noxious weed seeds or large numbers of other weed seeds should not be sown. In the case of small grains, most weed seeds and lightweight or scabby kernels of grain can be removed by a fanning mill.

The State has attempted to aid in the problem of weed control by making it unlawful to sell crop seeds containing certain weed seeds. The Iowa pure seed law was revised in 1924. A brief summary of the main points in this law is given here.

"A. Labeling of Agricultural Seed.

All agricultural seed offered for sale or exposed for sale shall have a printed label showing:

1. Variety of seed.
2. The approximate percentage by weight of the purity of the seed.
3. The approximate total percentage by weight of weed seed.
4. The name of each kind of seed of noxious weeds which is present.
5. The approximate percentage of germination of such agricultural seed, together with the month and year said seed was tested, and year grown, and if corn, the county and state where grown, and if clover of any variety or alfalfa, the state or country where grown.

B. Exemptions: Agricultural seed or mixtures of same shall be exempt from the provisions of this title:

1. When possessed, exposed or offered for sale, or sold for food purposes only.
2. When sold or in store for the purpose of re-cleaning.
3. When sold by one farmer to another and delivered upon the vendor's premises; but if such seed is advertised for sale or is delivered thru a common carrier, then the seed shall be subject to all the requirements of this title, but this exemption shall in no event be construed as permitting the sale of agricultural seed containing the seeds of Canada thistle, quack grass, buckhorn, wild carrot, horse nettle, or dodder (clover, alfalfa, or field).

C. Certain Sales prohibited.

No person shall sell, offer or expose for sale, or distribute, for seeding purposes, any agricultural seed if the seeds of Canada thistle, quack grass, buckhorn, wild carrot, horse nettle, or dodder (clover, alfalfa, or field) are present, singly or collectively, as follows:

1. In excess of one seed in each 5 grams of grasses and clovers.
2. One in 25 grams of millet, rape, flax, or other agricultural seed not specified in subsections 1 or 3 of this section.
3. One in 100 grams of wheat, oats, and the larger seeds."

Farmers have the privilege of reporting to the State Department of Agriculture any violations of the provisions of this law.

In addition to tests for purity it is often important to determine the vitality as well as the amount of disease found in seed.\* Diseases carried on the seeds of corn, grains and truck crops are factors in reducing the stand and yield of those crops. Farmers should make greater use of the facilities in the state for seed testing. The standard quantity of each kind of seed for a complete test is 2 ounces each of alsike, timothy or lawn grass, 5 ounces each of red clover, sweet clover, alfalfa, millet, flax, rape or brome grass and 1 pound each of corn, wheat, barley, rye, oats, beans or sorghum.

#### **MOW ROADSIDES ABOUT THREE TIMES EACH YEAR**

A number of the noxious weeds as well as many other weeds grow readily along the roadside, in fence lines and in waste lots. It is not uncommon for fields adjoining the public highways to become infested with foul weeds either by wind-blown seed or by creeping underground roots. Flowering dates of roadside weeds extend over a long period of time. Sour dock, red sorrel and squirrel tail develop seed early, whereas Russian thistle and wild sunflower bloom late in the season. If roadsides are mowed once the last week in May or the first of June, a second time in July and a third time in August or September no weeds should mature seeds and in the course of a few years bluegrass will be the predominant part of the soil cover unless such other perennials as quack grass or Canada thistles have established themselves. Roadsides which are fairly level can profitably be seeded to alfalfa, a crop which will remain established for several years. It will prevent the growth of weeds and furnish two or three crops of hay each year.

#### **PRACTICE CROP ROTATION**

Most tillable land in Iowa is rotated in some way. In weed control a rotation system is valuable because several methods may be employed over a period of years to suppress certain weeds. The mere adoption of a plan of rotation, however, will not result in the eradication of weeds. The success of any system will depend on how thoroly the land is farmed

\*The seed laboratory maintained by the Botany Department, Ames, Iowa, is well equipped to make purity and viability tests as well as to determine the presence of seed-borne diseases.



each season to prevent the weeds from seeding or spreading.

Most of our common weeds can be controlled without seriously affecting the yield of crops by a rotation system which includes one or two crops of corn, one of small grain and one or more crops for hay or pasture. Cultivation of the corn crop should include thoro preparation of the soil, blind plowing when necessary and frequent cultivation to kill all weeds until the crop is laid-by. In some cases hoeing or pulling weeds in the cornfield during July, August and September may be necessary in order to eradicate some of the annual and perennial weeds. When small grain is sown it is usually best to sow a legume crop at the same time. Alfalfa furnishes an excellent hay or pasture crop which can be used several years and which prevents the growth of many weeds. Sweet clover by its rapid and dense habit of growth furnishes an excellent cover on the land for at least one year; it crowds out weeds and prevents their spread by means of underground roots. An additional value of a legume crop is that it can be used for green manure to build up the fertility of the soil, a condition which aids in the control of such weeds as sheep sorrel and buckhorn.

Pasturing with sheep, cattle and hogs is an important part of a rotation system. Creeping Jennie, wild morning-glory, sow thistle and quack grass can be prevented from spreading by close pasturing with sheep and cattle. Hogs are of value in digging out the roots of morning-glories, quack grass and Canada thistle especially in land recently plowed.

