Crop Profile for Corn (Field) in Iowa

General Production Information

Major uses in Iowa:

- feed grain
- processing
- silage - 260,770 acres were harvested for silage in 1997.

These acres produced 4,096,921 tons of corn silage.

Table 1. Corn production data for the twelve North Central states, 1997.

Rank	State	Production (billion bu)	Planted (million acres)	Harvested (million acres)	Average yield (bu. per acre)	% U.S. production	value* (billion)
1	***Iowa***	***1.656***	***12.2***	***12.0***	***138***	***17.7***	***3.31***
2	Illinois	1.425	11.2	11.05	129	15.2	2.85
3	Nebraska	1.151	9.0	8.73	132	12.3	2.3
4	Minnesota	0.858	7.0	6.45	133	9.2	1.72
5	Indiana	0.720	6.0	5.85	123	7.7	1.44
6	Ohio	0.462	3.6	3.45	134	4.9	0.92
7	Wisconsin	0.403	3.8	3.05	132	4.3	0.81
8	Kansas	0.386	2.85	2.7	143	4.1	0.77
9	South Dakota	0.333	3.8	3.4	98	3.6	0.66
10	Missouri	0.333	2.95	2.87	116	3.6	0.66
11	Michigan	0.263	2.6	2.25	117	3.2	0.53

19	North Dakota	0.06	0.8	0.61	99	0.6	0.12
U.S. Totals		**9.365**	**80.23**	**73.7**	**127**	**100.0**	**18.73**

*Assuming $2.00 market price per bushel

Production Regions

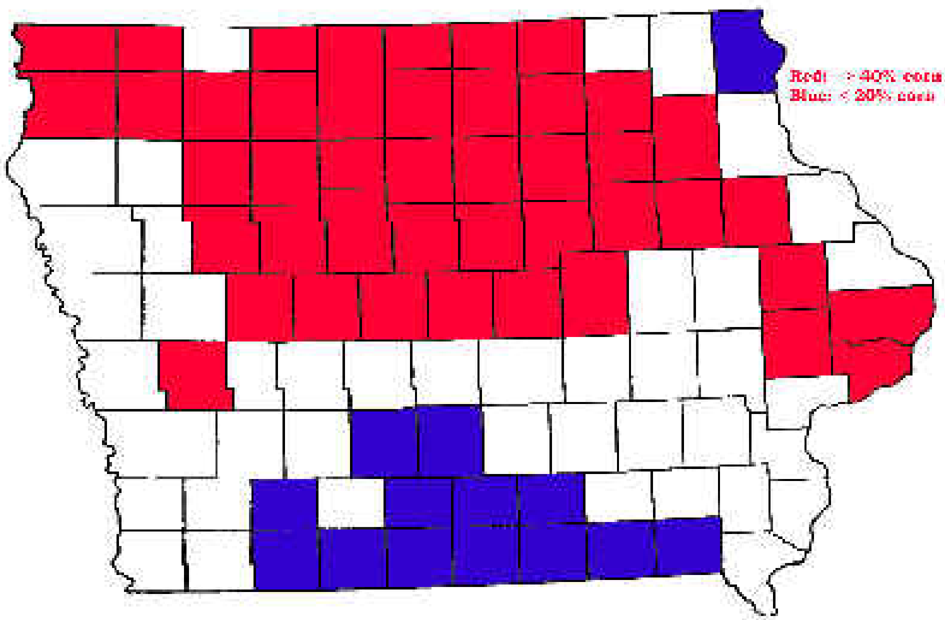


Figure 1. Forty-three counties (red) have more than 40 percent of their farm acres dedicated to corn production. Thirteen counties (blue) in south central Iowa and Allamakee County in extreme northeast Iowa are more dominated with forage production, with less than one fifth of farmland planted to corn annually.

Cultural Practices

Iowa benefits from a temperate climate and deep, fertile soils conducive to intense row crop production. Average annual rainfall ranges from about 25 inches in the extreme northwest corner to over 35 inches in the southeast. In general, soils are neutral to alkaline, and have relatively high water holding capacity. The bulk of Iowa row crop acreage is mollisols and deep entisols in alluvial areas, with a few areas of alfisols where lower organic matter and lower pH are management factors. The combination of climate and soils are ideally suited to production of corn and soybean.

Nearly all corn and soybean acreage is planted in a 6-week period in the mid-spring. Corn planting begins in earnest when soil temperatures approach 50°F, typically in the second week of April, and it is completed by the third week in May, if weather if favorable. Soybean planting usually lags a bit behind the corn, mostly because the growing points of young corn plants remain below ground where it is safe from frost damage for a few weeks, in contrast to soybean which exposes its growing point upon emergence. Crop development in the southern third of Iowa typically leads the northern third by as much as a week and a half during the growing season because of warmer average temperatures.

Operation	"conventional system"	reduced till	"no-till"
Primary tillage/land preparation	Stalk chopping Chisel plow Disk-harrow/field cultivator	Stalk chopping Chisel plow	stalk chopping (opt.)
Planter operations	row-crop planter	planter or grain drill	planter or grain drill
Secondary tillage	row-crop cult. (1-3 passes) rotary hoe	0-1 pass cultivation rotary hoe	rotary hoe (optional)
Harvest	combine	combine	combine

Insect Pests

There are four major insect pests of corn in Iowa, and a number of secondary problems. The insect species that occur are listed below chronologically according to stage of corn development with brief narrative detailing their effects and remedies.

Pesticide classes are indicated as follows:

1. **-**Organophosphate
2. **-**Biological
3. **-**Carbamate
4. **-**Organochlorine
5. **-**Pyrethroid
6. **-**other

GERMINATION, EMERGENCE

Seedcorn maggot is the larva of a small fly. The flies are attracted to fields where relatively fresh manure and other organic material is present. The larvae are maggots that seek out germinating soybean and corn seeds and eat the germ, killing the plant. There are no rescue treatments available for control of seedcorn maggot, so most treatment is made in replant situations.

Chemical controls: Replant treatments (no rescue treatments)

- 1,4 Kernel Guard as a seed box treatment

True white grub [*Phylophaga* sp.], wireworm [*Melanotus* sp.], seedcorn beetle, and slender seedcorn beetle are all insects that attack the germinating corn seed. There are no rescue treatments for control of these insects. Generally, infestations will be in patchy areas in fields, and often damage is likely to recur in suceeding years

Chemical controls: Replant treatments (no rescue treatments)

- 1,4 Kernel Guard as a seed box treatment

VEGETATIVE STAGES

Corn rootworm beetles (western and northern) [*Diarotica* sp.] are the most significant insect pest problem of corn in the U.S. Midwest from the standpoint of insecticide use. Adults lay eggs in the late summer and fall that hatch in early June. Corn rootworms (CRW) larvae feed on a narrow range of host species. In general, a corn-soybean rotation disrupts their life cycle and constitutes the most effective management tool available for farmers. Some populations of northern CRW have shown a life cycle adaptation called extended diapause. Extended diapause occurs when some of the eggs rest through the next summer and hatch the second spring after being laid. With extended diapause, control by a corn-soybean rotation can be defeated. Recently, populations of western CRW have been found in a neighboring statewith adults that lay eggs into soybean fields, but this phenomenon is not widespread to date. Soil-applied insecticide treatment is generally a standard practice in corn acreage following corn targeted to control larvae. Corn rootworm adults occasionally cause economically significant problems when they feed on emerging corn silks. If silk feeding is too severe, pollination suffers with a resulting loss in yield. In addition, some producers scout for significant populations of adults in mid to late summer, and treat for adults to reduce the egg density, and the need for spring soil-insecticide treatment.

***Chemical treatments*:**
(Soil-applied insecticides for larval control)

- 1,5 Aztec 2.1G @ 6.7 ounces per 1,000 ft. of row.
- 1 Counter 15G @ 8 ounces per 1,000 ft. of row.
- 1 Counter CR @ 6 ounces per 1,000 ft. of row
- 5 Force 1.5G @ 8 ounces per 1,000 ft. of row
- 5 Force 3G @ 4 ounces per 1,000 ft. of row
- 3 Furadan 4F @ 2 pints per acre   broadcast post- (at cultivation)
- 1 Lorsban 15G @ 8 ounces per 1,000 ft. of row
- 1 Lorsban 4E @ 6 pints per acre   broadcast PPI
- 1 Thimet 20G @ 6 ounces per 1,000 ft. of row.

