Crop Profile for Peas in Minnesota

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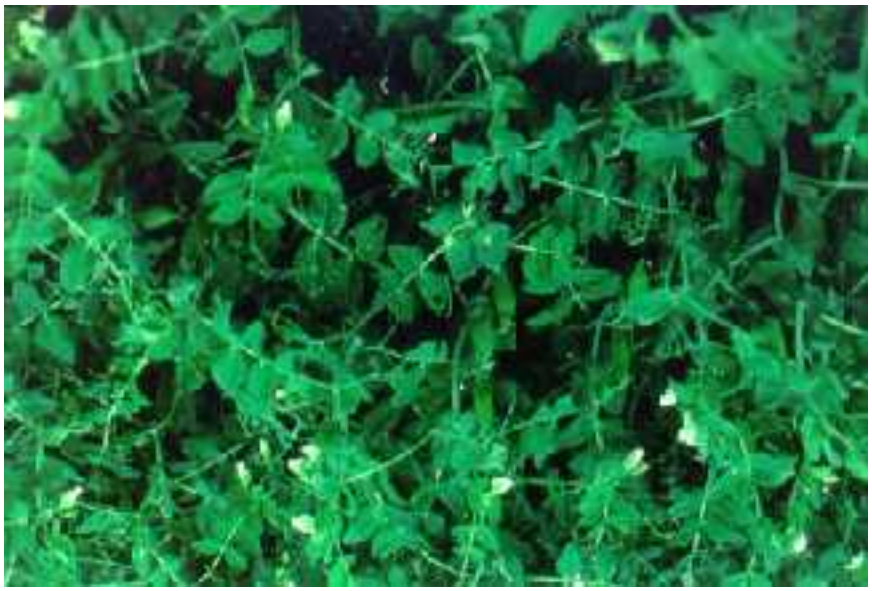

General Production Information

Minnesota is the largest producer of processing peas in the United States, averaging 89,000 Ac of planted peas from 1995-99. Over this same period, yields averaged 116,600 tons/year (1.31 tons/Ac). The average return for Minnesota green peas for processing was $332/ton with an average annual production value of $38.7 million from 1995-99 (9, 10).

Production Regions

The majority of green peas grown for processing is produced in central, south-central, and southeast Minnesota. Renville (>14,300 acres), Brown (>6,200 acres in 1999), and Olmsted (>4,800 acres) counties led the state in production for the 1999 growing season. Renville, Brown, and Olmsted counties are located in central, south-central, and southeast section of Minnesota, respectively (9).

Cultural Practices

The Crop Profile/PMSP database, including this document, is supported by USDA NIFA.

Peas are a cool season, annual crop that is often planted in rotation with other crops such as potatoes, sweet corn, or snap beans. Peas are often planted early in the growing season and then cropped over with snap beans, soybeans, or winter wheat once the peas have been harvested (13).

Peas require well-drained, sandy to loamy soils that warm quickly in spring facilitating early planting. Peas are planted into a tilled seedbed 4-5 inches deep with a drill seeder at a rate of 6-8 seed/foot, with row spacing of 32-36 inches (100-150 lbs. seed/Ac). Optimum pH for pea production is 6.0-6.8; this can be achieved in acidic soils by adding lime. Soil nitrogen content is very important for peas and can be determined by a soil test. Soils with >3% organic matter and following a grass-legume hay crop require no nitrogen while soils with <3% organic matter following a legume crop require 20 lb. N/Ac. Peas following corn, rye, oats, wheat, or other vegetable crops require approximately 40 lb. N/Ac. The amount of phosphorus and potassium should be based on soil tests. These fertilizers should not be applied in-furrow as germinating pea seeds are especially sensitive to fertilizer salt injury (4, 13).

Pea harvest takes place after 1100-1600 degree-days, or approximately three weeks after full bloom. Pods should be full, soft, and immature. Pea harvest is accomplished by means of machinery, including self-propelled combines, which separates peas and vines (4).