#### DESTROY WEEDS IN THE SEEDLING STAGE

When weeds whose seeds live for many years in the soil, are found growing in a field it is folly to plow the mature seeds under and then depend on ordinary methods of farming to eradicate them. Sour dock, mustard, butter-print, shoo-fly, pigweed, smartweed and others listed in table II have seed which retain their vitality in the soil for long periods of time. In any such case the most important thing to do is to encourage the germination of the weed seeds and kill them before any top growth is produced. This can be done by discing and harrowing the plowed land early in the spring or by plowing cornstalk ground late in the spring just before time to plant corn. If the former method is followed a good seedbed should be prepared and then the land can be worked with a harrow or weeder at intervals of 5 to 7 days to drag the germinating seeds out on top of the soil where they will be killed. This practice can be used with the production of a soybean crop because beans can be planted as late as the first of June, thus allowing time for the germination of weed seeds. In addition the crop can be cultivated until late in the season.

### PLOW SMALL GRAIN STUBBLE EARLY IN THE FALL

Early fall plowing is a valuable practice in destroying weeds, since it prevents seed production as well as top growth of perennials. When clover or alfalfa are seeded with small grain this method cannot be followed, but in some cases it is of value to grow two crops of small grain in succession and plow immediately after the first crop is removed. This method can be carried out in the southern half of Iowa by sowing winter wheat after early oats. Such weeds as cocklebur, wild morning-glory and horse nettle can be controlled by summer fallowing from the time the oats are harvested until the wheat is sown. If quack grass is abundant a spring tooth harrow should be used during that time.

In northern Iowa barley may be seeded successfully the year after a crop of early oats is grown; it allows the same practice of summer fallowing to be followed as previously mentioned. Red top, quack grass, devil's shoe string and to some extent Canada thistle can be controlled by using the two-year method with small grain.

### USE MACHINES WHICH KILL WEEDS

The disc is of value in the preparation of a seedbed but does not kill many weeds. The weeder, the common harrow, the spring tooth harrow and the surface cultivator, all have their place in weed control. For tough-rooted perennials like quack grass whose rooting stems are not deep, the spring tooth is the only tool to use. It should be employed in the driest and hottest part of the summer as well as in the spring before the corn is planted. In some seasons, when the soil is dry early in the spring, the spring tooth may be used to advantage prior to the seeding of small grain. Whenever possible the underground parts combed out should be raked and burned. The picture on the cover page of this bulletin shows a spring tooth harrow in operation. It has levers which make it possible to regulate the depth. Nearly every farmer in the state could use such a machine to advantage.

Another tool whose value is not sufficiently recognized is the surface cultivator equipped with knives or sweeps. This machine prevents top growth of perennials like sow thistle, Canada thistle, leafy spurge, bindweed, morning-glory and horse nettle. Cornfields having these weeds can be kept much cleaner with a surface cultivator than with a common shovel cultivator. After the corn is too large to use a two-horse machine a one-horse, five or seven-tooth surface cultivator can be used successfully. This system of cultivation keeps down top growth and thus prevents the storage of organic food reserves in the roots and underground stems of perennials.

### SMOTHER CROPS

Under certain conditions weeds may be killed by growing

smother crops for a part of one season or continuously for several years.

Alfalfa is probably the ideal smother crop because it is a perennial, and when once well established makes such rapid growth and is cut so often each year that no weeds are able to make much vegetative growth. In using alfalfa, however, one must consider the type and condition of the soil, the amount of fertility available, lime requirements and the extent of the weed cover. Smothering is necessary mainly for perennial weeds, therefore, the extent and condition of their rootstocks is of paramount importance. If such weeds as Canada thistle, perennial sow thistle or creeping Jennie are well established in a piece of land it is always advisable to prevent the storage of food reserves in their roots either by summer fallowing or by constant cultivation in corn the year before alfalfa is sown. It is best to give alfalfa an additional advantage by providing a seedbed which will insure the establishment of a dense stand. Lime, manure, seed inoculation, plenty of seed and even superphosphate may be necessary. From 20 to 25 pounds of high grade seed are required per acre for best results.

Sorghum, millet and sudan grass are good smother crops for the warm period of the summer. Best results with any of them are usually secured by fallowing the land from early spring until the latter part of June and then sowing from 50 to 100 percent more seed than would be used normally. The principle of using smother crops, of course, is to prevent top growth of the weeds and thus starve the roots. Annual smother crops need even more advantage over the weeds than alfalfa, hence fallowing is an essential part of the program.