(Treatments for adult beetles)

- 5 Ambush 2EC @ 6.4 to 12.8 ounces per acre   at brown silk stage
- 5 Asana XL 0,66 EC @ 5.8 to 9.6 ounces per acre, 21 day pre harvest interval (PHI)
- 3 Furadan 4F @ 0.25 to 0.5 pints per acre, 30 day PHI
- 1 Lorsban 4E @ 1 to 2 pints per acre, 21 day PHI
- 1 Penncap-M @ 1 to 2 pints per acre, 12 day PHI
- 5 Pounce 3.2EC @ 4 to 8 ounces per acre   prior to brown silk stage
- 3 Sevin XL+ @ 2 to 4 pints per acre, no PHI
- 5 Warrior 1E @ 1.92 to 3.2 fluid ounces per acre
- 3 SLAM   semiochemical treatments
- 3 Sevin 80WSP @ 1.25 to 2.5 pounds per acre.   Classified as a bee hazard. 48 days PHI

European corn borer [*Ostrinia nubilalis* (Hubner)] is the pest responsible for the second most insecticide applications to corn. Corn borers overwinter as larvae that pupate once the soil warms sufficiently in the spring. Moths emerge from these pupae in June, where the adults mate and females place eggs on the underside of corn leaves and on other suitable plant species. The moths prefer the tallest corn for oviposition, and when larvae hatch, they feed on leaf tissue. These larvae mature and pupate, with a second emergence of moths, usually occurring in late July and August. Second-generation ECB moths prefer younger corn for oviposition. The newly hatched second generation larvae feed lightly on leaves, but soon bore into leaf midribs, stalks and ear shanks. Economic thresholds for second generation corn borer are difficult to determine. There are predictive models available that help farmers scout and plan treatments if they are needed.

Chemical treatments:

- 5 Ambush 2EC @ 6.4 to 12.8 ounces per acre   at brown silk stage
- 5 Asana XL 0,66 EC @ 5.8 to 9.6 ounces per acre, 21 day pre harvest interval (PHI)
- 3 Furadan 4F @ 0.25 to 0.5 pints per acre, 30 day PHI
- 1 Lorsban 15G @ 5 to 6.5 pounds per acre
- 1 Penncap-M @ 1 to 2 pints per acre (Iowa bee law applies)
- 5 Pounce 1.5G @ 6.7 to 13.3 ounces per acre
- 5 Pounce 3.2EC @ 4 to 8 ounces per acre   prior to brown silk stage
- 2 Bacillus thuringiensis (several trade names): See individual labels for rates
- 5 Warrior 1E @ 2.56 to 3.84 fluid ounces per acre

Black cutworm [*Agrotis ipsilon* (Hufnagel)] is an insect that causes stand losses to young corn in the first month of growth. BCWs do not overwinter in the north central states. Southerly winds carry moths north from overwintering areas along the Gulf of Mexico, and mated females lay their eggs in fields. The moths seem to prefer areas with weeds growing, and also plant residue to lay their eggs, but will lay them in any field. Prophylactic treatment is not recommended, because of the sporadic nature of the infestation patterns and intensities. Scouting based on monitoring degree day accumulations since significant moth flights are detected within an area.

Chemical treatments:

- 1 Lorsban 15G @ 5 to 6.5 pounds per acre
- 5 Ambush 2EC @ 6.4 to 12.8 ounces per acre   at brown silk stage
- 5 Asana XL 0,66 EC @ 5.8 to 9.6 ounces per acre, 21 day pre harvest interval (PHI)
- 3 Furadan 4F @ 0.25 to 0.5 pints per acre, 30 day PHI
- 1 Lorsban 15G @ 5 to 6.5 pounds per acre
- 1 Penncap-M @ 1 to 2 pints per acre (Iowa bee law applies)
- 5 Pounce 1.5G @ 6.7 to 13.3 ounces per acre
- 5 Pounce 3.2EC @ 4 to 8 ounces per acre   prior to brown silk stage
- 2 Bacillus thuringiensis (several trade names): See individual labels for rates
- 5 Warrior 1E @ 1.92 to 3.2 fluid ounces

Stalk borer [*Papaipema nebris*] is a native insect that damages corn by tunneling into the plants and typically destroying the growing points. The damage is typically confined to field areas that are adjacent to borders of perennial grasses, including road ditches, terrace backslopes, and grassed waterways. Large broadleaf weeds, especially hemp (Cannabis sativa) and giant ragweed (Ambrosia trifida) can be favored oviposition sites in the fall, and if these weeds are disseminated throughout the field, general damage can occur. Typically, stalk borer damage is limited to border rows, and treatments can be targeted to those border areas.

Chemical treatments:

- 5 Ambush 2EC @ 6.4 to 12.8 ounces per acre   at brown silk stage
- 5 Asana XL 0,66 EC @ 5.8 to 9.6 ounces per acre, 21 day pre harvest interval (PHI)
- 1 Lorsban 15G @ 5 to 6.5 pounds per acre
- 1 Penncap-M @ 1 to 2 pints per acre (Iowa bee law applies)
- 5 Pounce 1.5G @ 6.7 to 13.3 ounces per acre
- 5 Pounce 3.2EC @ 4 to 8 ounces per acre   prior to brown silk stage
- 2 Bacillus thuringiensis (several trade names): See individual labels for rates
- 5 Warrior 1E @ 2.56 to 3.84 fluid ounces per acre

Corn leaf aphids [*Rophalosiphum maidis*] are colonial sucking insects that can rapidly increase population to cover the emerging tassels and youngest leaves of stage R1 corn plants. Although corn leaf aphid populations approaching 400 per plant are necessary to warrant treatment, such populations do occasionally occur under favorable (dry) weather conditions. The primary damage from large populations is physiological, but secretion of honeydew can cause tassels to gum up and can reduce the effective dissemination of pollen. Scouting is most critical under drought conditions, and seed corn producers must pay special attention to protect pollen availability from inbred lines.

Chemical treatments:

- 5 Ambush 2EC @ 6.4 to 12.8 ounces per acre   at brown silk stage
- 5 Asana XL 0,66 EC @ 5.8 to 9.6 ounces per acre, 21 day pre harvest interval (PHI)
- 5 Warrior 1E @ 2.56 to 3.84 fluid ounces per acre

Corn flea beetles [*Chaetocnema pulicaria* (Melsheimer)] are small insects that feed on corn leaf surfaces where they abrade the surface tissue and cause minor loss of leaf photosynthetic area. Flea beetles play a major role in overwintering and transmission of Stewart s wilt, a bacterial disease of corn. The incidence of Stewart s wilt is generally tied to winter conditions that favor winter survival of corn flea beetles. A model has been developed that is predictive of damage potential. The average air temperatures (in degrees F) for December, January and February are added and if the total is greater than 95, Stewart s wilt is of special concern. If the 3-month sum of averages is below 95, the risk is relatively small.

Chemical treatments:

- Counter 15G @ 8 ounces per 1,000 ft. of row
- Counter CR @ 6 ounces per 1,000 ft. of row
- 3 Furadan 4F @ 0.25 to 0.5 pints per acre, 30 day PHI

Sod webworm [*Crambus* species] is an occasional pest of corn and treatments are rarely required

Chemical treatments:

- Bacillus thuringiensis (several trade names): See individual labels for rates

Hop-vine borer is the larva of a weak-flying moth and is found predominantly in the northeast quadrant of Iowa. Hop vine borers are soil dwelling and feed into the base of young corn plants where they destroy the growing points. Localized infestations can be intense.

Chemical treatments:

- 5 Pounce 3.2EC @ 4 to 8 ounces per acre, 30 day PHI

True Armyworm [*Pseudaletia unipuncta* (Haworth)] damage is characterized by ragged feeding and large amounts of frass (fecal pellets) on plants. The most sever damage occurs in cornfields that are no tilled into grass. The grass is a favored oviposition site for adult moths that arrive from the gulf-coast states on strong southerly winds, similar to black cutworm. Often, the damage to young corn happens suddenly when the grass supply is consumed or when it is killed with a herbicide treatment. No-till fields must be observed closely, and treatments should be based on the presence of small armyworm larvae feeding on the grass.