Insect Pests

Most of the peas grown in Minnesota are used for processing. In the upper Midwest, pea aphids are the most serious economic pests in peas but generally do not seriously affect pea yields except if peas are suffering from drought stress. Although the remaining pests discussed below can also affect yield, their potential to become contaminants during harvesting can seriously affect the quality of the final product. Although >60 species of arthropods are potential pea contaminants, about 15 species are found regularly on final inspection belts. Since the tolerance for contaminants in processed foods is very low, action thresholds for insecticide applications are reduced further than if the insects only affected yield (5, 7, 12).

Major (annual) pests of processing peas:

Pea aphid (*Acyrthsiphon pisum*)

Pea aphids are the most important economic insect pests of peas because of their direct feeding damage and ability to vector several viruses. Pea aphids are small (about 1/6” in length), green, soft-bodied insects with red eyes, while their legs and cornicles may be tipped with yellow. In the northern climates, pea aphids overwinter as eggs placed on alfalfa, clover, and other legumes and migrate from southern locations in the spring. Aphids can produce 5-6 young per day until 100 or more have been produced. There can be multiple generations of aphids during a growing season depending on weather conditions

and the presence of predators, parasites and fungal diseases.

Aphids use their piercing-sucking mouthparts to obtain sap from the plant cells. The extent of the damage depends on the growth stage when the feeding occurs, aphid population levels, and environmental conditions that may exacerbate the stress caused by the feeding. Peas are most susceptible to damage during the flowering and early pod development when yields can be reduced dramatically if blossoms drop or pods become deformed from feeding. Significant feeding can affect pea quality and yield even if the insects do not kill the plants. Aphids have many natural enemies such as the syrphid fly larvae, lady beetles, lacewing larvae, and braconid wasp parasites. In addition, the fungus Erynia neoaphidis often attacks aphids during cool and humid weather. During hot, dry weather, however, aphid populations can explode. When >35 aphids/sweep are encountered on peas >15 days from harvest, insecticide treatment is recommended. Pea aphids can vector seedborne mosaic and alfalfa mosaic virus, both of which can limit yield (5, 8, 11).

Looper Complex

At least three looper species (alfalfa, cabbage, and celery) are potential contaminates in processed peas. Later instar larvae (>0.75 inch long) are the most common contaminants found in processed peas. The larvae of these three species appear to be quite similar, with varying shades of green with white stripes in various widths on their backs and sides. Looper larvae arch their backs in their characteristic looping motion as they move across vegetation. Adults are moths with wingspans of 1.5-1.75 inches. They have slightly different wing coloration which helps to distinguish the difference species. Initial signs of a looper infestation are ragged holes in foliage. The threshold for insecticide application is >1 caterpillar/25 sweeps when peas are within 10-15 days of harvest (5, 8, 11).

Cabbage Looper (*Trichoplusia ni*)

The cabbage looper (CL) is an economic pest of peas in Minnesota and the upper Midwest. The insect does not overwinter in the upper Midwest but migrates into the region from southern states from mid-June through September. There are 1-3 generations depending on temperature and summer wind patterns. Larvae are pale green with narrow white lines running along each side. Larvae have a characteristic looping motion as they move across vegetation. Larvae feed for 2-4 weeks after hatching from eggs. When they initially hatch, they produce small holes that generally do not break through to the upper leaf surface. Later instars, however, chew large, ragged holes in the leaves. Cabbage loopers are contaminants in peas grown later in the season.

Alfalfa Looper (*Autographa californica*)

Alfalfa looper adults emerge in the spring once temperatures have reached 40?F. Adults have a dark fringe along the edge of their silvery-gray wings and an ivory mark on their forewings. Alfalfa loopers tend to fly in the evening when temperatures are above 50 F°. Larvae range in color from light to dark green. Depending on temperature, alfalfa loopers progress through 5 larval instars in about 2 weeks. They are potential contaminants throughout the growing season.

Celery Looper (*Anagrapha falcifera*)

Celery loopers overwinter as pupae in the soil in the upper Midwest and emerge when temperatures reach 50-55° F. Adults have grayish-brown forewings and a rust colored patch partially outlined in silver that resembles a long-tailed goldfish. Celery loopers tend to be contaminates later in the growing season.