#### ADOPT A SOIL BUILDING PROGRAM

Certain weeds are able to thrive in worn out soils and crowd out less persistent crop plants. Sheep sorrel, buckhorn, bracted plantain, dandelion and the cocklebur all persist in meadows, pastures, lawns and to some extent in cultivated fields low in fertility, to the exclusion of hay and pasture crops. In such cases the first step is to build up the fertility of the soil. This can be accomplished mainly in two ways: (1) by applying barnyard manure and (2) by growing green manure crops. If land is sour it should be first limed, then seeded to small grain and sweet clover and plowed either the same fall or the next spring when a heavy crop of green manure has been produced. This treatment is of special value where sheep sorrel has gained a foothold because it thrives in sour soil. Following the treatment with organic matter one or two crops of corn may be grown, which system, with clean cultivation, will kill weeds that bother in worn out soils. Permanent pasture land which cannot be plowed should be manured and in some cases treat-

ed with superphosphate.\* Mowing the weeds before seed is produced may be advisable in many cases.

#### SPECIAL METHODS FOR PERENNIAL WEEDS

There are five perennial weeds which may be considered the worst in the state. All of them produce extensive underground rootstocks from which new sprouts come up thruout the season. These rootstocks act as storage organs for organic food reserves, thus making it unnecessary for the plants to produce seed when once established in a field. Unfortunately all five of these weeds produce seed if they are not cut several times during a season. The five weeds referred to are Canada thistle, perennial sow thistle, European bindweed or creeping Jennie, quack grass and horse nettle. Leafy spurge and hoary cress (perennial pepper grass) are two other perennials which are becoming established in parts of the western and northwestern sections of the state.

#### Canada Thistle

Canada thistle is undoubtedly present in every county of the state. Its persistence in fields, pastures and meadows is well known; it is one of the worst weeds to eradicate in the state. Figure 2 shows a thistle plant illustrating the type of leaves and flowers, the shape of the seed and the underground rootstocks. There are certain principles to keep in mind in order to deal effectively with this weed.

#### Function of the Rootstocks

Rootstocks of Canada thistle extend down into the soil and also parallel to the surface at depths ranging from 6 inches to 3 feet, altho in some soils the roots may extend to several feet below the surface. When a few plants or even one plant gets a start, the area of infestation will constantly enlarge because of the spreading habits of the rootstocks. The primary function of these roots seems to be food storage and vegetative reproduction. It has been found that these underground parts are weakest near the blossoming period, that is, the food reserves are lowest. Late in the fall and winter the rootstocks are in their most vigorous condition, which means of course that the top growth produced after the blossoming period until fall, provides the roots with their reserves. Any successful method of eradication must be one that prevents top growth from the first of June until the end of the growing season.

#### Seed Production

Small patches of thistles often become established from seed carried in either by grass, clover and small grain seed or by the wind. There is a common impression that Canada thistles do not produce seed in Iowa. This is not true. It matures

\* Further information on soil improvement may be secured from the Soils Department, at Iowa State College.

seed in every part of Iowa, but fortunately the percentage of mature seed is not as great as it is with sow thistle or horse nettle. This is due largely to the seeding habits of Canada thistle. There are two kinds of flowers, staminate or pollen flowers and carpellate or seed-producing flowers. Each individual plant has only one kind of flower. This condition explains why seed production is limited. For example, one patch may have originated from a single seed in which case all of the plants would be of the same kind. If the flowers were staminate no seed could be produced; if they were carpellate



Fig. 2. Canada thistle plants showing rootstocks, new plants, blossoms and seed.

or female flowers, seed production would be dependent on the transfer of pollen from staminate flowers in another patch by wind or insects.

#### Varieties of Thistles

There are many variations among Canada thistle plants. Some have nearly smooth leaves with few spines; others have crinkled or rugose leaves, cut in deeply at intervals along the margins and well supplied with spines, and other varieties fall in between the two extremes. Cross fertilization occurs readily from which different types arise as a result of segregation. This variation confuses farmers and in many cases patches of thistles are allowed to remain because they are not recognized. In case of doubt specimens should be sent either to the Extension Service or the Botany Department, at Ames, Iowa, for identification. Several years of hard work may be saved by having doubtful plants identified when first observed.

#### Methods of Eradication

##### **SPRAYING**

For small patches of thistles in meadows, pastures, along roadsides or in fence lines spraying with chlorates is probably the most efficient method of control. The use of chlorates will be discussed under the section on chemical weed killers.

##### **CULTIVATION**

It is possible to eradicate patches of thistles in cultivated fields while a crop is being grown if proper methods of cultivation are used. It is necessary, however, to grow at least one crop of corn—in some cases two crops. The land should be worked in the spring with a spring tooth harrow until corn planting time after which a surface cultivator with knives or sweeps should be used each week until the middle of July. During August and September top growth of the thistles should be prevented either by hoeing or by using a one-horse surface cultivator. This method prevents the storage of food reserves in the rootstocks and at the same time allows some crop return for the extra labor involved. If the thistles continue to grow late in the fall the cultivation should be continued again the second year with either corn or soybeans, but if the land is cultivated as often during the summer as new thistle shoots appear above the soil surface, alfalfa and small grain may be seeded in the spring of the second year. For information on the use of alfalfa, see the section devoted to smother crops.

##### **FALLOWING**

Many farmers prefer the summer fallow method which may be successful but more expensive than any other because no crop returns are possible for at least one year. If fallowing

is preferred it is best to use either a surface cultivator or a spring tooth harrow rather than a stirring plow and a disc. It is essential either to keep cutting the plants just below the surface of the soil or to drag out the rootstocks and burn them.