Chemical treatments:

- 5 Ambush 2EC @ 6.4 to 12.8 ounces per acre at brown silk stage
- 5 Asana XL 0,66 EC @ 5.8 to 9.6 ounces per acre, 21 day pre harvest interval (PHI)
- 3 Lannate LV @ 0.75 to 1.5 pints per acre, 21 day PHI
- 1 Lorsban 15G @ 5 to 6.5 pounds per acre
- 1 Penncap-M @ 1 to 2 pints per acre (Iowa bee law applies)
- 5 Pounce 1.5G @ 6.7 to 13.3 ounces per acre
- 5 Pounce 3.2EC @ 4 to 8 ounces per acre prior to brown silk stage
- 2 Bacillus thuringiensis (several trade names): See individual labels for rates

Two-spotted spider mites [*Tetranychus urticae* (Koch)] are not normally a pest of corn in Iowa. They are controlled during most years in Iowa by a naturally occurring disease. However when there are prolonged periods of low humidity, the fungus is suppressed, allowing the spider mite population to proliferate. If adverse weather conditions continue, re-treatment may be needed.

Chemical controls: spot treatments are recommended; re-infestation is possible.

- 1 Cygon 400 @ 1 pt. per acre, pre harvest interval (PHI) of 21 days. Do not use for forage or straw.
- 1 Lorsban 4E @ 0 .5 to 1 pint per acre, PHI of 28 days. Do not use for forage or straw.
- 1 Dimethoate @ labeled rates (24C registration)

Grasshopper (predominantly 3 species: differential [*Melanoplus differentialis* (Thomas)], two-striped [*Melanoplus bivittatus* (Say)], red-legged [*Melanoplus femurrubrum* (DeGeer)]) are common mid- to late-summer pests of corn in Iowa. These insects hatch in grassy field edges and other grassy areas where they will feed, and then gradually spread into fields. The presence of grasshoppers in border areas is not necessarily a cause of alarm. Greatest yield losses are caused by the loss of leaf area during tassel and silking stages. A 20% loss of leaf area during this time will result in about 7% loss in yield. However, scouting is important, because it is important to only treat when the population reaches economic thresholds. Adult grasshoppers are most easily controlled with some of the pyrethroid and carbamate insecticides.

Chemical treatments:

- 5 Ambush 2EC @ 6.4 to 12.8 ounces per acre at brown silk stage
- 5 Asana XL 0,66 EC @ 5.8 to 9.6 ounces per acre, 21 day pre harvest interval (PHI)
- 3 Furadan 4F @ 0.25 to 0.5 pints per acre, 30 day PHI
- 1 Lorsban 15G @ 5 to 6.5 pounds per acre
- 1 Penncap-M @ 1 to 2 pints per acre (Iowa bee law applies)
- 5 Pounce 1.5G @ 6.7 to 13.3 ounces per acre
- 5 Pounce 3.2EC @ 4 to 8 ounces per acre prior to brown silk stage
- 2 Bacillus thuringiensis(several trade names): See individual labels for rates

Diseases

Diseases reduce yields to some extent every year in corn production. Diseases also are responsible for reductions in grain and seed quality. Disease losses vary from year to year, and their occurrence is strongly influenced by weather conditions. Some diseases occur commonly but may not cause much damage; some have the potential to be very serious.

Much of the following information is taken from *Corn Diseases*, Iowa State University Publication Pm-596.

Seed decay and seedling blight	Stalk rots
Root rots	Ear and kernel rots
Foliage and aboveground diseases	Fungicide information

Seed Decay and Seedling Blight

These diseases are generally caused by soil-inhabiting fungi such as *Pythium, Fusarium, Diplodia Rhizoctonia,* and *Penicillium*. These fungi also may be seedborne, except for *Pythium*. Seeds may be rotted before germination or the seed may germinate and the seedling infected and blighted (damping-off). This can occur as either pre-emergence damping-off or post-emergence damping-off. Damping-off is favored by cool, wet soils, so it is more common in low-lying or poorly drained areas or in fields planted too early in the spring. Heavy residue on the soil surface can favor damping-off by suppressing soil temperature and drying. Other factors that delay germination and emergence such as herbicide damage, compaction, crusting, or planting too deep, can result in more seedling blight.

Control

Damping-off is generally controlled by seed treatment with a fungicide such as fludioxonil, captan, or metalaxyl, standard on almost all seed corn. This is sufficient in most cases, but not under severe conditions. Plant corn when the soil temperature is above 50°F and soil moisture is not excessive. Seeds should not be planted too deep; about 1 1/2 to 2 inches is best, depending on soil conditions.

Root Rots

Root rots of corn are very common, and can be caused by a number of fungal pathogens including *Pythium graminicola, Fusarium graminearum* and other *Fusarium* species, and *Exserohilum pedicellatum*. Losses to root rots vary substantially from year to year, and are difficult to estimate. Root rots occur to some extent in every field. But under wet conditions, root rots cause economic losses. Wet soil conditions predispose plants to root rots because of oxygen deficiency, and the root rot fungi thrive under these conditions. Highly compacted or otherwise poorly drained soils are particularly prone to root rots. Many of the stalk rot pathogens enter through the roots and cause a root rot in advance of the stalk rot.

Control
Under good growing conditions losses to root rots are negligible, and control measures are not necessary. Most hybrids are tolerant to some degree of root rot. Some hybrids are more resistant than others, but high levels of root rot resistance are not available. Improved drainage reduces the risk of root rots when wet conditions occur. Soil drying can be enhanced through a reduction in surface residue or cultivation, but the value of these practices in reducing root rot has not been demonstrated.

Foliage and Aboveground Diseases

Eyespot

Eyespot is caused by the fungus *Aureobasidium zeae*, previously known as *Kabatiella zeae*. This fungus overwinters in corn residue and in wet conditions produces conidia that are spread by splashing water and wind. The disease is much more common when corn follows corn. Eyespot may appear early in the season on lower leaves and again near the end of the season on upper leaves. It is more prevalent in the northern part of the Corn Belt.

Control
Resistant hybrids are available. Inoculum can be reduced by crop rotation or reducing surface residue through tillage. In reduced tillage systems, resistance and rotation are very important control measures.

Fungicides can be used to control leaf diseases in corn, but usually they are economical only in seed corn, popcorn, or sweet corn production. Registered fungicides include mancozeb, propiconazole, chlorothalonil, and others. Check fungicide labels for specific diseases controlled, and check with your extension specialist for current information on available fungicides. To be effective, a fungicide program must be started when the disease is at very low levels (1 percent or less of leaf area affected). More than one application is necessary when conditions are favorable for disease.

Common smut

Common smut is caused by the fungus *Ustilago zeae*, previously known as *Ustilago maydis*, which overwinters in corn residue or soil. This fungus produces black teliospores that are resistant to environmental conditions, so that they can survive well in soil. These teliospores germinate during the spring and summer, with each teliospore then producing four smaller spores, called sporidia. These are spread by wind and water. All above ground plant parts are susceptible, especially the actively growing meristematic tissue. Sporidia can infect through unwounded cells, but wounds caused by insects, detasseling, cultivation, hail, or blowing soil are important infection sites as well. Disease is favored by excess nitrogen, excess manure or herbicide injury, and relatively dry, warm weather.

Control

Some hybrids are less susceptible than others. Rotation and tillage will not affect the occurrence of smut, since the teliospores survive well in the soil. Avoiding mechanical damage through cultivation can reduce the risk of disease. Maintenance of balanced fertility and avoiding herbicide injury also will reduce the risk of disease.

Northern Corn Leaf Blight

Northern leaf blight is caused by the fungus *Exserohilum turcicum*, previously called *Helminthosporium turcicum*. This has traditionally been the most consistently damaging leaf disease of field corn in the northern Corn Belt, but its severity has decreased due to improvements in resistance. It occurs throughout the eastern half of the United States, as far west as eastern Nebraska. The fungus overwinters as mycelium and spores in corn residue. Spores are dispersed by wind and splashing water. Disease development is favored by extended periods of leaf wetness (rain or dew) and moderate temperatures (64-81°F). There are at least four races of the fungus.

Control

Northern leaf blight can be controlled by two types of resistance, monogenic or polygenic. The monogenic Ht resistance does not confer resistance to all races of the fungus. Hybrids with an Ht gene may become susceptible if new races appear in the area. Polygenic resistance confers resistance to all races, but the resistance is not as absolute as Ht resistance. The level of polygenic resistance varies among hybrids. Inoculum can be reduced by crop rotation or reducing surface residue through tillage. In reduced tillage systems, resistance and rotation are very important control measures.

Fungicides can be used to control leaf diseases in corn, but usually they are economical only in seed corn popcorn, or sweet corn production. Registered fungicides include mancozeb, propiconazole, chlorothalonil, and others. To be effective, a fungicide program must be started when the disease is at very low levels (1 percent or less of leaf area affected). More than one application is necessary when conditions are favorable for disease.