Alfalfa Caterpillar (*Plathypena scabra*)

Alfalfa caterpillars are most often contaminants in processed peas in their pupal form, but later instar larvae (>0.75 inch long) can also be contaminants. Adult butterflies are sulfur-yellow in color with black margins on the upper wing surfaces. Alfalfa caterpillars overwinter as pupae and emerge in the spring to lay single eggs on the lower surfaces of alfalfa leaves. They often move into other crops once alfalfa has been cut. Larvae are velvety green with a white strip on each side of the body through which runs a very fine red line. Sampling for caterpillar larvae is often conducted in nearby alfalfa fields rather than in peas. Thresholds have been developed to reduce contamination. The threshold for peas is 1 larva/25 sweeps and when peas are approximately 15 days from harvest. Because pupae are often contaminants and the pupal stage lasts 5-7 days, it is very important to monitor fields several weeks prior to harvest. A major outbreak of alfalfa caterpillar occurred in Minnesota during 2001. A primary factor contributing to a high incidence of larval contaminants was the application of insecticide after the larvae had pupated. Pupae remained on plants during the harvest resulting in a highly contaminated product. Alfalfa caterpillars have numerous natural enemies including braconids, tachinids, and chalcrids and are also susceptible to viruses (5, 8, 11).

Imported Cabbageworm (*Pieris rapae*)

The imported cabbageworm (ICW) is a day-flying butterfly that overwinters in the upper Midwest. ICW is also an economically important pest that affects numerous crops in addition to peas. Larvae are velvet green, about 1 inch long in the last instar, and move sluggishly when touched. As the caterpillars develop, they contaminate leaves and pods with large fecal pellets. Adults are white butterflies with 2-inch wingspans.

Also see fact sheet: http://vegedge.umn.edu/vegpest/colecrop/cabbworm.htm

Cutworms and Armyworms

Although the various cutworm and armyworm species do not cause significant feeding damage to peas, the larvae are often contaminants especially if the peas have been harvested at night and/or following a rain. These species tend to crawl up from the soil from their hiding places at night or on cloudy days to feed. They are easily dislodged from pea plants during harvesting. Cutworms quickly curl up “C” position when disturbed (5, 12).

Stink bug (*Euschistus servus* and *Euschistus variolarius*)

Two stink bug contaminates in peas are the one-spotted stink bug, Euschistus variolarius, and the brown stink bug, Euschistus servus. These insects use piercing-sucking mouthparts to feed on >50 plant species as well as numerous insects. Usually considered beneficial, they become processed contaminants if an insecticide which was sprayed to control lepidopteran pests has lost its residual activity and fails to eliminate the stink bugs. To reduce contamination, the recommended threshold for

insecticide application is 1 stink bug/100 sweeps when peas are >5 days from harvest (5).

Colorado potato beetle (*Leptinotarsa decemlineata*)
Colorado potato beetles (CPB) can be a significant contaminant species in peas. Although Colorado potato beetles do not feed on peas, they will feed on solanaceous weeds such as nightshade and smooth ground cherry, both of which can be found in pea fields. Weed control helps reduce contamination by CPB (5).

Minor (sporadic/occasional) pests of processing peas:
Seed corn maggot (*Delia platura*)
Seed corn maggot is considered an occasional pest of sweet corn with resulting damage being highly variable from year to year. Insects overwinter as pupae in the soil and emerge as adults in the spring. The flies mate within 2-3 days after emerging and lay eggs in soil with abundant decaying organic matter and/or on seeds or plantlets within these fields. Maggots are yellowish-white and approximately ¼ inch long. Maggots complete their entire development within the soil by burrowing into seeds or feeding on cotyledons emerging from seeds. In some cases, feeding damage completely destroys the growing point. Adults resemble small houseflies and are dark gray. Seed corn maggots generally complete their life cycle within 3 weeks and have 2-4 generations in Minnesota. Although multiple generations are present throughout the growing season, first generation maggots are responsible for the majority of damage. Adult females lay eggs in the soil and upon hatching, maggots begin feeding on the roots. Poor germination and emergence problems can be the result of infestations involving this insect. Surviving plants often have numerous small holes on their cotyledons, evidence of maggot feeding. Larger plants are more tolerant of damage and as such will typically not express signs of feeding damage.

