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Texas Crop Profile

# POTATOES

AgriLIFE EXTENSION
Texas A&M System

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This profile on potato production in Texas gives an overview of basic commodity information; discusses insect, disease and weed pests; suggests cultural and chemical control methods; and refers to the Food Quality Protection Act.

## Basic Commodity Information

State Rank: .............................Not ranked in total U.S. production, but ranked No. 1 in summer potato production in 1997-98.
Percent U.S. Production: ..........Less than 1 percent of total production.
Acres Planted: ..........................19,150
Acres Harvested: ......................17,850
Cash Value:................................$46,577,500
Yearly Production Costs: ..........$1,925 per acre

### Commodity Destination

About 70 percent of the Texas potato crop goes to fresh market and 30 percent goes to processing (mostly potato chips).

### Production Regions

Nearly 50 percent of the potatoes are grown in the High Plains as far north as Dallam County and as far south as Gaines County. Thirty-four (34) percent are grown in the Winter Garden, an area southwest of San Antonio, and 19 percent in the Lower Valley.

### Cultural Practices

***Varieties:*** Recommended Russet varieties are Russet Norkotah, Norgold M and Century Russet. Recommended White varieties are Atlantic, Gemchip, Chipeta and Kennebec. Yukon Gold is the recommended Yellow Flesh variety. Red LaSoda and Viking are the recommended Red varieties.

***Soil type:*** Preferred soil types are well drained, sandy loam, loamy sand or sandy clay loam with a pH 6.0 to 7.8.

***Optimum growing conditions:*** Potatoes are a cool season crop and prefer warm days (75 degrees F to 85 degrees F), long days (16 to 18 hours), and cool nights (50 degrees F to 60 degrees F). Optimum mean temperatures are 60 degrees F to 65 degrees F.

***Establishment methods:*** Plant 20-ounce tuber seed pieces 2 weeks after the last freeze when the soil temperature is greater than 50 degrees F. Plant at the rate of 1,600 pounds to 2,200 pounds of seed per acre. Plant 2 to 3 inches deep, 7 to 10 inches apart on 34-inch to 40-inch raised beds. In the Winter Garden, some plant protection is gained from planting on low beds and throwing soil to plants as they grow.

***Fertilization:*** Fertilization rates should be based on actual soil test results. Generally, fertilization needs will be about 175 pounds of nitrogen, 80 pounds of phosphorus, and 80 pounds of potassium. Potassium is generally not needed in the High Plains, although many growers apply it.

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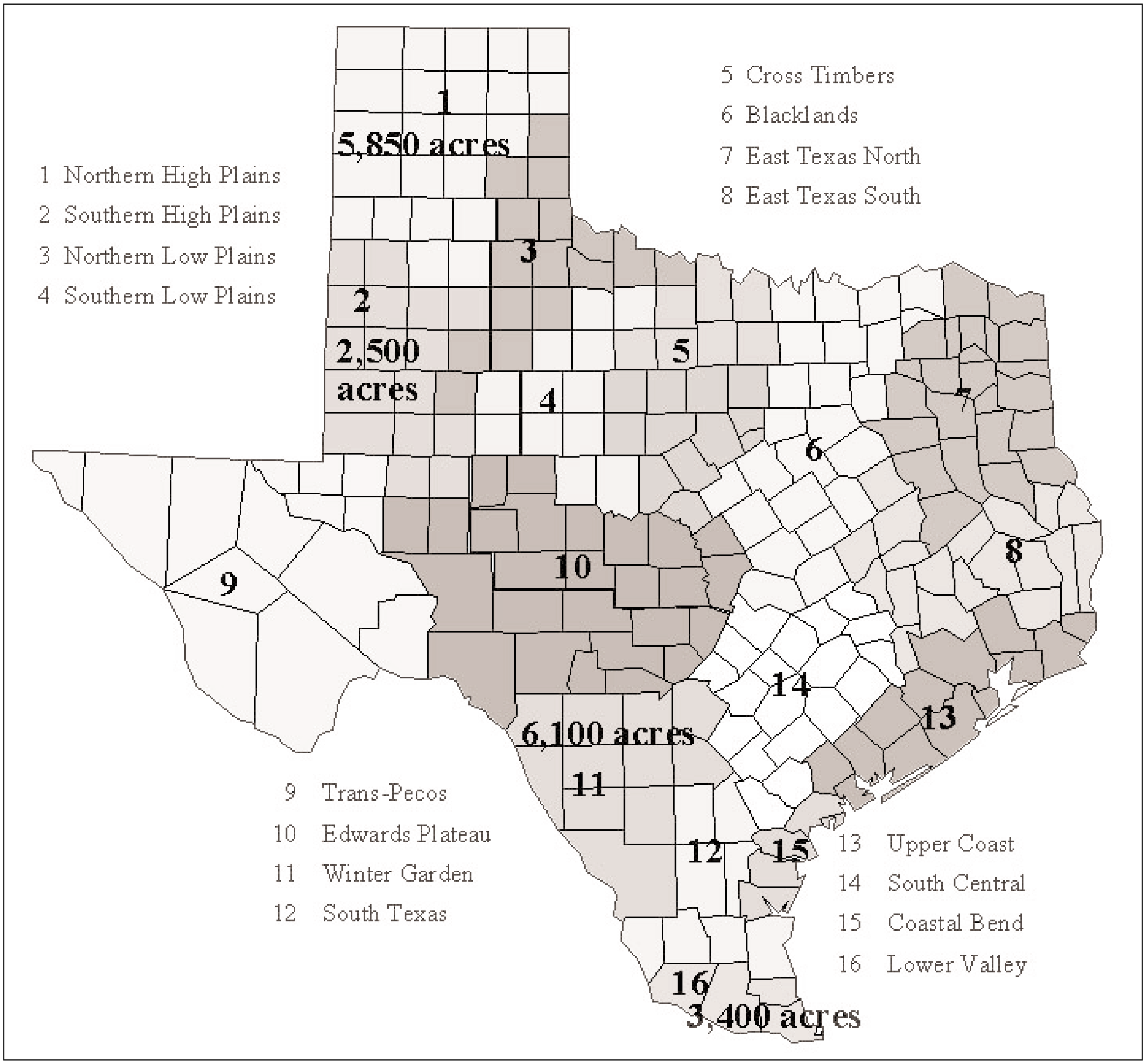