### CULTIVATION AND CHEMICAL TREATMENT

A method which has been used recently by a number of farmers with considerable success is to use the cultivation method in corn until the crop is laid by, then spray the thistles in September and again in November. By September the corn is sufficiently mature to prevent any injury from the chlorate solution and the soil is moist enough for more effective action on the thistles. The advantage of the combination method is that no cultivation is required during August and September, a period which demands the time of most farmers for other work.

#### Quack Grass

Quack grass, a perennial weed, produces considerable viable seed and develops a dense mat of underground rooting stems which form a heavy sod that is nearly impossible to plow. There is no weed in Iowa which can more completely take possession of farm land than quack grass. This weed is especially persistent in poorly drained land where it cannot be easily eradicated. Quack grass starts growth early in the spring and continues late into the fall. Figure 3 illustrates the appearance of the tops and the arrangement of the underground stems.



Fig. 3. Quack grass showing root development.

#### Method of Eradication

For small areas where cultivation is impracticable it is probably advisable to use chlorates or other chemicals, a discussion of which will be found under "Chemical Weed Killers."

Large areas can be most successfully eradicated with a spring tooth harrow (see cover page). Each spot should be cultivated separately to avoid scattering the roots about the field. The spring tooth harrow should be used at any season of the year when the soil is dry. Land which is to be planted to corn or in some seasons corn-stalk ground to be used for small grain can be worked prior to planting the crop. When meadows or small grain fields

are infested with quack grass the individual spots should be plowed as early in July as possible, and fallowed until October. If a spring tooth harrow is not available the next best tool is a six or eight-shoveled cultivator. When the underground parts are combed out it is best to rake and burn them. After one summer of thoro working, plow the land just before it freezes, work again the next spring with the spring tooth until the middle of May, then plant to corn and cultivate at least once a week as late in the summer as possible.

#### Perennial Sow Thistle

Perennial sow thistle is new to the state, being confined largely to the northern part. Small areas, however, have been found as far south as Tama, Jones and Polk counties, which means that it is finding its way into new localities. The sow thistle has a large yellow flower and is often confused with wild lettuce. It produces an abundance of seed which is readily scattered by the wind. It is somewhat similar to Canada thistle in its root system and rate of spread, but it is more difficult to control because of its heavy production of seed. The general appearance of the plant is well illustrated in fig. 4.

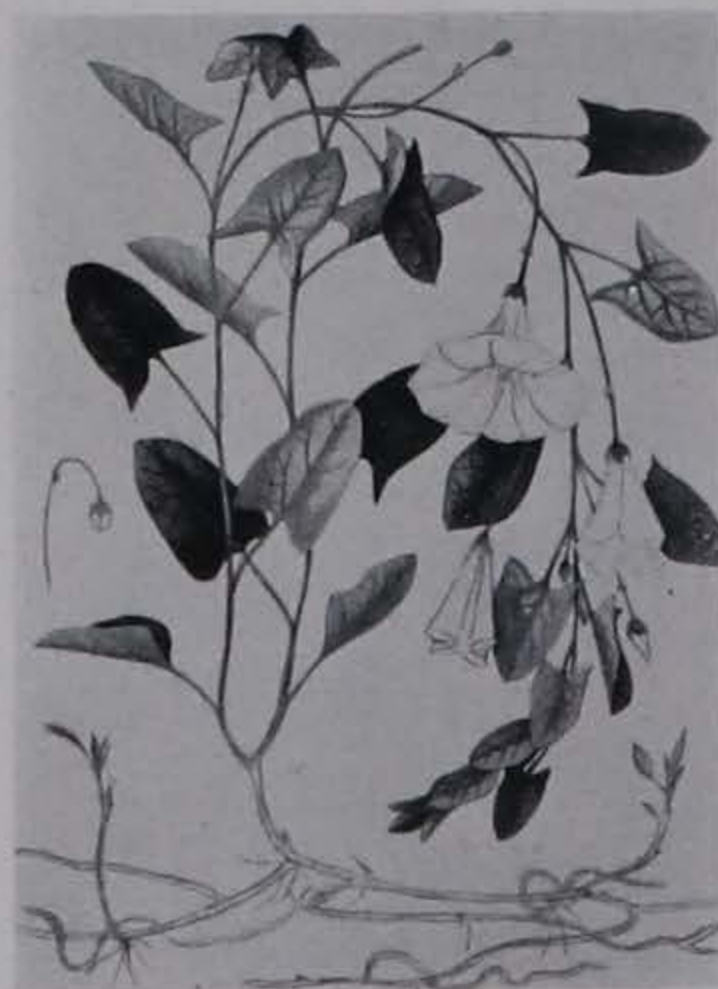


Fig. 5. European bindweed or creeping Jennie.