Chemical control options are preventative; no products are labeled for use once an outbreak has occurred. One option is to plant seed treated with a product containing diazinon or a lindane-diazinon combination (11).
Also see factsheet: http://www.vegedge.umn.edu/vegpest/seedmag.htm

Insect Control Options: Chemical Control

Control options for pea insect pests (type of control/insecticide class):

Organic/Alternative
***Bacillus thuringiensis* (Javelin WG)** *Bacillus thuringiensis* (Bt) products can be applied as foliar insecticides to control of caterpillars. Products are applied at a rate of 0.12-1.5 lb./A. There is a field re-entry interval (REI) of 4 hours.
Spinosad (SpinTor 2SC) SpinTor is biologically derived from the fermentation of the soil organism Saccharopolyspora spinosa and can be used to control Lepidopteran larvae on a variety of crops,

including peas. The product is applied at a rate of 4-6 fl. oz/A.

Insecticide control options

Carbamates

Carbaryl (Sevin XLR Plus) Sevin can be used to control armyworms. There is a 12-hour REI for Sevin and a 21 day PHI. The labeled rate for Sevin XLR Plus in peas is 1 qt/Ac, respectively.

Methomyl (Lannate LV) Restricted-use product (RUP). Lannate is labeled to control aphids, loopers, cutworms, and alfalfa caterpillars. The labeled rate for Lannate LV is 1-3 pts./Ac not to exceed 2.7 lbs. AI/Ac/yr. Lannate carries a field REI of 48 hours and a 1-day PHI. Vines should not be feed to livestock for 14 days.

Pyrethroids

Esfenvalerate (Asana XL) RUP. Asana XL is labeled for use on peas to control loopers, armyworms, cutworms, and alfalfa caterpillars. The labeled rate is 2.9-9.6 fl. oz/Ac not to exceed 0.1 lb. AI/Ac/yr. Peas should be treated 8-10 days prior to harvest. There is a field REI of 12 hours and a 3-day PHI.

Bifenthrin (Capture 2EC) RUP. Registered in the late 1990s, this pyrethroid is effective on loopers, armyworms, cutworms, alfalfa caterpillars, and aphids. Total product applied per season must not exceed 12.8 fl. oz/Ac/yr. There is a field REI of 24 hours and a 3-day PHI.

Organophosphates

Diazinon (Diazinon 50W) RUP. Diazinon can be used to control cutworms and aphids. The product is applied at a rate of 0.75-1.0 lb./Ac. There is a field REI of 12 hours and a 7-day PHI.

Dimethoate (Dimethoate) RUP. Dimethoate is labeled for use on aphids. The labeled rate is 0.5 pt./Ac and is limited to one application/season. Treated vines should not be fed to livestock. There is a field REI of 48 hours and a 21-day PHI.

Organochlorines

Endosulfan (Thiodan 50WP) RUP. Thiodan is labeled for use on aphids, loopers, stink bugs, and Colorado potato beetle. The product is applied at a rate of 2 lbs./Ac, not to exceed 2 applications/ season. There is a field REI of 24 hours and a 5-day PHI.