**Texas potato production–number of acres harvested by production region, 1997-98 averge.**

***Irrigation:*** Potatoes need 20 to 40 inches of water from rainfall or irrigation through the growing season. After establishment, the critical demand periods are vining, bloom, tuber initiation and tuber growth.

***Land preparation:*** Shred or apply herbicide to destroy previous crop and weeds. Disk two or three times, apply fertilizer and irrigate.

***Planting:*** Use treated seed to control common fungal and bacterial diseases. In the Lower Valley, plant in late November or December. In the Winter Garden, plant in December and January. In the High Plains, plant in February through early April.

***Growing season activities:*** Growing season activities include monitoring fields for pest problems and field conditions, applying fertilizer and pesticides, hilling, irrigating and cultivating.

***Vine killing:*** Kill vines before harvest to stop growth and aid ease of harvest. Chemicals used for vine killing or desiccation include Des-I-cate, Gramoxone® Extra, Diquat® and sulfuric acid. Vine mowers and beaters also can be used to kill vines.

In current operations, all potato plants are treated with paraquat (Gramoxone® Extra) or diquat (Diquat®). Diquat is less effective and, therefore, paraquat is used by most growers. One application is made at the full label rate of 1.5 pints per acre of paraquat or 1 pint per acre of diquat.

***Harvest:*** Harvest occurs 100 to 120 days after planting. Potatoes are harvested mechanically onto hopper bottom trucks for hauling to the shed. The potatoes are washed, graded and sacked in burlap bags (100-pound bags) or packaged in box-waxed paper cartons (50-pound boxes). Potato grades are U.S. #1 and U.S. #2, sized and unsized. Sizes range from 6-ounce to 12-ounce tubers. Anticipated yield is 250 to 350 cwt. (hundredweight) per acre. Potatoes are harvested in April and May in the Lower Valley; in April, May and June in the Winter Garden; and July through October in the High Plains.

## Pest Information

Pests of potatoes include numerous foliar feeding insects, several soil insects, diseases, nematodes and weeds.

### Foliar feeding insects

**Colorado potato beetle** (*Leptinotarsa decemlineata*), **potato aphid** (*Macrosiphum euphorbiae*), **leafhopper** (*E. fabae* and *E . abrupta*), **grasshoppers, spider mite, potato psyllid** (*Paratrioza cockerelli*), **false cinch bug** (*Nysius raphanus*), **cabbage looper** (*Trichoplusia ni*), and **tomato hornworm** (*Manduca quinquemaculata*)

***Frequency of occurrence:*** Every year these insects will appear in some part of the state and cause problems in potatoes. In the High Plains, psyllids and grasshoppers are a problem every year.

***Damage caused:*** Colorado potato beetle larvae and adults devour the foliage. Potato aphids suck plant juices and curl leaves. They transmit viral pathogens that cause more damage than actual feeding damage. Leafhopper feeding causes curling, stunting and dwarfing, accompanied by a yellowing, browning or blighting of foliage. Injection of saliva into the phloem during feeding results in a physiological disturbance that produces disease-like symptoms. Grasshoppers feed on the potato foliage. Immature potato psyllids inject a toxin when they feed on the potato plants. Plant yellowing is the most common symptom. Twenty (20) percent to 50 percent yield losses can result. Cabbage loopers are voracious feeders that can strip foliage from infested plants in a short time. Often, when populations become crowded, a virus disease that causes high larval mortality can strike. Tomato hornworm larvae are voracious foliage feeders. They can defoliate a plant in a single day.

***Percent acres affected:*** One hundred (100) percent of the Texas potato acreage is affected by potato aphids, leafhoppers and psyllids, 50 percent by grasshoppers, and 20 percent by cabbage loopers. An estimated 2 percent of Texas potato acreage is affected by Colorado potato beetle. Colorado potato beetles can be found on 100 percent of the acreage but very seldom do they reach the economic threshold where they cause a problem and require treatment.

***Pest life cycles:*** Colorado potato beetle deposits about 500 eggs in batches of about 24 on the underside of leaves. The eggs hatch in 4 to 9 days and larvae become full-grown in 2 to 3 weeks. Larvae consume the plant leaves. Pupation occurs in the soil and requires 5 to 10 days. Two to three generations occur per year.

Potato aphids overwinter as eggs on a variety of crops and weeds. The eggs hatch in the spring, and after one or more generations on the overwintering host plant, winged aphids are produced and migrate to a variety of other hosts, including potatoes. Females can reproduce without mating with males. Each aphid can give birth to 50 to100 live young, all females. There may be five to10 generations per season. In the fall, a generation with winged males and females is produced. These migrate back to overwintering hosts, mate, and lay eggs.

Leafhopper females deposit slender, white eggs into stems and larger veins of plant leaves. Eggs hatch in 6 to 9 days during summer; nymphs molt four times before becoming adults. Shortly after adults appear, mating takes place, followed by egg laying. Several generations overlap each season. Adults are very active, jumping or flying when disturbed. Both adults and nymphs can run backwards or sideways as rapidly as they move forward.