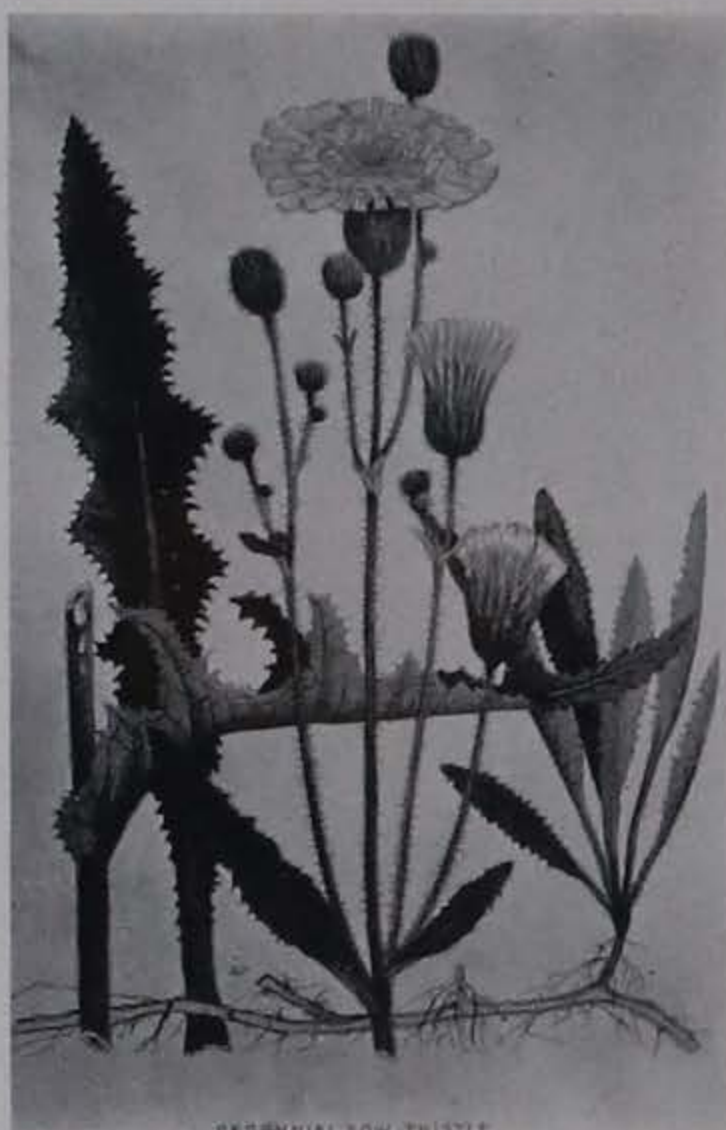


Fig. 4. Perennial sow thistle.

It is somewhat similar to Canada thistle in its root system and rate of spread, but it is more difficult to control because of its heavy production of seed. The general appearance of the plant is well illustrated in fig. 4.

Farmers should be on the lookout for this pest and send specimens either to the Extension Service or Botany Department, Ames, Iowa. Methods of eradication are similar to those described for Canada thistle, except that sheep will eat sow thistle, a fact which may be of value in preventing top growth.

#### European Morning-glory

No weed is more of a pest in northwestern Iowa than the



European morning-glory, known also as creeping Jennie. It is a close relative of the hedge bindweed or common wild morning-glory but it has smaller flowers and leaves. It propagates freely from long, underground rootstocks. The vines creep over the surface of the ground, covering it with a dense mat which crowds out other forms of vegetation. Figure 5 illustrates the shape of the leaves and the flowers and shows the type of root system which it develops. Considerable seed is produced in the latter part of the summer. This weed may be controlled by the same methods outlined for Canada thistle except that when infested areas are planted to corn, young lambs may be allowed to run in the field in August and September. They will eat the tops of the morning-glory plants and prevent further storage of food reserves. In case lambs are not used the plants should be sprayed with chlorates in September and November.\*

### Horse Nettle

Horse nettle, also known as bull nettle, is a deep rooted, thorny perennial which belongs to the potato family (see fig. 6). The flowers are purplish white and are shaped like a potato or tomato flower. The seeds are borne in small green fruits which ripen to a purple black color. This plant is widely scattered in the southern half of the state and is found occasionally in some of the northern counties. It has a shorter growing season than most perennial weeds. New plants seldom appear before the first of June and all plants are killed by the first killing frost. The rootstocks are slightly fleshy and deep, sometimes extending to a depth of 8 feet straight down into the soil. Lateral roots, parallel to the surface are not common; hence, this weed does not extend its area of distribution rapidly by roots. Seed is produced in great abundance if the plants are not cut often.

#### Methods of Eradication

Horse nettle does not take possession of land to the extent that the Canada thistle and quack grass do. Good crops of corn or small grain can be grown where horse nettles abound provided the seedbed is



Fig. 6. Horse nettle.

\* Iowa Experiment Station Circular No. 124, "European Bindweed," may be obtained free on request.

well prepared and the crop is cultivated frequently. This weed is more troublesome in hay fields and in pastures; hence, a successful method of eradication is needed.

A method which will hold this weed in check is to grow a crop of early oats, plow the stubble in late July, cultivate with a disc or surface cultivator and plant fall wheat in September. The second year, plow the land as soon as the wheat is cut and cultivate again until late October. The third year plant to corn and use a surface cultivator as described for Canada thistles. If the area of infestation is small the land may then be sowed to alfalfa with oats or barley. For large fields sweet clover may be substituted for alfalfa.