Table 1. Insect control options: chemical products

Foliar Products	Field Rate	A.I. Rate	PHI/ REI	Application Schedule	Remarks
Bacillus thuringiensis (Bt)					

Javelin WG	0.12-1.5 lb/A	0.01-0.11 lb/A	0 d 4 h	as needed	Alfalfa caterpillars, cutworms, armyworms, loopers, imported cabbageworm
Spinosad					
SpinTor 2SC	3-6 oz/A	0.05-0.10 lb/A	28 d 4 h	Prior to egg hatch, 3 day intervals	ECB, CEW, looper, leafminer; total <12 oz/A/year
Carbamates					
Lannate LV	0.75-3 pts/A	0.23-0.92 lb/A	14 d 48 h	5-7 d	ECB, CEW, beetles, mites; total <4.5 lb/AI/A/year AND <10 applications
Sevin XLR Plus	0.5-1.5 qts/A	0.5-1.5 lb/A	21 d 12 h	7+ d	ECB, CEW, beeteles, leafhopper, aphids; total <6 qt/A/year
Pyrethroids					
Asana XL	2.9-9.6 oz/A	0.02-0.05 lb/A	21 d 24 h	3+ d	ECB, CEW, beetles, leafhopper, mites, aphids; total <0.2 lb/AI/A/year
Capture 2EC	1.6-6.4 oz/A	0.025-0.10 lb/A	3 d 24 h	As needed	ECB, CEW, beetles, leafhopper, mites, aphids; total <0.2 lbAI/A/year
Organophosphates					

Diazinon 50W	0.78-8 lb/A	0.35-4 lbs/A	7 d 24 h	broadcast before planting or apply as needed	Cutworm, aphids; may feed to cattle and sheep after waiting 7 d; total <3 apps./yr
Dimethoate 2.67 EC	0.5 pt/ yr	0.17 lb/ A	0 d 48 h	1 application/yr	Aphids; do not feed treated vines to livestock.
Organochlorines					
Thiodan 3 EC	0.67-1.3 qt/ A	0.23-0.44 lb/ A	5 d 24 h	2 applications/ yr max	Aphids, loopers, stink bugs, Colorado potato beetle, do not feed treated vines to livestock or allow livestock to graze in treated fields; total <2.0 lb AI/ A/yr

Table 2. Insecticides applied to MN processing peas, 2000 (10).

Product	% Acres Treated	Total Area Treated (1000 Ac)	Rate Applied (lbs. AI/Ac)	Total Applied (1000 lbs. AI)
Capture 2EC (Bifenthrin)	56	53.3	0.04	2.1
Asana XL (Esfenvalerate)	5	4.8	0.03	0.2
Dimethoate	2	1.9	0.17	0.3

Diseases

Peas are susceptible to several disease organisms from seedling to maturity. The frequency of occurrence of the following diseases is highly dependent on the weather, soil moisture, and other environmental factors encountered throughout the growing season. Both fungal and viral diseases affect peas in Minnesota.

Fungal Diseases

Aphanomyces Root Rot (*Aphanomyces euteiches* Drechs)
Aphanomyces root rot is one of the most damaging funguslike diseases of peas in the upper Midwest and can infect peas of any age. Warm, rainy weather fosters growth of Aphanomyces. The soil borne disease spreads among adjacent plants and can is also transferred by farm machinery that has been contaminated with infected soil or pea debris. Depending on the extent of the root rot infection, symptoms can include yellowing of leaves, stunting, wilting, and death. Root rot also makes the plant more susceptible to other root disease pathogens. Levels of Aphanomyces spores increase if peas are grown in the same field over several consecutive years. Spores can remain quiescent in the soil for at least 10 years, and as a result, can remain unsuitable for peas for almost a decade. There are no resistant cultivars or fungicides available to control Aphanomyces.

Ascochyta Blight (*Ascochyta pisi Lib, Phoma medicaginis* var. pinodella, and *Mycosphaerella pinodes*)
Ascochyta blight is a disease complex involving three different fungi: Ascochyta pisi, Phoma medicaginis var. pinodella, and Mycosphaerella pinodes. All of these fungi overwinter in plant debris. Spores are spread through fields via rain and wind and cause lesions on the leaves, stems, pods, and roots. Symptoms of the different species vary to a certain extent. Lesions caused by A. pisi are slightly sunken, tan, and surrounded by a dark border and tend to infect the leaves, stems and pods. Mycospaerella pinodes, the most serious Ascochyta disease and tends to infect the leaves, stems, and pods whereas P. medicaginis tends to infect the roots. Initial symptoms of M. pinodes include small, dark, irregular flecks on leaves, stems, and pods. Lesions on the stem may enlarge and eventually girdle the stem, pedicels, or tendrils while lesions on the leaves or pods may also develop into large concentric rings of alternating shades of brown. Severe infections may result in desiccated leaves. Phoma medicaginis typically affects the stem and taproot near the soil; severe infections may kill seedlings. Ascochyta blight may be managed by removing and disposing of diseased plants and by planting disease-free seed. Crop rotation is another control tactic used to manage the disease. There are currently no resistant cultivars or fungicides available to control Ascochyta blight.