Grasshoppers pass the winter in the egg stage. Eggs are laid during summer and fall in packet-like masses below the soil surface of pasture land, field margins and roadsides. Eggs hatch into small nymphs in April, May and June. Exact time and percentage of eggs hatching depends on weather conditions and locality.

Potato psyllids pass through egg, nymph and adult life stages in development. Psyllid eggs are frequently deposited along leaf margins but may occur on either leaf surface. Eggs hatch in 6 to 10 days. Newly hatched nymphs undergo four molts. While feeding, psyllid nymphs excrete small, waxy beads of material resembling granulated sugar. This material may cover leaves during heavy psyllid infestations. The nymph stage usually lasts from 14 to 22 days. Newly emerged adults remain green in color for a day or so before turning darker. There are four to seven generations of psyllids in a year with some overlap of generations.

There are continuous generations of cabbage loopers. Reproduction slows during cold periods. In colder areas, the insects overwinter as pupae in flimsy silken cocoons attached to food plant residue. A complete generation occurs in 4 to 6 weeks in warm weather.

***Timing of control:*** Pesticides are applied when necessary as determined through scouting activities. In the High Plains, initial foliar applications for insect control are not needed until about the middle of the growing season.

Grasshopper populations normally build up on field edges, and that is the best place to scout and treat when high numbers begin developing. Treating border areas is less expensive than treating whole fields. Producers are urged to carefully monitor field margins adjacent to pastures and roadside areas for grasshoppers, damage and the need to treat. Control measures should be initiated early in the season while grasshoppers are in the nymphal stages and still within hatching sites (roadsides or fence rows, etc.). During dry periods, grasshoppers will migrate from border areas to the crop. Persistence is the key to managing grasshoppers. Several insecticide applications may be required, particularly under dry conditions, as the season progresses. In essence, an insecticide treatment will reduce numbers within the treated area; however populations will soon be replaced by hoppers migrating from adjacent areas.

***Yield losses:*** If present and not controlled, Colorado potato beetles can cause yield losses of 30 percent; potato aphids, 40 percent; leafhoppers, 30 percent; potato psyllids, 40 percent; false cinch bugs, 50 percent; grasshopper, 50 percent; spider mites, 50 percent; and cabbage loopers, 40 percent.

***Regional differences:*** There is no regional difference in frequency of occurrence for Colorado potato beetles, potato aphids, leafhoppers, false chinch bugs, and spider mites. Potato psyllids are a big problem in the Winter Garden, less of a problem in the High Plains, and a minor problem in the Lower Valley. Grasshoppers and potato psyllids are becoming a big problem in the High Plains. Cabbage loopers are more of a problem in the Winter Garden and the Lower Valley than in the High Plains.

***Cultural control practices:*** Reduce migration of Colorado potato beetle from field to field with trenches, mulches, and no till. Rotate to nonsusceptible crops to delay arrival of the first generation of the adults.

Control weeds along ditch banks, roads, in farmyards, and other noncultivated areas to reduce potato aphid habitat. Plant disease-free seed to reduce the incidence of potato leafroll virus.

***Biological control practices:*** Apply insecticides judiciously. Only apply what is needed after scouting reveals economic threshold is reached to avoid killing beneficial insects as much as possible. Follow recommended integrated pest management practices.

**Table 1: Chemical Controls for Foliar Feeding Insects.**

| Pesticide | % Acres Treated | Type of Appl. | Typical Rates | Timing | # of Appl. | Postharvest Interval (days) | Reentry Interval (hours) | Target Insects |
|---|---|---|---|---|---|---|---|---|
| *Esfenvalerate (Asana® XL)* | 20 | foliar | 5-8 fl. oz. | Apply at first appearance of pests, repeat as needed at 7-day intervals. | 2 | 7 | 12 | Aphids, flea beetle, leafhopper potato psyllid, cabbage looper and grasshopper |
| *Phorat (Thimet®, Phorate)* | 75 | soil | 11.2 lbs. 20G | Apply at planting. | 1 | 90 | 48 | Early season control of potato psyllid, aphid, Colorado potato beetle, flea beetle, and leafhopper |
| *Endosulfan (Thiodan®, Phaser)* | 50 | foliar | 1 qt .of 3EC | Apply at appearance of insects or feeding activity. | 2 | 1 | 24 | Colorado potato beetle, aphid, flea beetle, leaf hopper, potato psyllid and false chinch bug |