Helminthosporium leaf spot

Helminthosporium leaf spot or northern leaf spot is caused by the fungus *Bipolaris zeicola*, previously known as *Helminthosporium carbonum*. There are five known races of this fungus with different virulence characteristics and symptoms. Race 0 is nearly avirulent to corn, and race 1 is virulent on only a few genotypes. Races 2 and 3 are the most common races in the Midwest. Race 2 is not specific for corn genotypes, while race 3 is only a problem on certain susceptible lines. A fifth race has been reported recently. B. zeicola overwinters as mycelium and spores in corn residue, and the spores are dispersed by wind and splashing water. It is favored by high humidity and moderate temperatures.

Contol

Resistant hybrids and inbreds are available. Inoculum can be reduced by crop rotation or reducing surface residue through tillage. In reduced tillage systems, resistance and rotation are very important control measures.

Fungicides can be used to control leaf diseases in corn, but usually they are economical only in seed corn, popcorn, or sweet corn production. Registered fungicides include mancozeb, propiconazole, chlorothalonil and others. To be effective, start a fungicide program when the disease is at very low levels (1 percent or less of leaf area affected). More than one application is necessary when conditions are favorable for disease.

Anthracnose leaf blight

Anthracnose leaf blight is caused by the fungus *Colletotrichum graminicola*, the same fungus that causes anthracnose stalk rot (see page 16). It overwinters as mycelium or sclerotia in corn residue or seed. Several weed species also are hosts and may act as inoculum sources. Spores are spread primarily by splashing water. Disease development is favored by wet weather with moderately warm temperatures. Anthracnose is much more common where corn follows corn. Anthracnose is usually more severe in the eastern corn states, but its importance in the Midwestern states is increasing.

Control

Resistant hybrids are available, but resistance to anthracnose leaf blight and anthracnose stalk rot are not necessarily found in the same hybrid. Inoculum can be reduced by crop rotation or reducing surface residue through tillage. In reduced tillage systems, resistance and rotation are very important control measures.

Fungicides can be used to control leaf diseases in corn, but usually they are economical only in seed corn, popcorn, or sweet corn production. Registered fungicides include mancozeb, propiconazole, chlorothalonil, and others. To be effective, a fungicide program must be started when the disease is at very low levels (1 percent or less of leaf area affected). More than one application is necessary when conditions are favorable for disease.

Gray leaf spot

Gray leaf spot is caused by the fungus *Cercospora zeae-maydis*. This disease is a problem in the eastern United States, and it has grown in importance in the western Corn Belt as far west as central Nebraska. In Iowa, gray leaf spot is much more common in the southern half of the state. It is particularly severe when corn follows corn. The fungus survives as mycelium in corn residue, and spores are dispersed by wind and splashing water. Sporulation and disease development are favored by warm, humid weather.

Control

Some hybrids are more resistant to gray leaf spot, but control may no t be adequate in some areas. Inoculum can be reduced by crop rotation or reducing surface residue through tillage. In reduced tillage systems, resistance and rotation are very important control measures.

Fungicides can be used to control leaf diseases in corn, but usually they are economical only on very susceptible hybrids or in seed corn, popcorn, or sweet corn production. Registered fungicides include mancozeb, propiconazole, chlorothalonil and others. Check fungicide labels for specific diseases controlled. To be effective, a fungicide program must be started when the disease is at very low levels (1 percent or less of leaf area affected). More than one application is necessary when conditions are favorable for disease. For more information see ISU Extension publication Corn Gray Leaf Spot, IPM-49. Each year corn hybrids entered in the Iowa Crop Performance Test are evaluated for gray leaf spot severity.

Stewart's Disease

This disease, also called Stewart's wilt or bacterial wilt, is caused by the bacterium *Erwinia stewartii*, which overwinters in the gut of the corn flea beetle (*Chaetocnema pulicaria*). The occurrence of this disease is strongly linked to the winter survival rate of the corn flea beetle (Figure 24), because the beetle introduces the pathogen into the corn plants as it feeds and carries the bacterium from plant to plant. The beetles survive in high numbers following a mild winter, resulting in high disease levels. If the sum of the mean monthly temperatures for December, January and February is 90°F or more, the beetles will survive and the threat of Stewart's wilt is high. This disease is more common in the southern and eastern parts of the Corn Belt. Dent corn is not very susceptible except for a few inbreds, but sweet corn can be very susceptible.

The disease can be spread by insects other than the flea beetle, but they are not as important. Stewart's disease is also seedborne, but seed transmission is very rare.

More information can be found in Iowa State University Extension publication Corn Stewart's Disease, Pm-1627.

Control
Most cultural practices do not influence Stewart's disease because the pathogen survives in the flea beetle. Weed control may have some effect because the insects prefer grassy weeds and damage to corn is highest in weedy fields. Most hybrids are resistant enough that no further management is required. If flea beetle numbers are extremely high, and insecticide applications can reduce the beetle population and the disease spread. This will occur only after a very mild winter. In seed production with susceptible inbreds, an insecticide may be justified more often.

Stalk Rots

Stalk rots are a consistent problem in corn production, causing yield losses through premature plant death and/or lodging. When plants die prematurely, the result is poor yields and low test weight grain. If a plant with severe stalk rot survives to maturity, yield may not be greatly affected. However, rotted stalks will easily lodge, making harvest impossible. Stalk rots are caused by several different fungi that infect plants through the roots or through wounds in the stalk. The major stalk rot pathogens are *Gibberella zeae*, *Fusarium* species, and *Colletotrichum graminicola* (anthracnose). The occurrence of stalk rots is strongly affected by stresses on the corn plant during the grain filling stage of development. Any conditions that reduce photosynthesis and the production of sugars can predispose the plant to severe stalk rot. Such stresses include severe leaf diseases or hail damage, drought or soil saturation, lack of sunlight, extended cool weather, low potassium in relation to nitrogen, and insect damage. Insects such as the European corn borer cause stress to the plant as well as providing wounds for entrance of the stalk rot fungi. Many stalk rot infections can be traced back to stalk boring insect wounds. Early maturing hybrids sometimes suffer more stalk rot damage than full-season hybrids.

Control of Stalk Rots
In general, losses to stalk rots can be reduced by scouting fields 40 to 60 days after pollination and looking for symptoms or pinching stalks. If more than 10 to 15 percent of stalks are rotted, the field should be scheduled for the earliest possible harvest. Severe stalk rot can be avoided by reducing the stresses that predispose plaints. This means balanced fertilization, appropriate plant population and adapted hybrids, insect and weed control, avoidance of root and stalk injury, good drainage, proper irrigation (where applicable), and using hybrids that are resistant to foliar diseases. Resistance is available for some stalk rots, and some hybrids are tolerant of stalk rots (will not lodge even if rotted). For more information see ISU Extension publication, *Corn Stalk Rot in Iowa*, IPM-50.

Ear and Kernel Rots
Fusarium Rots

Fusarium ear and kernel rot is the most common ear disease in the Midwest. It is caused by several fungi in the genus *Fusarium*, but *F. moniliforme* is considered to be the primary species on corn in the Midwest. Fusarium ear rot occurs under a wide range of weather conditions. The fungus causes a stalk rot and can colonize any part of the corn plant, overwintering in the corn residue and on dead grassy weeds. *F. moniliforme* also is commonly found in corn seed. *Fusarium* spores are spread by wind and splashing rain to the silks, which are most susceptible for the first 5 days after they appear. Infections also occur through wounds made by insects or other types of wounds in the kernels. There is some evidence that insects act as vectors of *Fusarium*. *F. moniliforme* can grow throughout the corn plant, and some ear infections may be the result of the fungus entering the ear through the shank. Several of the *Fusarium* species causing corn ear rot can produce harmful mycotoxins, so caution should be used in feeding molded corn. *Fusarium* species usually do their damage in the field, but they can be a problem in storage if grain moisture is 18 percent or above.

Gibberella ear rot

This ear rot is common throughout the Midwest. It is caused by the fungus *Gibberella zeae* which is the sexual reproductive stage of *Fusarium graminearum*. This fungus also causes a stalk rot, and overwinters in corn residue. The spores are spread by splashing rain and wind infecting ears through the silks. Silks are most susceptible 2 to 6 days after emergence. The disease is favored by cool, wet weather after silking. This is the most consistently important mycotoxigenic fungus in the northern corn belt, producing vomitoxin, zearalenone, and other toxins. *Fusarium* species usually do their damage in the field, but they can be a problem in storage if grain moisture is 18 percent or above.