A second method which is being used with considerable success is to spray the plants with chlorates in August and again in September in cornfields. The corn will be eared well enough by the middle of August so that spraying the nettles will not hurt the corn crop.

### Leafy Spurge

Leafy spurge is a perennial which is becoming established in certain areas in western Iowa. It produces an extensive system of underground rootstocks from which new plants arise thruout the season. The leaves are dark green and lance shaped. White flowers are borne in a cluster on the ends of the branches. The general appearance of a leafy spurge plant is illustrated in fig. 7

Leafy spurge may become a serious menace in certain parts of the state if measures are not taken to eradicate it. Similar



Fig. 7. Leafy spurge showing extensive root system.

methods of control as recommended for Canada thistle should be used consisting of cultivation in the spring with a spring tooth harrow, followed by frequent plowing of the corn with a surface cultivator. After the corn is too large for a two-horse machine a one-horse surface cultivator should be used or the plants may be cut off with a hoe. After two years of such treatment the land may be seeded to alfalfa. Another method is to plant early oats, plow immediately after the oats are cut, then summer fallow to keep down top growth until the end of the season.

### Hoary Cress or Perennial Pepper Grass



Fig. 8. Hoary cress with terminal flowers and seed pod.

This species of pepper grass is spreading in Carroll, Crawford, Ida and other counties in western Iowa. The plants grow about 10 to 15 inches high, branching only at the top to produce the flower stalks. The leaves are dark green, short, sessile and clasp the stem. The flowers are white and scattered along the seed stalk. This plant propagates from seed and from underground creeping rootstocks. The appearance of the parts above the ground is shown in fig. 8.

At present hoary cress in Iowa is confined mostly to small patches, and preliminary tests with sodium chlorate indicate that it can be eradicated by spraying. Methods outlined for leafy spurge should also be successful against hoary cress.

### Devil's Shoestring

This member of the smartweed family is also called tanweed and marsh smartweed. It resembles lady's thumb and Pennsylvania smartweed except that the leaves are more hairy. Blossoming is rare but when the flowers do appear they are a rose color. The rootstocks are long, dark red, exceptionally tough and covered with scales which arise from the nodes. Figure 9 shows the general appearance of this weed. It occurs most commonly in low, rich bottom lands, altho it may be found on high ground.

The best tool for eradication is the spring tooth harrow used either in the spring before planting small grain and corn or in the summer after a small grain crop has been removed. The rootstocks should be gathered and burned if possible.

### CHEMICAL WEED KILLERS

Discovery of the value of the chlorates as herbicides has opened up new possibilities for weed control. Prior to this discovery chemicals had been used to a limited degree. Among the products which



Fig. 9. A well-developed group of Devil's shoestring plants.

have been used are iron sulphate, sodium arsenite, common salt, sulfuric acid and carbon bisulfide. A brief discussion of the merits of some of these follows:

#### Iron Sulfate

Iron sulfate has been used to a limited extent in spraying small grain fields for the destruction of plants of the mustard family. This chemical is only slightly harmful to plants of the grass family but is decidedly poisonous to mustards and dandelions. It has been recommended some for lawn treatment but other methods are more effective. The solution is prepared by dissolving 2 pounds of the commercial material in 1 gallon of water. It should be sprayed with some type of spray machine, either a knapsack or wheelbarrow sprayer (see figs. 10 and 11). Effectiveness of the solution depends upon the relative humidity of the atmosphere which should be high at the time of application. Spraying grain fields with iron sulfate has never been tried to any extent in Iowa and it is questionable if it will ever be practicable.

#### Sodium Arsenite

Sodium arsenite is sold commercially in a highly concentrated liquid form. The amount of dilution is determined by the plants to be treated. For some plants, 1 pound per 25 gallons of water is needed, but for the more resistant plants 2 to 5 pounds are required. It kills the tops of Canada thistles and morning-glories but does not kill the underground roots unless several applications are made as often as the new growth gets up enough to receive the spray. This chemical simply keeps the tops down and in that way starves the roots by preventing food storage. **Sodium arsenite even in small quantities is deadly poisonous to livestock and man and for that reason its use should be discouraged.** If it is used as a soil drench in large enough quantities to kill the roots, the soil is rendered non-productive for a number of years.

#### Sodium Chloride or Common Salt

During the past 5 years large quantities of salt have been used to kill barberry plants by applying it around the base of the bushes. It is also effective in killing buckthorn plants when applied in August. From one to 25 pounds are required per plant, depending on the size.

Salt will not kill perennial weeds unless it is applied in large enough quantities to completely saturate the soil around the roots. This treatment injures the soil for a number of years. Small quantities of salt fed to cattle on a patch of Canada thistles often results in death of these weeds due in part to the frequent trampling of the cattle.

#### Sulfuric Acid

Sulfuric acid has been used experimentally and has been found more effective in killing mustard plants under more varying conditions than has iron sulfate. A so-



Fig. 10. A compressed air sprayer for use on small weed patches.