Fusarium Wilts (*Fusarium oxysporum f. sp. pisi*)
Fusarium wilt is a fungal disease that can infect peas in all stages of development. The disease enters the fibrous pea roots and invades the vascular system causing initial symptoms including downward

curling of leaves and discoloration in the vascular tissue. As the disease develops, the leaves turn yellow, starting at the base of the plant and progressing upwards, eventually causing the entire plant to wilt. Fusarium spores can survive in the soil for up to 10 years and are disseminated via wind and rain. Farm machinery that contains contaminated soil or plant debris can also spread the disease. Cultivars have been developed that show varying degrees of resistance to several races of Fusarium.

Damping off (*Pythium spp.*) and Rhizoctonia Seedling Blight (*Rhizoctonia solani*)
Soilborne fungi, Rhizoctonia solani, or several of the Pythium spp. cause damping-off and seedling diseases of peas. Spores from Rizoctonia and Pythium spp. can lay dormant in the soil for years, but under the right environmental conditions, they attack susceptible seedlings. Both diseases can occur anywhere in a field but both typically occur under wet soil conditions. Peas are more susceptible to Pythium spp. when planted in cold, damp soils because the seeds germinate more slowly. Poor quality or cracked seeds may stimulate the growth of Pythium spp. and cause the seeds to rot prior to germination. Additionally, Pythium can affect seedlings before or after they emerge from the soil. Pythium often causes lesions to form on stems resulting in collapsed seedlings that become dark and shriveled.

Rhizoctonia tends to be more aggressive when soil temperatures are warm, 75-85° F, damp, and high in organic matter. Rhizoctonia tends to invade the hypocotyl and the epicotyl of young seedling above the soil line. Stems appear water-soaked, and lesions which develop may girdle the stem causing delayed growth, stunting, or death. The best control methods include good sanitation practices, planting in well-drained soils, and rotating crops. In addition, seeds treated with fungicides are less susceptible to Pythium.

Powdery Mildew (*Erysiphe pisi*)
Powdery mildew tends to be more prevalent in late-planted peas when days are dry and nights are cool with dew formation. Small, off-colored spots appear on the upper leaf surfaces at the onset of the disease. These spots develop into white, powdery areas that can cover the entire leaf surface. Depending on the extent of the powdery mildew infection, the plant is less vigorous and matures more slowly. Moderate-severely infected pods often develop an objectionable flavor that lowers the quality of the peas. Powdery mildew overwinters as spores in plant debris and alternative hosts and may also be carried in affected seed. Several pea cultivars are resistant to powdery mildew while other control measures consist of early season planting, sprinkler irrigation, and the application of sulfur.

Downy Mildew (*Peronospora viciae*)
Downy mildew sometimes attacks peas grown in moist, cool conditions. Infection occurs once the disease penetrates the hosts' stomata, aided by wind or rain. Symptoms may appear as lesions on leaves or pods and may be yellow or brown in color. They are irregular shaped spots on the upper leaf surfaces and grayish white, fluffy fruiting body growth on the underside of leaves. Infections tend to move from the bottom foliage and progress up the plant. The disease typically kills plants when infected prior to flowering, but will stunt or deform pods if the plant is affected later in development. Downy mildew overwinters as resting spores in plant debris, therefore the best control is to remove all infected crop debris. Additionally, it can persist in soil for 10-15 years making elimination of the disease nearly

impossible. There are no effective chemical control options.