Diplodia ear rot

Diplodia ear rot is caused by the fungus *Diplodia maydis* (*Stenocarpella maydis*), which also causes Diplodia stalk rot. This disease is not typically as common as Fusarium or Gibberella ear rots, but it can be destructive when it occurs. The fungus overwinters as mycelium, spores, and pycnidia on corn residue or seed. The spores are spread primarily by splashing rain. The infection process for this disease is poorly understood, but infections first appear at the base of the ear. Corn borer damage in the shank can provide an entry wound for the pathogen. Diplodia is rot is favored by cool, wet weather during grain fill. Rainfall during August, September, and October is correlated with Diplodia ear rot incidence. *D. maydis* is not known to produce harmful mycotoxins. *Diplodia maydis* usually does its damage in the field, but it can be a problem m storage if grain moisture is 20 percent or above.

Control of ear and kernel rots

Control of the various ear and kernels rots can be achieved by similar practices. Prevention of their occurrence is difficult because of their dependence on weather and the limited affects of cultural practices. Control of these diseases places an emphasis on harvest and grain handling.

- Plant more resistant hybrids. Resistance to the ear rots varies among hybrids, although complete resistance is not available. Hybrids with tight husk coverage and ears that do not remain erect after maturity tend to suffer less damage.
- Crop rotation can reduce the occurrence of some ear rots, such as Diplodia. Others may not be affected much because of the movement of spores from neighboring fields. Insect control may reduce ear rots to some extent.

- Scout fields as the corn begins to dent and identify areas with mold problems. Harvest these areas as soon as possible to prevent further mold development.
- Properly adjusted combines will reduce kernel damage. Damaged kernels are more susceptible to mold development. Combine adjustments also can be used to help discard light weight, moldy kernels during combining.
- Cleaning grain before drying will remove fine particles which are often the moldiest and most toxic component of grain.
- Moldy grain should be dried immediately and rapidly to 15 percent or less (13-14 percent for long-term storage). Holding this grain for even a short time can result in substantial mold and toxin development. Grain that does not have obvious mold problems also should be dried immediately, but there may be more economical options to rapid, high-temperature drying.
- Cool the grain after drying.
- Clean bins before storing new grain.
- Aerate and stir stored grain; periodically check for condensation and mold growth.
- Control storage insects.
- Antifungal agents such as propionic acid can retard mold growth in storage, but they do not kill fungi already present or destroy toxins that are already formed. These compounds have some disadvantages in Test molded grain for mycotoxins prior to feeding.

For more information, see ISU Extension publication, *Corn Ear Rots, Storage Molds, Mycotoxins, and Animal Health*, Pm-1698.

Data on percent crop treated are estimates provided for this report by Iowa State University Extension specialists.

Fungicide information

mancozeb

- **Trade name and formulation:** Dithane (M-45, DF, F-45 formulations), Penncozeb 75DF and 80WP,
- **Percent crop treated:** <1%
- **Use rates:** 1.125 lb a.i./A
- **Application timing:** start applications at onset of symptoms and, depending on severity, continue on a 4 to 14 day schedule.
- **Pre-harvest interval:** 40 days
- **REI:** 24 hours
- **Component of other products:** Ridomil Gold MZ, Ridomil MZ
- **Primary use:** helminthosporium leaf blights, common rust

propiconazole

- **Trade name and formulation:** Tilt
- **Percent crop treated:** 2%
- **Use rates:** 0.05-0.1 lb a.i./A
- **Application timing:** apply at onset of symptoms and continue on a 7 to 14 day schedule.
- **Pre-harvest interval:** 30 days. Do not apply after corn silking stage.
- **REI:** 24 hour

- **Component of other products:** none
- **Primary use:** helminthosporium leaf blights, gray leaf spot, common rust

captan

- **Trade name and formulation:** various
- **Percent crop treated:** 20%
- **Use rates:** 0.62 - 1.18 oz/100 lbs. seed
- **Application timing:** seed treatment
- **REI:**
- **Primary use:** seed treatment for seed rots and seedling blights

carboxin

- **Trade name and formulation:** Vitavax 34
- **Percent crop treated:** <1%
- **Use rates:** 0.8 - 0.16 oz a.i./100 lbs seed
- **Application timing:** seed treatment
- **REI:**
- **Primary use:** seed treatment for seedling diseases and seedborne head smut

chlorothalonil

- **Trade name and formulation:** Bravo 500, Bravo 720
- **Percent crop treated:** <1%
- **Use rates:** 2.25 - 3 lb a.i./A
- **Application timing:** postemergence at onset of symtpoms at 4-7 day intervals.
- **Pre-harvest interval:** 14 days
- **Application timing:** seed treatment
- **REI:** 24 hours
- **Primary use:** rust, helminthosporium leaf blights

fludioxonil

- **Trade name and formulation:** Maxim 4FS
- **Percent crop treated:** 80%
- **Use rates:** 0.04 oz a.i./100 lbs seed
- **Application timing:** seed treatment
- **REI:**
- **Primary use:** seed treatment for seed rots and seedling blights

mefonoxam

- **Trade name and formulation:** Apron XL
- **Percent crop treated:** projected to be >80% in year 2000
- **Use rates:** 0.016 - 0.032 oz a.i./100 lbs
- **Application timing:** seed treatment

- **REI:**
- **Primary use:** seed treatment for pythium
- **Component of other products:** Maxim XL

metalaxyl

- **Trade name and formulation:** Apron 50W, Ridomil
- **Percent crop treated:** 99%
- **Use rates**: 0.032 - 0.5 oz a.i./100 lbs seed
- **Application timing:** seed treatment
- **REI:** 12 hours
- **Primary use:** seed treatment for seed rots and seedling blights

thiram

- **Trade name and formulation:** 42-S Thiram
- **Percent crop treated:** ,1%
- **Use rates:** 0.75 oz a.i./bu
- **Application timing:** seed treatment
- **REI:**
- **Primary use:** seed treatment

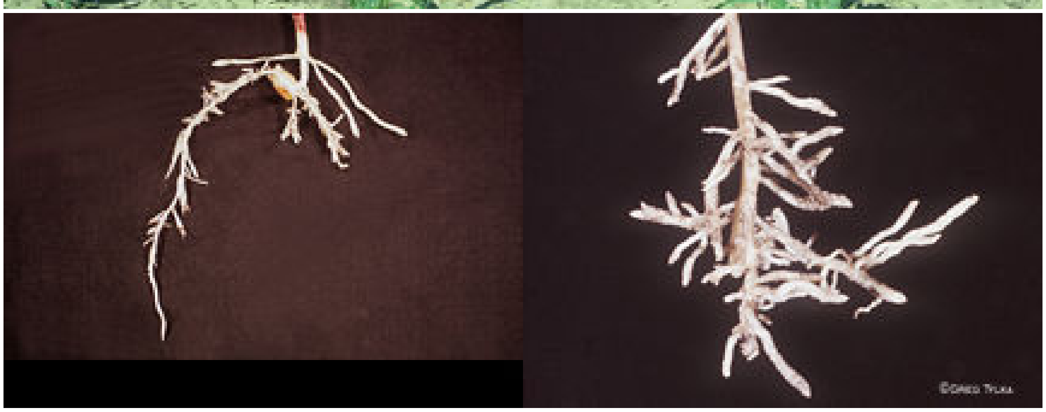
Nematodes

Every cornfield in Iowa contains nematodes actively feed on plants. Nematodes that attack corn are microscopic roundworms, approximately 3/10 to 3/64 inch long. The presence of nematodes depends on the soil type and its properties, other soil microorganisms, cropping history, climatic factors such as temperature and rainfall, tillage practices, and the use of pesticides.

There are many species of nematodes that feed on corn in Iowa. Dagger and spiral nematodes may be the most common and widespread nematodes that feed on corn in Iowa. Needle nematode probably is the most damaging, but is not widespread throughout the state. The most important species that is a parasite on corn in Iowa probably is the lesion nematode.

In general, damage to corn from plant-parasitic nematodes results in poor or uneven stands if high nematode densities occur early in the season. Symptoms also include yellowing or chlorosis of foliage, unevenness in the height of the corn plants, and small or poorly filled ears during mid- to late-season. The symptoms and damage caused by plant-parasitic nematodes can occur in distinct patches or "hot-spots" that often elongate in corn fields in the direction of tillage operations. Damaged corn roots will be stunted, discolored, swollen, and lacking fine roots, and may contain dark brown or black lesions. However, other factors also can cause these types of above-ground and below-ground symptoms, so nematode damage easily can be misdiagnosed.