Fig. 11. A wheelbarrow pressure sprayer suitable for weed spraying.

lution containing  $\frac{1}{4}$  to  $2\frac{1}{2}$  ounces of commercial sulfuric acid per gallon of water will kill mustard plants in a few hours, even in a dry atmosphere without injury to oat plants. The cost of the acid would be high for extensive use.

#### Chlorates

The value of the chlorates as weed killers was discovered in Europe where they have been used both in liquid and dry form on Canada thistles. The exact action on plants by this class of chemicals is not known, but they are far more destructive to the roots of perennials than are any of the other substances described above. Chlorates have the ability to kill the tops of a large number of plants and at the same time work down into the roots killing them gradually.

Chlorates are divided into two classes (1) those which are not hygroscopic, that is, they do not absorb moisture to any extent where exposed to the air, and (2) those which are extremely hygroscopic, so much so that they dissolve readily following the absorption of moisture on exposure to the atmosphere. Sodium and potassium chlorate belong to the first class and the chlorates of calcium and magnesium belong to the second class.

Sodium chlorate has been used most extensively of all the chlorates up to the present time. Its action has been studied on Canada thistle, quack grass, Johnson grass and to a limited extent on creeping Jennie, perennial sow thistle, horse nettle, poison ivy, leafy spurge, hoary cress and coral berry (buck brush). Dry sodium chlorate is inflammable and explosive and if a heavy application of the solution is used on plants, the tops when dry are readily ignited. Precautions which should be observed in handling the chlorates as well as information on how to prepare and use chlorate solution are listed below:

- (1) Do not use chlorates near buildings, and keep the steel container closed when not in use.
- (2) Keep the floors of trucks or wagon boxes and all wooden parts of the spray machine well painted.
- (3) Wash saturated clothing in water before wearing again.

- (4) Thoroly rinse out spray machine in which chlorate has been used before spraying trees or plants for protection against insects and diseases.
- (5) Do not spray during periods of excessive heat and drought.
- (6) Dissolve from 1 to 1½ pounds of chlorate in each gallon of water. Subsequent studies may show that 2 pounds per gallon should be used.
- (7) Spray plants at the rate of 2½ to 5 quarts per square rod, depending on the thickness of the stand and the height of the plants.
- (8) Do not mow areas to be treated just before the application is made.
- (9) Do not cut nor burn plants after they have been treated. There may be a progressive killing of the roots which is more rapid and complete when the tops are not removed.

"Atlacide" is a trade name for a special chlorate product obtainable in large quantities. It takes up moisture readily from the air and remains moist on plants longer than does sodium chlorate. For this reason it is apparently less dangerous to use. The relative effectiveness of "Atlacide" and sodium chlorate has not been adequately determined. In the more arid section of the United States "Atlacide" has replaced sodium chlorate to a considerable extent.

#### TIME OF APPLICATION

Considerable information as to the time of application is now available. In 1929 experiments were conducted in Iowa which showed that light applications on quack grass at intervals of two months were more effective than to apply the same total equivalent at any one time. For example, three applications each of 100 gallons per acre when made either in May, July and September or June, August and October killed approximately 100 percent. Two sprayings each in June and August or September and November at the same rate as above (100 gallons per acre) gave equally good results. There is also evidence that one treatment of about 200 gallons per acre in November is effective. When only one application was made in one season the June, September or November applications were most effective. Single applications in July or August were not successful except when 500 gallons per acre were used.

Less information on the best time to spray Canada thistles, creeping Jennie and horse nettle is available for Iowa conditions. For the present it is suggested that treatments on thistles and creeping Jennie be made in June, August and October or September and November at the rate of 3 to 5 quarts per square rod each time. When the soil is exceptionally dry in August the treatment should be delayed until September.

It is also probable that a combination of cultivation and spraying will be most successful in many cases. For example, if a crop of corn is grown and kept clean until July, patches of such weeds as Canada thistle, sow thistle, creeping Jennie and horse nettle may then be sprayed in September without injuring the corn. A second treatment in November may be given if needed. This method has been successfully used to a limited extent by farmers in Iowa.

The effect of chlorates may be detected on Canada thistle and horse nettle within a few hours after treatment, in fact on Canada thistle the effect may be noticeable within a half-hour. The plants begin to wilt and become yellow, then brown and finally black. On quack grass and creeping Jennie several days must elapse before any marked effect is noticeable.

#### METHODS OF APPLICATION

Patches of weeds covering a few square rods may be sprayed by using a knapsack or compressed air sprayer of the type shown in fig. 10.

This machine can be purchased in a 3, 4 or 5-gallon size. It is convenient to carry but is not designed to give high pressure. Figure 11 shows a wheel barrel type of spray machine with a capacity of about 10 gallons. It is equipped with a strong pump, a pressure gauge and sufficient length of hose to allow a radius of at least 10 feet in which to operate without moving the machine. A regular barrel sprayer which is used in orchards may also be used and in some cases power outfits have been used to cover large areas. A potato sprayer equipped with a boom and several nozzles would be most satisfactory for spraying several acres of land.