Viral Diseases

Viruses are typically disseminated between plants by pea aphids serving as vectors, or through affected seed. Viruses generally cause leaf chlorosis, mottling or mosaic patterns on leaves, distortion of pods and other plant parts, stunting, and death. Although a number of viruses affect peas, the following viruses are the most economically important: pea enation mosaic, bean leaf roll, pea seedborne mosaic, pea streak, and red clover vein mosaic. Alfalfa and other legume plants often serve as alternate hosts of viruses. Because there are no chemicals that can counteract plant viruses, they are often best controlled by planting tolerant pea cultivars and managing insect vectors.

Disease Control Options

Cultural practices/crop rotation
Cultural control practices can play an important role in the management of diseases in peas. Most disease pathogens that affect peas overwinter in field debris, on or below the soil surface, or are vectored by insects. As such, managing the amount of crop residue, organic matter, or fertilizer applied becomes critical to the suppression of many of the above mentioned diseases. Rotating crops can drastically reduce the presence of disease inoculum in fields. Crop rotation also benefits soil health as it allows nutrients to be cycled into the soil.

Conventional Fungicides
Seed treatments: Captan or Thiram are used as seed treatments to prevent damping off. These chemicals are applied to seed before planting.
Foliar treatments: Sulfur controls powdery mildew on peas at a rate of 8-10 lb./100 gallons of water but should not be applied when temperatures exceed 85F.

Weeds

Weeds compete with peas for light, nutrients, and water. Weeds can also harbor disease pathogens and insect pests that can invade peas after planting. Many annual weeds produce copious amounts of seeds that often remain viable in the soil for many years. Early season cultivation may control weed seedlings, but as the growing season progresses, cultivation damages pea roots. Herbicide application may be the only effective control method.

Broadleaf Weeds

Many broadleaf weeds adversely affect peas in Minnesota. Examples of annual broadleaf weeds are velvetleaf, Abutilon theophrasti, common lambsquarters, Chenopodium album, pigweed, Amaranthus retroflexus, and giant and common ragweed, Ambrosia trifida and Ambrosia artemisiifolia, respectively. All of these weeds grow taller than peas and can out-compete peas for available light and soil nutrients. In absence of control, weeds can significantly reduce yield. Berries of Eastern black nightshade, Solanum ptycanthum, and hairy nightshade, both annual broadleaf weeds, can contaminate peas during harvesting because they are pea-sized (13). In addition, nightshade is attractive to Colorado potato beetles, which also feed on and contaminate peas (5). Canada thistle, Cirsium arvense, is a perennial broadleaf weed that is a potential contaminant in peas. Both its flower and thistle buds are the same size as peas and can also serve as contaminates (13).

Grasses

Annual grasses cause significant problems with pea production because of their fast growth and ability to compete for resources. They are very tolerant of extreme moisture and temperature variation once established and can be very difficult to eliminate from production areas once established. Given their reproductive potential, they require management prior to seed-set. Examples are foxtail, Setaria spp., wild proso millet, Panicum miliaceum, and crabgrass, Digitaria spp.

Pre-emergence Herbicides

Clomazone (Command 4E) is a preemergent herbicide that is incorporated into the soil at 1 pt/A. to provide control of annual grasses and many broadleaf weeds but is less effective on pigweed and nightshade. Pea varieties differ in tolerance to Command.

Imazethapyr (Pursuit) is a preemergent and postemergent herbicide that provides control of broadleaf annual weeds and foxtail grasses at a rate of 1.08 oz./A. There is a 30 day PHI and a 12 hour REI. Imazethapryr is applied as a preemergent herbicide within one week of planting. Imazethapyr cannot be applied to sandy or sandy loam soils or applied north of the 46th parallel in Minnesota.

Metolachlor (Dual II Magnum) provides good control of annual grass, nighshade and pigweed. It provides poor control of lambsquarters, ragweed, smartweed and velvetleaf. Metalachlor is applied at a rate of 1-2 pt./A. and is not incorporated into the soil. There is a 24 hour REI.