Uneven stand and yellowing of corn foliage caused by plant-parasitic nematodes.



Nematode damage to corn roots may look similar to herbicide damage.
Left: herbicide damage; right: nematode damage

Corn nematodes can feed without causing appreciable yield loss if nematode numbers are low and/or the environmental conditions are such that the corn crop is not stressed. Much is still unknown about the nematode population densities needed to cause damage to the many corn hybrids grown throughout Iowa, and about the environmental and host factors involved in the build-up of nematode densities.

Management options for control of nematodes on corn are limited. Many effective nematicides have been removed from the market and very few new nematicides are being developed, but a few compounds (including some soil insecticides) are still labeled for control of plant-parasitic nematodes on field corn. Cultural control strategies such as crop rotation, delayed planting, and alternative tillage have little effect on corn nematode densities and nematode-resistant corn hybrids are lacking. More information about plant-parasitic nematodes that affect corn in Iowa is available in an ISU Extension publication, *Nematodes That Attack Corn in Iowa*, Pm-1027.

Weeds

Annual weed species comprise a majority of the weed control problems in Iowa corn production. Many of the primary weed species are introduced rather than native. The most troublesome weeds are those adapted to the two-crop rotation system primarily used in Iowa. Weeds that are able to germinate in the spring following primary tillage, compete with the crop, and produce seed before frost or harvest are the most common. However, as the amount of tillage in Iowa row-crop production decreases, there has been an increase in the frequency of perennial and biennial weed problems.

Weeds reduce corn yield primarily by competing for water, sunlight and nutrients, thus diminishing total corn yield potential. Heavy weed infestations can also affect harvest efficiency by increasing grain moisture content at harvest and increasing foreign material levels in harvested grain, both resulting in added cost to the producer.

Current information regarding weed management in Iowa can be found at http://www.weeds.iastate.edu

Annual grasses

Annual grasses infest approximately 98% of all corn acres in Iowa. Many of these are controlled with preemergence herbicide applications and tillage. While not as competitive as broadleaf weed species, annual grasses can reduce crop yields when significant populations are present. In most weed management programs, control of grasses is of secondary concern to control of broadleaf weed species. Of the many species present, three of the most prevalent are discussed below.

Foxtails

There are three important foxtail species in Iowa: giant foxtail (*Setaria faberi),* yellow foxtail *(Setaria glauca),* and green foxtail (*Setaria viridis).* At least one of these species infest nearly 100 percent of the corn acres in Iowa. While low populations cause little crop competition, because of seed production an unchecked population can quickly become a severe problem. None of these species is native to Iowa.

A primary control method for foxtail spp. is the application of preemergence grass herbicides. These provide early season control, reducing early season competition with the corn.

Woolly cupgrass

Woolly cupgrass (*Eriochloa villosa* [Thunb.] Kunth.) is a relatively new and potentially serious weed problem in Iowa. Woolly cupgrass was first collected in 1957 from one county in Southwest Iowa and it is currently distributed throughout most Iowa counties. The spread has increased rapidly in the last 10 to 15 years and is currently estimated to infest over 20% of Iowa cropland. Woolly cupgrass populations have increased rapidly in the last decade and the distribution has spread widely.

This annual grass weed demonstrates biological, biochemical, and morphological characteristics that make it economically damaging and adds to the difficulty in developing effective management strategies. Woolly cupgrass is a prolific seed producer. This seed tends to germinate earlier and at higher populations than other annual grass weeds. Woolly cupgrass has demonstrated tolerance to most herbicides commonly used for control of annual grasses in corn.

Shattercane

Shattercane (*Sorghum bicolor)* is an annual grass that is found only in cultivated fields where it reseeds itself. Shattercane is commonly found in areas where forage sorghum has been grown. All sorghums are members of the same species and can hybridize. It may develop if seeds from hybrid grain or forage sorghums are allowed to grow and flower through several generations. Therefore, it is highly variable. While found in areas throughout the state, it is more prevalent in the southern and western regions of Iowa.

Other annual grasses of economic importance in corn:

- barnyardgrass (*Echinochloa crusgalli*)
- fall panicum (*Panicum dichotomiflorum)*
- wild proso millet (*Panicum miliaceum)*

Perennial grasses

Perennial grasses were once a severe problem in Iowa corn production prior to herbicides and when pasture was a standard part of the crop rotation. With the introduction of effective herbicides and decline in pasture rotations, many perennial grasses have declined in importance.

Quackgrass

Quackgrass (*Agropyron repens)* is a perennial grass that spreads by rhizomes. These rhizomes are effectively spread by tillage, increasing the scope of the population in a field. While quackgrass can be found in nearly every county in Iowa, it is more common in small grains and lawn areas than in corn production. Tillage is an effective control by depleting food reserves and bringing rhizomes to the surface. Atrazine is also provides excellent control.

Wirestem muhly

Wirestem muhly (*Muhlenbergia frondosa)* is a perennial grass that reproduces by seeds and underground rhizomes. It is native to Iowa. It was not considered a common row crop weed until the 1950's when serious infestations developed in cultivated fields. Wirestem muhly is most common as a weed of cultivated fields in northeast and east central Iowa. Delayed seedbed preparation will help control wirestem muhly in corn by bringing rhizomes to the soil surface to dry out.

Johnsongrass

Johnsongrass (*Sorghum halepense)* is nearly identical to shattercane. Listed as a noxious weed in Iowa, it is commonly found in rich soils and can be a problem in overflow areas. As a sorghum species, it is a result of hybridization of grain and forage sorghums. Johnsongrass produces large rhizomes that can be spread throughout the field making it difficult to contain and control. Johnsongrass is more common in the southern and western portions of Iowa.

Annual broadleaves

Annual broadleaf weed species are the main weed management target in Iowa corn production. Velvetleaf (*Abutilon theophrasti)* is one of the most common broadleaf weeds found in Iowa, infesting nearly 90 percent of all corn acres. Common cocklebur (*Xanthium strumarium)* is found on approximately 60 percent of the corn acres. Common sunflower (*Helianthus annuus)* infests 50 percent of Iowa corn acres. These three weeds can provide significant crop yield reduction because of their aggressive growth habit, canopy structure, and competitiveness.

Waterhemp
Common waterhemp is a relatively new weed problem in Iowa. However, common waterhemp is a native species that has been identified by botanists in the historic taxonomic records. Currently, common waterhemp is a serious weed problem throughout Iowa. There have been changes in agricultural practices that have favored this weed. These changes include reductions in tillage, herbicide selection, simplified crop rotations, and recent weather patterns that have resulted in the relatively rapid rise in importance of common waterhemp to Iowa agriculture. Because waterhemp is a relatively new weed problem, there has been little research conducted. Most of the research has focused on the relationship of this weed complex with herbicides. Specifically, there have been many studies documenting difficulties in controlling common waterhemp with herbicides that inhibit acetolactate synthase (ALS) activity.

There are many factors that have contributed to the increase in common waterhemp populations in Iowa. Studies have shown the common waterhemp emerges late in the growing season when compared to other annual broadleaves such as velvetleaf (*Abutilon theophrasti*). Over the past few years, a common pattern of waterhemp emergence has been emergence approximately two weeks after velvetleaf and continuing for two months. Velvetleaf demonstrated a relatively short germination period of three weeks. In many weeds, late emergence is not a major management issue because the crop canopy effectively competes with the weed. However, common waterhemp is able to emergence late and grow through the crop canopy. The survival of emerged waterhemp is highly dependent on environmental conditions. Abundant rainfall during the growing season will promote high waterhemp populations.

Other biological characteristics that contribute to the rapid increase in common waterhemp populations are high seed production and an ability to germinate from shallow soil depths. Small-seeded annual weeds like common waterhemp must be near the soil surface to successfully germinate and emerge. Reduced and no tillage systems which have increased in the Midwest favor the establishment and success of common waterhemp populations.

Control of common waterhemp has become increasingly difficult due to resistance to ALS-inhibiting herbicides. Waterhemp has demonstrated cross-resistance to all herbicides with this mode of action.

Other broadleaf weeds of economic significance in Iowa corn production:

- redroot pigweed (*Amaranthus retroflexus)*
- lambsquarter (*Chenopodium album)*
- Pennsylvania smartweed (*Polygonum pensylvanicum)*
- common ragweed (*Ambrosia artemisiifolia)* and giant ragweed (*Ambrosia trifida)*

Perennial broadleaves

The occurrence of perennial broadleaf weeds is highly dependent on the tillage regime used in corn production. Since most perennial broadleaf weeds do not tolerate tillage, these weeds are more of a problem in reduced tillage and no-till operations.