Any spray machine should be rinsed out thoroly each time chlorate solution is used because the chlorate corrodes metal if allowed to remain in contact with it long.

#### **EFFECT OF CHLORATES ON SOIL AND LIVESTOCK**

The effect of chlorates on the soil and on livestock is not completely understood. In a few cases where heavy applications have been made in Iowa, the soil has been somewhat non-productive the next season. The effect, however, seems to be dependent on the amount of rainfall in the summer and fall following the treatment as well as in the next spring. Whatever the effect, it is not permanent and may be noticed only occasionally.

The possibility of livestock poisoning is worthy of consideration. At one experiment station milk cows when fed small quantities of sodium chlorate became ill and lost their appetites but did not die. For the past three years, thousands of farmers have used sodium chlorate in pastures and not a single case of livestock poisoning in pastures has come to the writer's attention. Until more is known about the effect on livestock it is well to keep salt constantly before them and if possible keep them away from sprayed areas for two or three days.

#### **WHEN SHOULD CHLORATES BE USED**

At present it is impossible to say under what conditions chlorates should or should not be used in Iowa. At the prices which have prevailed during the past three years it costs from \$25 to \$50 per acre to kill quack grass or Canada thistle with the chlorates. For fence lines, roadsides, timber or other permanent pastures or for small spots in cultivated fields the use of chlorates is undoubtedly justified, but for large areas their use is questionable whenever it is possible to cultivate and grow a crop.

#### **"CK 10-90" A New Chemical**

Recently a new weed killer has been produced by the Botany Department, Iowa State College. This product has been found especially effective in killing quack grass along railroad tracks. It is a mixture of creosote and distillate, in the proportions of 1 part creosote and 9 parts distillate. The cost of this mixture when the ingredients are purchased in large quantities is \$5 to \$8 per 100 gallons. It should be applied as a spray or a soil drench using from 3 to 4 quarts per square rod. It is non-injurious to the soil and non-poisonous. It has been shown experimentally that quack grass can be destroyed by making three applications of 150 gallons per acre each, in May, July and September. The cost of killing quack grass, therefore, with "Ck 10-90" is apparently less than with chlorates. This chemical has been tried to a limited degree on horse nettles but not on Canada thistles.

There is no effect of the creosote-distillate combination on the soil. Oats and wheat seed planted a few days subsequent to the treatment germinated and produced normal plants. The seeds of annual weeds have also been observed to germinate soon after an application of the spray if the surface layer is disturbed.



## DEVELOPMENT OF A COMMUNITY PROGRAM

Since more than 50 percent of the farms of Iowa are tenant-operated, it is obvious that no satisfactory community program can be developed without solving the weed problem on these farms. In addition, many owner-operated farms need attention in order to make the program complete.

One of the most important factors in the development of a community program for weed control is the organization and perpetuation of an educational campaign in each county consisting of (1) an organized group that will take the responsibility of keeping the subject of weed control before the public constantly, (2) the establishment of demonstration farms in every township illustrating methods of eradication and (3) the dissemination of information by circular letters, news stories, bulletins and township or county meetings.

The county farm bureaus are well equipped to promote and carry on such a campaign but they need the support of the board of supervisors, the township trustees and weed commissioners. The board of supervisors has the responsibility of enforcing the weed law but laws cannot be enforced without the moral support of the majority of the public; hence, the county officials and the farmers organizations need to work closely together in promoting education on weed control. Every weed commissioner should familiarize himself with weeds and their control, aid in establishing successful demonstrations, give out information in public or private discussion and at all times urge the absolute necessity of community cooperation as the first step in the weed program. It is also essential that the supervisors, trustees and weed commissioners outline and agree on a common goal so that all commissioners will be moving in the same general direction.

If such a campaign as described above is carried on in any county for several years, it will be much easier to enforce the provisions of the weed law\* on those individuals who steadfastly refuse to cooperate for the good of the community. Several counties in Iowa have already made a beginning on a county-wide program of the type described above.

### Landlord-Tenant Relationship

Successful control of weeds on tenant-operated farms is dependent on the type of relationship which the owner establishes with his tenant. Obviously the long-time lease is most conducive to a satisfactory weed control program but in the final analysis the owner must accept the responsibility of solving the problem. When a man moves to a farm he should be made responsible for any patches of bad weeds which he allows to take possession of the land during his tenure, but he should not be expected to use labor for which he gets no return in killing noxious weeds that have been allowed to establish themselves prior to his term of leasing. If a crop can be grown and reasonable returns secured, however, the tenant ought to put in the necessary labor to grow the crop.

The landowner could donate the crop that can be grown on patches infested with persistent perennials to the tenant for one or two years provided the tenant will put in the necessary labor for the destruction of the weeds in question. If cash rent is collected the owner could pay the renter a sum agreed upon by both parties for the extra labor involved. It is also possible to grow a crop and spray the noxious weeds in September or later. With this plan the owner might buy the material and the tenant do the spraying. Whatever the plan, it is evident that the principle of joint responsibility must be recognized and the application made on that basis.

\* For information on the "Iowa Weed Law" write to the Secretary of Agriculture in Des Moines.