**Table 1: Chemical Controls for Foliar Feeding Insects. *(continued)***

| Pesticide | % Acres Treated | Type of Appl. | Typical Rates | Timing | # of Appl. | Postharvest Interval (days) | Reentry Interval (hours) | Target Insects |
|---|---|---|---|---|---|---|---|---|
| *Imidacloprid (Admire®, Provado®)* | 65 | Admire® 2F[1], Provado® 1.6[2] | Provado® 1.6, 3.25 fl. oz.; Admire® 2F, 1.3 fl. oz. | Admire® 2F – Apply narrow band directly below seed row up to 7 days before planting or as in-furrow spray during planting. Provado® 1.6 – Apply before infestation becomes damaging. | 3 | 21, 7 | 12 | Colorado potato beetle, aphid, flea beetle, leaf-hopper and potato psyllid |
| *Methamidophos (Monitor®)* | 40 | foliar | 1.2 pts. 4E | Apply when pest problem is observed. | 2.2 | 14 | 48 | Colorado potato beetle, aphids, flea beetle and leafhopper |
| *Permethrin (Ambush®, Pounce®)* | 20 | foliar | 6 fl. oz. Pounce®3.2EC | Apply as needed when problem is observed | 1.5 | 7 | 24 | Colorado potato beetle, aphid, flea beetle, leaf-hopper and potato psyllid |
| *Disulfoton (Di-Syston®)* | 42 | in-furrow soil | 1 pt. 8E | Apply at planting | 1 | 75 | 48 | Colorado potato beetle, aphid, flea beetle, leaf-hopper and potato psyllid |
| *Oxamyl (Vydate® L)* | 14 | seed furrow, broadcast or foliar | 1 gal. | Seed furrow: during planting. Broadcast: pre-plant within 1 week of planting and incorporate 4 to 6 inches. Foliar: if needed after scouting. | 1 | 7 | 48 | Colorado potato beetle, aphid, flea beetle and leafhopper |
| *Azinphos-methyl (Guthion®)* | 25 | foliar | 1.5-3 pts. 2EC | Apply as needed, at least 7 days apart. | up to 3 | 7 | 72 | Colorado potato beetle, flea beetle and leafhopper |
| *Carbaryl (Sevin®),* | 2 | foliar | 1pt.-4 pts. 4F 1lb.-1.5 lbs XLR Plus | Apply as needed after scouting. | 1 | 0 | 12 | Colorado potato beetle, flea beetle, grass-hopper (on field borders), and leafhopper |
| *Methomyl (Lannate® LV)* | 45 | foliar | 1 qt. | Apply when insects first appear. Repeat as necessary. | 1.5 | 6 | 48 | Aphids, flea beetle, cabbage looper and leafhopper |
| *Methyl-parathion (Pencap®-M)* | 25 | foliar | 1 pt. | Apply when insects first appear. | 1 | 5 | 48 | Colorado potato beetle, flea beetle, and leafhopper |
| *Chlorpyrifos (Lorsban 4E)* | 30 | foliar | 0.5-1 pt. | Apply on field edges and roadsides when grasshoppers are small. | 1 | 5 | 48 | Grasshopper |

[1]Applied as narrow band, in furrow or sidedress.

[2]Foliar application.

**Colorado potato beetle** – *Bacillus thuringiensis (Bt)*, variety *tenebrionis* and variety *san diego* are registered as bacterial controls. The pink spotted lady beetle (*Coleomegilla maculata*), a ground-dwelling beetle (*Lebia grandisa*), and the spined soldier bug are beneficial insects. *Beauveria bassiana* is an insect-pathogenic fungus that infects the larvae. *Beauveria* is used as a fungal microbial insecticide in some countries. Information on the efficacy of using these organisms for controlling the Colorado potato beetle is incomplete.

**Potato aphid** – The sevenspotted lady beetle, pink spotted lady beetle (*Coleomegilla maculata*), and convergent lady beetle are potato aphid predators. The pink spotted lady beetle and the convergent lady beetle are commercially available.

**Leafhopper** – Common green lacewings prey on leafhopper eggs and they are available commercially.

**Potato psyllid** – The minute pirate bug, the damsel bug and the convergent lady beetle are effective predators on the potato psyllid.

**Cabbage looper** – *Bt* is registered for use in control of cabbage looper.

***Postharvest control practices:*** Clean the field completely of all leftover tubers, vines, weeds and debris. Bury or feed leftovers to cattle.

***Other issues:*** Growers in the High Plains had a big problem with *potato psyllid* in 1999. Much of the crop was wiped out. When the infestation was large, growers sprayed with imidacloprid but control was poor. Aerial applications were ineffective. It was speculated that the greater than average rainfall increased vegetation, which allowed the psyllids to move to other host plants when the potato fields were sprayed and then return to the potatoes later. Growers believe they need more effective control methods. Optimum application methods, timing of control, and insecticides used are factors that need to be evaluated. Phorate is effective against potato psyllid but should be applied early before the infestation gets large. Growers in the High Plains did not anticipate a large infestation of potato psyllid in 1999.

***Alternatives:*** Novartis is in the process of applying for a label for thiamethoxam (Actara, Adage™) for use on potatoes, as well as cole crops, fruit and leafy vegetables and cucurbits, to control aphids, whiteflies and lepidopteras.

## Soil insects

**Wireworms, flea beetles** (*E. cucumeris*), and **white grubs** (*Phyllophaga* spp.)

***Frequency of occurrence:*** Sporadic occurrence is typical.

***Damage caused:*** Wireworms damage planted seeds and plant roots, which results in poor stands or complete loss. They also will bore into large roots, stems and tubers, reducing yields and quality.

Flea beetles chew numerous, very small, rounded or irregular holes in the foliage. The leaves look as though they have been peppered with fine shot. When holes are numerous, the leaves may wilt and turn brown, killing or stunting the plant.

White grubs will feed on roots and other underground plant parts. Most severe infestations occur on crops following grass.

***Percent acres affected:*** Fifty (50) percent to 75 percent of Texas potato acreage is affected by soil insects.

***Pest life cycles:*** Wireworm eggs are small, pearly white and spherical. A newly hatched larva or wireworm is white, and less than 1/8 inch. Mature larvae range from 1/2 inch to 1 inch in length. It takes 1 to several years, depending on species, for the larvae to complete development. After a short pupation period adults emerge, usually in May or June, and lay eggs. Eggs hatch in approximately 5 weeks.

Flea beetle adults diapause in the soil or in crop remnants. They become active in the spring and feed on the potato plants as new growth appears. They lay eggs on or in the soil near the plant base. The eggs hatch in about 1 week and the larvae feed on plant roots or tubers for 2 to 3 weeks. Then they pupate and the adults emerge. The life cycle from egg to adult may be completed in 6 weeks or less. One to four generations develop each year depending on the species. Adult feeding may last more than 2 months.

The white grub life cycle varies with species, but ranges from 1 to 3 years. Eggs are deposited in the soil. Larvae will migrate up and down through the soil with seasonal changes in temperature. Adults emerge from the soil during the spring when mating and egg laying take place.