Swamp smartweed (*Polygonum coccineum)* is commonly found in low, wet areas of fields. Because of an extensive root system it is a strong competitor with corn and difficult to eradicate. Because of it's similarity to Pennsylvania smartweed, an annual, many producers incorrectly identify this weed.

Field bindweed (*Convolvulus arvensis)* and hedge bindweed (*Convolvulus sepium)* are vining weeds commonly found in both cultivated and no-till fields. These weeds can rapidly engulf corn rows in vines reducing corn growth and yield. The extensive mass of vines also makes harvest very difficult.

Herbicide Control

Herbicides continue to be the primary strategy used for corn weed management in Iowa. Ninety-nine percent of Iowa corn acres were treated with at least one herbicide in 1995.

Atrazine continues to be the most widely used herbicide on corn. The percentage acres treated with atrazine increased even with the new restrictions placed on its use in 1993. In 1995, 67% of the acres were treated with atrazine, compared to 61% in 1990 and 49% in 1985. The continued growth in atrazine use is largely due to its popularity as a tank-mix partner with other postemergence products. This practice allows atrazine to be used at rates less than 1 lb per acre, therefore reducing the risk of carryover that has limited atrazine use in many areas of Iowa.

There has been a large change in herbicides used for controlling grasses in corn. Alachlor (Lasso) was used on 22% of the corn acres in 1990 but dropped to 2% in 1995. The two thiocarbamate herbicides, EPTC (Eradicane) and butylate (Sutan+) decreased from use on 14% of the acres in 1990 to 4% in 1995. In 1979 these three herbicides were used on over 70% of the corn acres. Acetochlor, introduced in 1993, was used on 26% of the acres in 1995.

Postemergence herbicides have increased in importance. In 1979, approximately 30% of the corn acres were treated postemergence for weed control. It is estimated that over 70% of the corn acres were treated after crop and weed emergence in 1995. The leading postemergence products include dicamba (36%), bromoxynil (15%), and nicosulfuron (14%). A significant percentage of these products would have been applied in combination with atrazine.

Almost four times as much herbicide was applied to corn than to soybeans. The primary reason for this is differences in specific activity of the major herbicides used in the two crops. For example, metolachlor and trifluralin are the leading herbicides for grass control used in corn and soybeans, respectively. A typical use rate for metolachlor in Iowa is 2.5 lb per acre, whereas a typical rate of trifluralin would be 0.8 lb per acre. Although there was little change in the percentage of corn and soybean acres treated with herbicides, the total amount of product applied in the state continues to decline. This is largely due to the increasing popularity of new herbicides that are used at very low rates (less than 0.1 lb per acre), rather than changes in weed management systems that allow reductions in herbicide use.

The following is a review of the primary herbicide active ingredients currently used in Iowa corn production. Herbicides are grouped according to primary mode of action. Many times herbicides within a mode of action will control a similar spectrum of weeds and have similar use properties. Products that are package mixes are listed under the primary active ingredient with other ingredients noted. Information on acreage treated, if available, is from the *1995 Survey of Pesticide Use in Iowa*. For products or active ingredients introduced since the 1995 survey, no use data is provided.

[ALS-inhibitors and amino acid derivatives](#)
[PSII inhibitors (non-mobile)](#)
[Shoot inhibitors](#)
[Root inhibitors](#)
[Growth regulator](#)
[Pigment synthesis inhibitor](#)
[Unclassified](#)

ALS-inhibitors and amino acid derivatives

flumetsulam

- **Trade name and formulation:** Python 80WDG
- **Percent crop treated:** 0.5%
- **Use rates:** 0.6 - 1.1 oz a.i./A
- **Application timing:** can be applied preplant incorporated, preemerge or postemerge. Python can be applied from 30 days prior to planting until corn spike stage. Hornet can be applied from 30 days prior to planting until corn is 20 inches high. Scorpion III can be applied postemerge prior to the V4 growth stage or 8 inches.
- **Pre-harvest interval:** 85 days
- **REI:** 12 hours (Python)
- **Component of other products:** Broadstrike+Dual, Hornet, Scorpion III, Accent Gold
- **Comments:** Primary activity is on broadleaf species. Shows good to excellent control of pigweed species (non-resistant), velvetleaf and smartweed.

halosulfuron

- **Trade name and formulation:** Permit 75WDG
- **Percent crop treated:** 1.9%
- **Use rates:** 0.03 - 0.06 lb a.i./A
- **Application timing:** postemergence from spike stage to layby
- **Pre-harvest interval:** following application to foliage allow 30 days before grazing domestic livestock, harvesting forage or harvesting silage
- **REI:** 12 hours
- **Component of other products:** none

imazapyr

- **Trade name and formulation:** Lightning 70DF
- **Percent crop treated:** no current data
- **Use rates:** 1.28 oz product/A
- **Application timing:**postemergence - apply before weeds are 4 inches in height and before corn is 12 inches tall
- **Pre-harvest interval:** do not harvest or graze treated corn or fodder for at least 45 days after application. Do not harvest for grain for 45 days after application.
- **REI:** 12 hours
- **Component of other products:** none

imazethapyr

- **Trade name and formulation:** Pursuit 2AS, Pursuit 70DG
- **Percent crop treated:** no current data
- **Use rates:** 0.0625lb a.i./A
- **Application timing:** postemergence - apply to weeds less than 3 inches in height or before corn exceeds the 8-leaf stage
- **Pre-harvest interval:** apply prior to 45 of harvest
- **REI:** 4 hours
- **Component of other products:** Lightning 70DF

nicosulfuron

- **Trade name and formulation:** Accent 75DF
- **Percent crop treated**: 15.8%
- **Use rates:** 0.5oz a.i./A
- **Application timing:** Broadcast over top of corn up to 20 inches tall or 6 visible leaf collars. Applications on corn 20 - 36 inches tall are allowed with drop-nozzles.
- **Pre-harvest interval:** 30 day restriction on grazing or feeding harvested grain or silage following application
- **REI:** 4 hours
- **Component of other products:** Accent Gold, Basis Gold
- **Comments**: Nicosulfuron is the primary postemergence of grass control in corn. Selected broadleaf weeds such as pigweed spp., morningglory, and smartweed, are also controlled at the 1-4 inch stage.

primisulfuron

- **Trade name and formulation:** Beacon 75DF
- **Percent crop treated:** 4.5%
- **Use rates:** 0.29 - 0.57 oz a.i./A
- **Application timing:** over top on corn 4 - 20 inches tall. From 20 inches to pretassel apply with drop nozzles.
- **Pre-harvest interval:** Do not graze or feed forage to livestock within 30 days. Do not harvest silage within 45 days. Do not harvest grain within 60 days.
- **REI:** 12 hours
- **Component of other products:** Exceed 57WG, Spirit 57WG
- **Comments:** provides excellent control of shattercane. Provides good to excellent control of numerous broadleaves including pigweed, Jimsonweed, sunflower, velvetleaf, cocklebur and smartweed.

rimsulfuron

- **Trade name and formulation:** no products containing rimsulfuron as only active ingredient
- **Percent crop treated:** no current data
- **Use rates:**
- **Application timing:**
- **Pre-harvest interval:**
- **REI:**
- **Component of other products:** Accent Gold, Basis Gold

PSII inhibitors (non-mobile)

bentazon

- **Trade name and formulation:** Basagran 4S
- **Percent crop treated:** 6.2 %
- **Use rates:** 0.75 - 1.0 lb a.i./A
- **Application timing:** Postemerge when weeds are small and actively growing. Generally corresponds to 1 - 5 leaf corn.
- **Pre-harvest interval:** 12 days
- **REI:** 48 hours
- **Component of other products:** Laddok 5L, Headline B&G

bromoxynil

- **Trade name and formulation:** Buctril 2EC, Buctril 4EC, Moxy 2E
- **Percent crop treated:** 14.8%
- **Use rates:** 0.25 - 0.38 lb a.i./A
- **Application timing:** postemergence from 3 leaf until prior to tassel emergence
- **Pre-harvest interval:** 45 days
- **REI:** 12 hours
- **Component of other products:** Buctril+Atrazine