Trifluralin (Treflan) is incorporated into the top 3-4 inches of the soil before planting at a rate of 1.0-1.5 pt./A. Trifluralin provides control of the annual grass weeds, lambsquarters, and pigweed. It is not effective on high-organic soils. There is a 12 REI.

Post-emergence Herbicides

Bentazon (Basagran) controls annual broadleaf weeds at a rate of 0.75-1 qt./A. Bentazon provides better control when applied to small weeds.

Imazethapyr (Pursuit) is both a preemergent and postemergent herbicide that provides control of broadleaf annual weeds and foxtail grasses at a rate of 1.08 oz./A. There is a 30 day PHI and a 12 hour REI. As a postemergent herbicide, it is applied when peas have at least one true leaf.

MCPB (Thistrol 2EC) controls Canada thistle. MCPB is applied at a rate of 2-4 pt./A when peas have 6-12 nodes and weeds are <3 inches tall.

Paraquat (Gramoxone Extra 2.5EC) RUP, is a postemergence broadleaf and grass herbicide. Applied at a rate of 2-3 pt./A plus 1 qt. COC or 4-8 fl. oz. nonionic surfactant/25 gallons water, either before or

after planting, but prior to emergence.
Quizalofop (Assure II 0.88E) is an annual grass herbicide that is applied at a rate of 6-12 fl. oz./A. There is a 30 day PHI and a 12 hour REI.
Sethoxydim(Poast 1.5E) provides control of annual grasses that is applied at a rate of 1.0-1.5 pt./A. There is a 15 day PHI and a 12 hour REI.

Table 3. Weed control option: chemicals (4, 5, 9)

Pre-emergence Products	**Field Rate**	**A.I. Rate**	**PHI REI**	**Remarks***
Command 4E (Clomazone)	1 pt/A	0.5 lb/A	-- 12 h	G, BL; incorporate to 1"; plant below treatment zone; varieites vary in tolerance
Dual II Magnum (Metolachlor)	1-2 pts/A	1-2 lbs/A	-- 24 h	G. Do not incorporate; <2 pts/A/yr
Pursuit (Imazethapyr)	3-4 oz/A	0.05-0.06 lb/A	30 d 12 h	BL and some G. Apply to incorporate 1 week prior ot planting or within 1 day post-plant. Not for sandy or sandy-loam soils or on fields treated with Treflan or north of the 46th parallel (in MN)
Treflan (Trifluralin)	1-2 pts/A	0.5-1 lb/A	-- 12 h	G, BL; Apply before planting. Incorporate into the top 3-4" of soil. Ineffective on highly organic soils.
Post-emergence Prodcucts				
Poast 1.5E (Sethoxydim)	2.5 pts/A	0.47 lb/A	15 d 12 h	G. Apply to actively growing grasses. Total <4 pt/A/yr

Assure II 0.88E (Quizalofop)	6-12 oz/A	0.04-0.08 lb/A	30 d 12 h	G. Apply to actively growing grass. <14 oz/ yr
Basagran (Bentazon)	0.75-1 qt/ A	0.75-1 lb/ A	30 d 48 h	BL. Apply when weeds are small and after peas have 3 pair leaves. Do not add COC to peas. Total <2 qt/A/yr
Glyphosate	8-24 oz/A	0.25-0.75 lb/A	30 d 12 h	G & BL. Apply before or after planting but prior to crop emergence; <8 qts/A/yr
Gramoxone Extra 2.5 EC (Paraquat)	1.5-3 pts/A	0.47-0.94 lb/A	0 d 12-24 h	G & BL. Apply before or after planting but prior to crop emergence
Pursuit (Imazethapyr)	3-4 oz/A	0.05-0.06 lb/A	30 d 12 h	BL and some G. Apply after peas have 1 true leaf but prior to 5 nodes.
Thistrol 2EC (MCPB)	2-6 pts/A	0.5-1.5 lbs/A	** 12 h	Controls Canada thistlel. Apply when peas have 6-12 nodes & when weeds are <3" tall; DO NOT feed treated vines to livestock.

*G: grass, BL: broadleaf
** See label

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