***Timing of control:*** Pesticides are applied when necessary as determined through scouting activities. In the High Plains, initial foliar applications for insect control are not needed until about the middle of the growing season.

| Table 2: Chemical Controls for Soil Insects. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pesticide | % Acres Treated | Type of Appl. | Typical Rates | Timing | # of Appl. | Postharvest Interval (days) | Reentry Interval (hours) | Target Insects |
| *Diazinon (Diazinon 4E)* | 10 | soil | 1 qt. | Apply just before planting. | 1 | 35 | 24 | Wireworm |
| **Note:** No insecticide is available for white grub control. They burrow deep into the soil and are hard to kill. | | | | | | | | |

***Yield losses:*** If present and not controlled, wireworms can cause 50 percent yield loss; flea beetles, 45 percent; and white grubs, 25 percent. White grubs generally are not a sufficient problem to merit applying insecticide.

***Regional differences:*** Soil insects are more of a problem in the High Plains than in the Winter Garden and the Lower Valley.

***Cultural control practices:*** Till the field adequately to destroy soil insects present in the soil. Deep tillage may be required. Rotate crops. Don't follow sod type crops with potatoes.

**Wireworm** – Avoid planting potatoes in fields immediately following clover, grass, pasture, small grains or weedy alfalfa. Summer fallow will reduce wireworm numbers by drying the soil. Avoid planting the same crop on the same land year after year.

**Flea beetle** – Keep fields free of weeds. Destroy plant residues and piles of cull potatoes to prevent beetle buildup. Destroy trash around plant beds where beetles diapause.

***Biological control practices:*** Apply insecticides judiciously. Only apply what is needed after scouting reveals that the economic threshold is reached to avoid killing beneficial insects. Follow recommended integrated pest management practices.

**Flea beetle** – Spined soldier bugs are natural enemies and are available commercially. Releasing spined soldier bugs for flea beetle control may not be practical, however.

***Postharvest control practices:*** Clean the field completely of all leftover tubers, vines, weeds and debris. Bury or feed leftovers to cattle.

***Alternatives:*** Fonofos, disulfoton, ethoprop and phorate are alternatives to diazinon for wireworm control.

## Diseases

**Early blight** and **late blight**: *P. infestans* (US - 8, A2 mating type)

***Frequency of occurrence:*** Both types can occur annually.

***Damage caused:*** Early blight (*Alternaria solani*) often kills lower leaves and reduces yields. Oval to angular dark-brown to black target spots develop on the leaves. The lowest or oldest leaves are infected first. There is often a yellow area around the spots. Tuber infection may appear as brown-black sunken spots. Under very humid conditions late blight (*Phytophthora infestans*) may produce white mold on the underside of the leaves. Lesions on infected leaves and stems become visible as small flecks within 3 to 5 days after infection. The infected tissue is initially water-soaked but becomes brown or black in a few days. Under high humidity, sporulation is visible as a delicate white mold surrounding the lesions. Under cool, wet conditions, blight may attack petioles and stems and ruin a field in a few days. Blight spores can infect tubers at harvest or while in the ground.

***Percent acres affected:*** Seventy-five (75) to 100 percent of Texas potato acres are affected by early blight, depending on weather conditions. Late blight affects 1 to 2 percent of the state potato acreage annually.

***Pest life cycles:***

**Early blight** – Mycelia and spores of *Alternaria* survive between crops in crop residue and on a wide host range. Spores are air-borne. Heavy infection occurs with frequent rain and heavy dews. Early blight is primarily a disease of senescent plants. Early symptoms appear on the oldest foliage (lower canopy). In the High Plains, early blight usually occurs from late May to early June.

**Late blight** – Spores of the late blight fungus are commonly carried by wind, reaching up to 100 miles in air, rain and equipment. Healthy seed pieces may be infested during seed handling and cutting operations. In the white cottony mycelial growth on lesions, microscopic lemon-shaped structures called sporangia form. These sporangia produce and release motile zoospores under cool, moist conditions. Rain may wash sporangia from blighted foliage to the tubers below, causing tuber infection. The late blight fungus overwinters in tubers in cull piles and in those left in the field. Late blight infections in these tubers provide initial inoculum for field infection. Infected seed potatoes also serve as an important source of inoculum. Current strains are resistant to metalaxyl and mefenoxam, previously an effective curative fungicide. Thus, late blight poses a much greater economic significance than in the previous decade.

***Timing of control:*** Fungicide seed piece treatments help reduce initial inoculum. Blight control efforts should be made throughout the growing season, including fungicide applications, depending on scouting results and weather conditions. Areas near outer points of center pivot irrigation systems should receive extra scouting and spraying because of increased leaf wetness.

***Yield losses:*** If not controlled, early blight can reduce yields by 40 percent. Late blight can reduce yields by 85 percent to 100 percent.

***Regional differences:*** Early blight is more of a problem in the High Plains than in the Lower Valley, but more of a problem in the Lower Valley than in the Winter Garden. Late blight is a sporadic problem in all potato growing areas in the state.