PSII inhibitors (mobile)

atrazine

- **Trade name and formulation:** many formulations - commonly found in 4L and 90DF formulations
- **Percent crop treated:** 67.2%
- **Use rates:** 1-2 lb a.i./A
- **Application timing:**
    1. pre-plant - up to 30 days prior to planting.
    2. preplant incorporated - apply within 2 weeks prior to planting.
    3. preemergence - apply during or shortly after planting and before weeds emerge.
    4. apply before broadleaf weeds exceed 4 inches in height, grasses exceed 1.5 inches and corn exceeds 12 inches in height.
- **Pre-harvest interval:** do not graze treated area or feed treated forage to livestock for 21 days following application.
- **REI:** 12 hours
- **Component of other products:** Contour 3.38SC, Extrazine II, Basis Gold 89.5DF, Bicep II 5.8L, Bicep II Magnum 5.5L, Bicep Lite II 4.9L, Bicep Lite II Magnum 6.0L, Buctril+Atrazine, Bullet 4ME, Extrazine II 4L, FieldMaster, FulTime 4CS, Guardsman 5L, Harness Xtra, Laddok S-12, Lariat 4L, Marksman 3.2L,

Shotgun 3.25L, Surpass 100SL

cyanazine

- **Trade name and formulation:** Bladex 4L, Bladex 90DF
- **Percent crop treated:** 18.6%
- **Use rates:** 1 lb a.i./A (maximum 1999 rate due to phase-out restrictions)
- **Application timing:**
    1. early preplant - up to 15 days prior to planting
    2. preplant incorporated or preemergence
    3. postemergence - 90DF may be applied from crop emergence through the 4-leaf stage of corn but before weeds exceed 1 to 1.5 inches in height.
- **Pre-harvest interval:** none listed
- **REI:** 12 hours
- **Component of other products:** Extrazine II 4L, CyPro AT 4L
- **Comments:** DuPont plans a complete phase-out of cyanazine by 2002.

metribuzin

- **Trade name and formulation:** Sencor 75DF
- **Percent crop treated:** 2.2%
- **Use rates:** 0.05 - 0.14 lb a.i./A
- **Application timing:** postemergence
- **Pre-harvest interval:** may be grazed or harvested for grain 60 days after application
- **REI:** 12 hours
- **Component of other products:** Axiom 68DF

Root inhibitors

pendimethalin

- **Trade name and formulation:** Prowl 3.3EC, Pentagon 60DG
- **Percent crop treated:** 1.0%
- **Use rates:** 0.74-1.98 lb a.i./A
- **Application timing:** preemergence (do not incorporate), postemergence, Culti-spray (applied after corn is 4 inches in height and incorporated with cultivator.)
- **Pre-harvest interval:** none. Livestock can graze or be fed forage from treated corn after 21 days following application.
- **REI:** 12 hours
- **Component of other products:** Pursuit Plus EC

Shoot inhibitors

acetochlor

- **Trade name and formulation:** Harness 7EC, Surpass 6.4EC, others
- **Percent crop treated:** 26.5%
- **Use rates:** 1 - 3lb a.i./A
- **Application timing:** early preplant (up to 30 days prior to planting), preemerge, or early postemerge before corn reaches 11 inches in height.
- b>Pre-harvest interval: no restriction
- **REI:** 12 hours
- **Component of other products:** DoublePlay 7EC, FieldMaster, FulTime 4CS, Harness Xtra, Surpass 100

alachlor

- **Trade name and formulation:** Lasso 4EC, Lasso II, Partner WDG, CropStar 20G
- **Percent crop treated:** 2.2%
- **Use rates: 2.5 - 4.0**
- **Application timing:**
- **">Pre-harvest interval:**
- **REI:**
- **Component of other products:** Freedom, Bronco, Bullet, Lariat

dimethenamid

- **Trade name and formulation:** Frontier 6EC
- **Percent crop treated:** 4.4%
- **Use rates:** 0.75 - 1.5 lb a.i./A
- **Application timing:** early preplant (30 days prior to planting), premergence, or postemergence (up to 8 inches tall)
- **Pre-harvest interval:** 40 days
- **REI:** 12 hours
- **Component of other products:** Guardsman

EPTC

- **Trade name and formulation:** Eradicane 6.7EC
- **Percent crop treated:** 4.1%
- **Use rates:** 4 - 6 lb a.i./A
- **Application timing:** preplant incorporated
- **Pre-harvest interval:** no restrictions
- **REI:** 12 hours
- **Component of other products:** DoublePlay

flufenacet

- **Trade name and formulation:** Axiom 68DF (a premix with metribuzin)
- **Percent crop treated:** registered for use in 1998
- **Use rates:** 0.4 - 0.78 lb a.i./A

- **Application timing:** early preplant, preplant incorporated, preemerge, early postemerge (prior to corn emergence)
- **Pre-harvest interval:** none
- **REI:** 12 hours
- **Component of other products:** Epic 58DF (1999 registration)

metolachlor

- **Trade name and formulation:** Dual II 7.8EC, Dual II Magnum 7.64EC
- **Percent crop treated:** 35.7%
- **Use rates:** 1.5 - 3.75 lb a.i./A
- **Application timing:** Fall application, early preplant (up to 30 days prior to planting), preemergence, or postemergence (corn not more than 12 inches tall)
- **Pre-harvest interval:** 30 days
- **REI:** 24 hours
- **Component of other products:** Bicep (various formulations)

Growth regulator

2,4-D

- **Trade name and formulation:** various formulations of 2,4-D amine and 2,4-D ester
- **Percent crop treated:** 13.9%
- **Use rates:** 0.25 - 0.5 lb a.i./A (amine), 0.15 - 0.33 lb a.i./A (ester)
- **Application timing:** postemerge when weeds are small and corn is less than 8 inches. For corn over 8 inches drop nozzles should be used. Preharvest applications may be made of 2,4-D ester following the denting stage.
- **Pre-harvest interval:** 7 days
- **REI:** 48 hours
- **Component of other products:** Shotgun 3.25L, various others

clopyralid

- **Trade name and formulation:** Stinger 3EC
- **Percent crop treated:** no current data
- **Use rates:** 0.1 to 0.25 lb a.i./A
- **Application timing:** postemergence from corn emergence to 24 inches of corn height
- **Pre-harvest interval:** Do not allow livestock to graze or harvest treated corn silage as feed within 40 days after last treatment
- **REI:** 12 hours
- **Component of other products:** Accent Gold, Hornet 85.6WG, Scorpion III 84.3WG

dicamba

- **Trade name and formulation:** Banvel 4SC, Clarity 4SC
- **Percent crop treated:** 35.7%

- **Use rates:** 0.25 - 0.5 lb a.i./A
- **Application timing:** postemergence from emergence to 36 inch tall corn or 15 days prior to tassel emergence, whichever occurs first
- **Pre-harvest interval:** do not harvest or graze prior to milk stage
- **REI:** 24 hours (Banvel), 12 hours (Clarity)
- **Component of other products:** Celebrity, Marksman 3.2L, Resolve 75SG

Pigment synthesis inhibitor

isoxaflutole

- **Trade name and formulation:** Balance 75WDG
- **Percent crop treated:** registered for use beginning in 1999
- **Use rates:** 1.125 - 2.25 oz a.i./A
- **Application timing:** preplant (up to 14 days prior to planting) or preemerge
- **Pre-harvest interval:** none
- **REI:** 12 hours
- **Component of other products:** Epic 68DF (1999 registration)

Unclassified

glufosinate

- **Trade name and formulation:** Liberty 1.67S
- **Percent crop treated:** not available
- **Use rates:** 0.209-0.119 lb a.i./A
- **Application timing:** apply postemergence by broadcast or directed drop-nozzles from corn emergence until 24 inches or V7, whichever occurs first. Use only drop nozzles to apply when corn is 24 to 36 inches.
- **Pre-harvest interval:** Do not apply within 60 days of harvesting corn forage or 70 days of harvesting grain and/or corn fodder.
- **REI:** 12 hours
- **Component of other products:**

glyphosate

- **Trade name and formulation:** Roundup Ultra 4SL
- **Percent crop treated:** prior to introduction of Roundup Ready corn 2.6%. Current data unavailable.
- **Use rates:** 0.75 - 1.0 lb a.i./A
- **Application timing:** emergence to 30 inches or V8 growth stage. For applications after 24 inches use drop nozzles.
- **Pre-harvest interval:** 50 days
- **REI:** 4 hours
- **Component of other products:** FieldMaster

Contacts

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Iowa Corn Growers Association

Iowa Independent Crop Consultants Association

Agribusiness Association of Iowa

Iowa Farm Bureau Federation

Iowa Agricultural Statistics Service

Iowa Certified Crop Advisor Board

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