***Cultural control practices:***

**Early blight** – A 2-year rotation and good soil fertility help control early blight.

**Late blight** – Select fields for planting without trees or other obstacles for complete field spraying. Avoid overlapping pivots. Delay harvest about 2 weeks until vines are killed by chemical treatment. Commercial varieties do not have useful levels of resistance. Proper hilling and vine-killing practices reduce the exposure of tubers to spores. Use of disease-free seed treated with late blight-specific fungicides is important, because disease-free seed is not always available. Cull piles should be eliminated (buried or otherwise destroyed) before plants emerge in the spring. Foliage and vines should be completely

**Table 3: Chemical Controls for Early Blight and Late Blight.**

| Pesticide | % Acres Treated | Type of Appl. | Typical Rates | Timing | # of Appl. | Postharvest Interval (days) | Reentry Interval (hours) | Target Diseases |
|---|---|---|---|---|---|---|---|---|
| *Chlorothalonil (Bravo® Ultrex)* | 100 | banded (early season); broadcast (late season) | 1 lb. | Begin applications when vines are first exposed and when leaf wetness occurs. Repeat at 7- to 10-day intervals. | 5 | 7 | 48 | Early blight and late blight |
| *Mancozeb/ Maneb (Dithane® M-45, Manex®)* | 50 | foliar | Dithane® 2 lbs., Manex® 1.6 qts. | Begin applications when the plants are 2 inches to 6 inches high and repeat at 5- to 10-day intervals. | 2 | 14 | 24 | Early blight and late blight |
| *Propamocarb + Chlorothalonil (Tattoo™ C, Bravo®)* | 40 | foliar | 2.3 pts. | Apply when late blight is observed. | 2 | 5 | | Late blight |
| *Copper (Basic copper)* | 5 | foliar | 4.5 lbs. | Apply when disease appears and repeat at 7- to 10-day intervals. | 2.5 | 0 | 24 | Early blight and late blight |
| *Triphenyltin hydroxide (Super Tin®)* | 5 | foliar | 3 oz. | Apply when early or late blight is observed or when weather conditions are favorable. | 1 | 21 | 48 | Early blight and late blight |
| *Cymoxamil (Curzate®)** | 15 | foliar | 3.2 oz. | Apply when at high risk of late blight. | | 14 | 12 | Early blight and late blight |
| *Mancozeb + Dimethomorph (Acrobat® MZ)* | 10 | foliar | 2.25 lbs. | Apply when at high risk of late blight. | | 14 | 24 | Early blight and late blight |

**Note:** Applications of the different products are alternated throughout the season to prevent resistance to any one product.

*Use only in combination with a protectant fungicide (products containing mancozeb, chlorothalonil, triphenyltin hydroxide, metiram). Do not use Curzate® 60DF alone.

| Table 4: Alternative Controls for Blight. | |
|---|---|
| **Alternative** | **Efficacy** |
| Azoxystrobin (Quadris®; Zeneca) | Use as an alternative for early blight and late blight control. |
| Cymoxanil (Curzate®) and dimethomorph (Acrobat®) | Cymoxanil and dimethomorph are available for use with a Section 18. They can be used as alternatives for propamocarb to control late blight. |

dead and dry before harvest to avoid inoculating tubers. Crop rotation is not effective.

***Postharvest control practices:*** Clean the field completely of all leftover tubers, vines, weeds and debris. Bury or feed leftovers to cattle.

***Other issues:*** Early blight enters Texas on infected seed. Texas growers are reminded to make sure the seed they purchase has been tested and certified blight free.

## Seed piece decay

**Dry rot** (*Fusarium* spp.), **black leg** (*Erwinia carotovora*), **stem canker** (*Rhizoctonia solani*), **common scab** (*Streptomyces scabies*), and **silver scurf** (*Helminthosporium solani*).

***Frequency of occurrence:*** Occurrences of dry rot, black leg, stem canker, common scab and silver scurf are sporadic, depending on weather conditions (cool or wet conditions at or following planting), irrigation management and seed quality.

***Damage caused:*** Potato seed pieces can become infected with fungal or bacterial pathogens that cause decay of seed pieces, stems and developing tubers. Yield loss is due to loss of plant stand. During potato storage, silver scurf can cause black circular lesions to occur on the surface. This affects potato quality and marketability.

***Percent acres affected:*** One hundred (100) percent of the Texas potato acreage is affected with seed piece decay.

***Pest life cycles:*** Seed pieces can become infected by *Fusarium*, *Rhizoctonia*, and *Streptomyces* spp. (common scab) as well as bacterial soft rot pathogens. These pathogens may be soil-borne or seed-borne. The silver scurf pathogen overwinters on infected seed pieces and survives on crop, residue. The symptoms appear as a smooth, gray-to-silver sheen on the skin at the stem end of the tuber.

***Timing of control:*** A seed treatment is applied at time of seed cutting, immediately before planting.

***Yield losses:*** Yield losses of around 33 percent can result if seed pieces are not treated to control seed piece decay.

***Regional differences:*** Seed piece decay is a severe problem in the High Plains, a moderate problem in the Winter Garden, and a minimal problem in the Lower Valley.

***Cultural control practices:*** Seed quality is the most important factor in minimizing seed piece decay losses. Seed treatment with fungicides is the second most important consideration. Seed should be warmed to 50 degrees F before handling, cutting or planting. Seed planted into warm, well-drained soil will emerge faster, minimizing risk of loss. Shallow planting and light cultivation to break up compacted soil will increase soil temperature, improve oxygen levels around the seed piece and speed plant growth. Physiological disorders caused by lack of oxygen and cold temperatures during storage or in transit contribute to seed piece problems and poor stand establishment. Irrigation practices affect incidence of blackleg-soft rot complex.

**Table 5: Chemical Controls for Seed Piece Decay.**

| Pesticide | % Acres Treated | Type of Appl. | Typical Rates | Timing | # of Appl. | Postharvest Interval (days) | Reentry Interval (hours) |
|---|---|---|---|---|---|---|---|
| *Fludioxonil* (Maxim®)* | 50 | seed piece treatment | 0.5 lb./cwt seed pieces | Apply before planting. | 1 | NA | 12 |
| *Thiophanate-methyl + mancozeb* (Tops®, Manzate®)* | 50 | seed piece treatment | 1 lb./cwt seed pieces | Apply before planting. | 1 | NA | 12 |
| *Captan (Captan 10 D)* | 2 | seed piece treatment | 12 oz./100 lbs. seed pieces | Apply before planting. | 1 | NA | NA |

*One hundred percent of the acres are planted with seed treated with either thiophanate-methyl or fludioxonil. Some of the seed also is treated with mancozeb, captan and thiobendazole.

Chemicals used to control silver scurf include mancozeb, thiophanate-methyl, thiophanate-methyl + mancozeb, and fludioxonil.

***Alternatives:*** Thiophanate-methyl + mancozeb (trade name Tops® MZ) from Gustafson is sold as late blight control but is also good for tuber infection control and control of many soil pathogens.

***Other diseases:*** Blackleg-soft rot complex incidence has been increasing. These bacteria, especially *Erwinia*, survive in cool, moist soil. Good irrigation practices help prevent buildup of this disease.

## Nematodes

***Frequency of occurrence:*** Nematodes are a major problem where known infestations occur.

***Damage caused:*** Several species of nematodes are pathogenic on potatoes. Damage caused by the various species includes root injury that severely reduces yields and may accelerate the early dying disease; galling of tubers that causes serious quality defects, pruning, stunting, and necrosis of roots; and production of severely misshapen, scruffy and abnormal russetting of tubers. Nematodes feed on the potato and cause water blisters that dry into wart pimples. These will show as brown spots on the outside ring of potato chips. Nematodes also cause wet breakdown when the potatoes are hauled.

***Percent acres affected:*** Twenty (20) percent of potato acreage is affected by nematodes.

***Pest life cycles:*** Root knot nematode females lay eggs in jellylike masses on or just below the surface of infected roots and inside infected tubers. Tuber cells surrounding egg masses turn brown. Eggs inside tubers can survive winter conditions. The worm-shaped juveniles that hatch from eggs can move as far as 2 or 3 feet through moist soil, but usually travel only short distances to find a host plant. They penetrate roots just behind root tips, where the root surface has not been strengthened with age. The nematode's salivary secretions contain enzymes and plant hormones that stimulate the formation inside the root or tuber of "giant cells," greatly enlarged cells that supply the nematode with food. As they mature, females swell, become pear-shaped, and lose the ability to move. Nematode populations increase at a rate that depends largely on soil temperature and moisture and the number of nematodes present in the spring. Populations usually decline by more than 50 percent during the winter; spring populations consist mostly of eggs and juveniles.

***Timing of control:*** Fumigate the soil 2 to 3 weeks before planting or use liquid or granular nematicide and apply broadcast or banded at planting time.

***Yield losses:*** Nematodes cause up to 30 percent yield losses if not controlled. Root knot nematode damage can result in rejection of whole potato fields by buyers.

***Regional differences:*** Nematodes are a significant problem in the Winter Garden, but only a minimal problem in the High Plains and the Lower Valley.

***Cultural control practices:*** Crop rotation with unrelated crops is a sound practice for reduction of nematodes and other kinds of soil-borne problems. Summer weed free fallow is beneficial if wind and water erosion risks are low.

***Postharvest control practices:*** Land should be disked as soon as possible after harvest to ensure death and desiccation or decomposition of all host plant tissues. If other cultural considerations make it practical, a brief fallow period during hot weather can reduce populations of nematodes. During the fallow period, land should be disked at least twice to expose additional hosts to desiccation and sunlight.

## Weeds

Common broadleaf, grass and sedge weeds include pigweed, purslane, sunflower (including yellow top or prairie sunflower), Russian thistle, morning-

**Table 6: Chemical Controls for Nematodes.**

| Pesticide | % Acres Treated | Type of Appl. | Typical Rates | Timing | # of Appl. | Postharvest Interval (days) | Reentry Interval (hours) |
|---|---|---|---|---|---|---|---|
| *1,3 Dichloropropene (Telone® II)* | 1 | broadcast field soil treatment | 9-12 gals. | Apply at least 14 days prior to planting. | 1 | N.A. | 120 |
| *Ethoprop (Mocap®* 10 percent G) | 10 | broadcast field soil treatment | 60-120 lbs. | Apply prior to planting. | 1 | N.A. | 48 to 72 |
| *Oxamyl (Vydate® L)* | 1 | in-furrow, broadcast soil or foliar | 2 gals. | | | 7 | 48 |

glory, field bindweed, mustard, barnyardgrass, johnsongrass, Texas panicum, bermudagrass and nutsedge.

***Frequency of occurrence:*** Weeds are present and need to be dealt with every year.

***Damage caused:*** Weeds compete with crops and reduce yields. They interfere with harvesting and act as alternate hosts for insects and pathogens, especially nematodes.

***Percent acres affected:*** One hundred (100) percent of Texas potato acreage is affected by weeds.

***Pest life cycles:*** The broadleaf weeds pigweed, morningglory, purslane and sunflower are native to Texas and are warm-season annuals. Field bindweed is a broadleaf warm-season perennial introduced to Texas. Russian thistle is an introduced annual warm-season broadleaf weed. Mustard is an introduced annual cool-season broadleaf weed. Bermudagrass and johnsongrass are introduced perennial warm-season grasses. Barnyard grass is an introduced annual warm-season grass. Texas panicum is a native annual warm-season grass. Nutsedge is a native perennial warm-season sedge.

***Timing of control:*** Preplant, preemergence, and postemergence applications can be used.

***Yield losses:*** If present and not controlled each weed can cause an estimated yield loss as follows: barnyardgrass - 40 percent, bermudagrass - 15 percent, field bindweed - 20 percent, johnsongrass - 30 percent, morningglory - 25 percent, mustard - 60 percent, nutsedge - 40 percent, pigweed - 50 percent, purslane - 10 percent, Russian thistle - 20 percent, sunflower - 55 percent, and Texas panicum - 50 percent.

***Regional differences:***

**Barnyardgrass** is a significant problem in the Lower Valley but a minimal problem in the High Plains and the Winter Garden.

**Bermudagrass** is a small problem in the Winter Garden and a minimal problem in the High Plains and the Lower Valley.

**Johnsongrass** is a severe problem in the Lower Valley, a moderate problem in the Winter Garden and a minimal problem in the High Plains.

**Morningglory** is a significant problem in the Winter Garden and a minimal problem in the Lower Valley and the High Plains.

**Mustard** is a severe problem in the Winter Garden and a minimal problem in the High Plains and the Lower Valley.

**Nutsedge** is a severe problem in the Winter Garden, serious problem in the High Plains and a significant problem in the Lower Valley.

**Pigweed** is a serious problem in the High Plains and the Winter Garden and a substantial problem in the Lower Valley.

**Purslane** is a small problem in the Winter Garden and the Lower Valley and a minimal problem in the High Plains.

**Russian thistle** is a small problem in the High Plains and a minimal problem in the Winter Garden and the Lower Valley.

**Sunflower** is a severe problem in the Winter Garden and the Lower Valley but a minimal problem in the High Plains.

**Texas panicum** is a severe problem in the Winter Garden and the Lower Valley and a minimal problem in the High Plains.

***Cultural control practices:*** Cultivate once or twice after planting.

***Postharvest control practices:*** Use cultivation to control all weeds. Use postharvest application of herbicides for additional perennial weed control.

***Other issues:*** A 1992 report relying on 1989, 1990 and 1991 data gives estimates of crop losses due to weeds. According to the report, weeds reduce potato yields in Texas an estimated 12 percent under best management practices. If no herbicide is applied, it is estimated that yields would be reduced by 35 percent.

## Food Quality Protection Act (FQPA) Concerns

Organophosphates, carbamates and pesticides on EPA's B2 carcinogen list are said to be the most risky pesticides and those which EPA intends to evaluate first under FQPA. Therefore, uses of these pesticides may be in the greatest jeopardy of being withdrawn or reduced. Nearly half (19 of 39) of the pesticides used on potatoes are from these pesticide groups. Ten are insecticides (phorate, oxamyl, azinphos-methyl, carbaryl, methomyl, methyl parathion, chlorpyrifos, diazinon, methamidophos and disulfoton), seven are fungicides (chlorothalonil, mancozeb, maneb, propamocarb, iprodione, captan and ethoprop), and two are herbicides (metribuzin and EPTC).

**Table 7: Chemical Controls for Weeds.**

| Pesticide | % Acres Treated | Type of Appl. | Typical Rates | Timing | # of Appl. | Postharvest Interval (days) | Reentry Interval (hours) | Weeds Controlled |
|---|---|---|---|---|---|---|---|---|
| *Metribuzin*[1] *(Lexone® DF)* | 85 | soil and/or foliar | 0.33 lb. | Apply preemergence and/ or postemergence before weeds are 1 inch tall. | 1.5 | 60 | 12 | Johnsongrass, sunflower (yellow top), mustard and pigweed |
| *EPTC (Eptam® 7E)* | 65 | preplant, drag-off, or layby incorporate or by irrigation | 4 pts.; 7 pts. for nutsedge | Apply just prior to planting. | 1.5 | 45 | 12 | Purslane, pigweed morningglory, bermudagrass, barnyard grass, johnsongrass, nutsedge and Texas panicum |
| *Metolachlor (Dual® II Magnum)* | 50 | soil | 1 pt.-2 pts. | Apply postplant preemergence to weeds and crop. | 1 | 60 | 24 | Pigweed, barnyardgrass and johnsongrass. Suppresses purslane. Some control of yellow nutsedge |
| *Pendimethalin (Prowl® 3.3 EC)* | 50 | soil incorporate | 1.5 pts. | Incorporate after planting, before potatoes and weeds emerge. | 1 | | 12 | Pigweed, purslane, barnyard grass, johnsongrass and Texas panicum |
| *Paraquat1*[2] *(Gramoxone® Extra)* | 35 | soil | 1.2 pts. | Apply preplant and preemergence. | 2 | | 12 | Emerged broadleaf weeds and grasses. Kills tops and suppresses perennials. |
| *Linuron*[3] *(Lorox DF)* | 40 | broadcast spray weeds | 1.5-4 lbs. | Apply postplant preemergence, just before potato seedlings emerge. | 1 | | 24 | Pigweed, purslane, mustard, sunflower, lambsquarter and barnyard grass |
| *Trifluralin*[4] *(Treflan® HFP 4EC)* | 50 | soil and foliar | 1 pt.-2 pts. | Apply preemergence, postemergence. | 1 | | 12 | Pigweed, purslane, Russian thistle, barnyardgrass, johnsongrass, lambsquarter and Texas panicum |
| *Sethoxydim (Poast®)* | 100 | foliar | 1 pt. | Apply postemergence. | 1 | 30 | 12 | Barnyardgrass, bermudagrass, johnsongrass and Texas panicum |
| *Glyphosate (Roundup® Ultra)* | 50 | broadcast spray weeds | 0.5 pt.- 10 pts. | Apply preemergence prior to crop emergence. | 1 | | 4 | Bermudagrass, johnsongrass and wheat cover crop before planting potatoes |

[1]Not used in the High Plains.

[2]Do not apply later than ground cracking, before potatoes have emerged. Add approved nonionic surfactant or crop oil concentrate. Do not pasture livestock in treated fields.

[3]Apply before grasses are 2 inches tall. Do not spray over the top of emerged potatoes. If weeds are present, add 1 pt. surfactant/25 gal. spray mixture.

[4]Apply after planting, before emergence, following drag-off or after potato plants have fully emerged. Controls weeds by disrupting growth process during germination. Does not control established weeds.

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