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Texas Agricultural Extension Service
THE TEXAS A&M UNIVERSITY SYSTEM

Texas Crop Profile

ONIONS

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This profile on onion production in Texas gives an overview of basic commodity information; discusses insect, disease and weed pests; and covers cultural and chemical control methods.

Basic Commodity Information

State Rank:.............................Sixth in total U.S. production, from 1997-98 data.
Percent U.S. Production: ....7 percent
Acres Planted: 16,400
Acres Harvested: 14,600
Cash Value:.............................$70,197,000
Yearly Production Costs: ....$2,915 per acre

Commodity Destination

About 92 percent of the Texas onion crop goes to fresh market and 8 percent is processed.

Production Regions

The majority of Texas onions, approximately 55 percent, are grown in the Lower Valley. The balance is produced in the Trans-Pecos, the Winter Garden and South Texas, and the High Plains (see map on page 2).

Cultural Practices

Soil Preference: Onions grow best in fertile, well-drained sandy loam soils that have good moisture holding capacity and a pH range of 6.0 to 8.4, but they can tolerate a wide range of soil types. Avoid acid soils or heady, tight soils with poor internal drainage or those that crust. Liming can be used to adjust the pH.

Irrigation: Onions have a high moisture demand (25 to 30 inches per season or 1 to 3 inches per week). Critical periods occur at stand establishment and from bulb initiation through maturity. Watering is discontinued at the first evidence of falling tops. Moisture deficit stress can cause splits and doubles.

Land preparation: Prior to seed bed formation, crop and weed residue is shredded and the land is disked and plowed. Fertilizer and herbicides are applied, preplant.

Planting: Recommended soil temperatures for onions are less than 95 degrees F for fall planting and more than 50 degrees F for spring planting. The seeding rate is 2 to 4 pounds raw seed per acre or 10 to 20 pounds coated seed per acre. Plant at a depth of 0.25 to 0.75 inch, 2 to 4 inches apart in two to four rows on 38-inch to 40-inch raised beds or five to seven rows on 80-inch raised beds. Optimum planting times are in October in the Lower Valley, October through mid December in the Winter Garden and South Texas and late February and early March in the High Plains.

Varieties: The recommended short day (bulb initiation at 11 to 12 hours of sunlight per day) onion varieties are TX 1015®Y, Colossals Y, Ringer Y, Grano 502 Y, TX Grano 438, Rio Bravo Y, Rio Solo and TX Early White. Intermediate day

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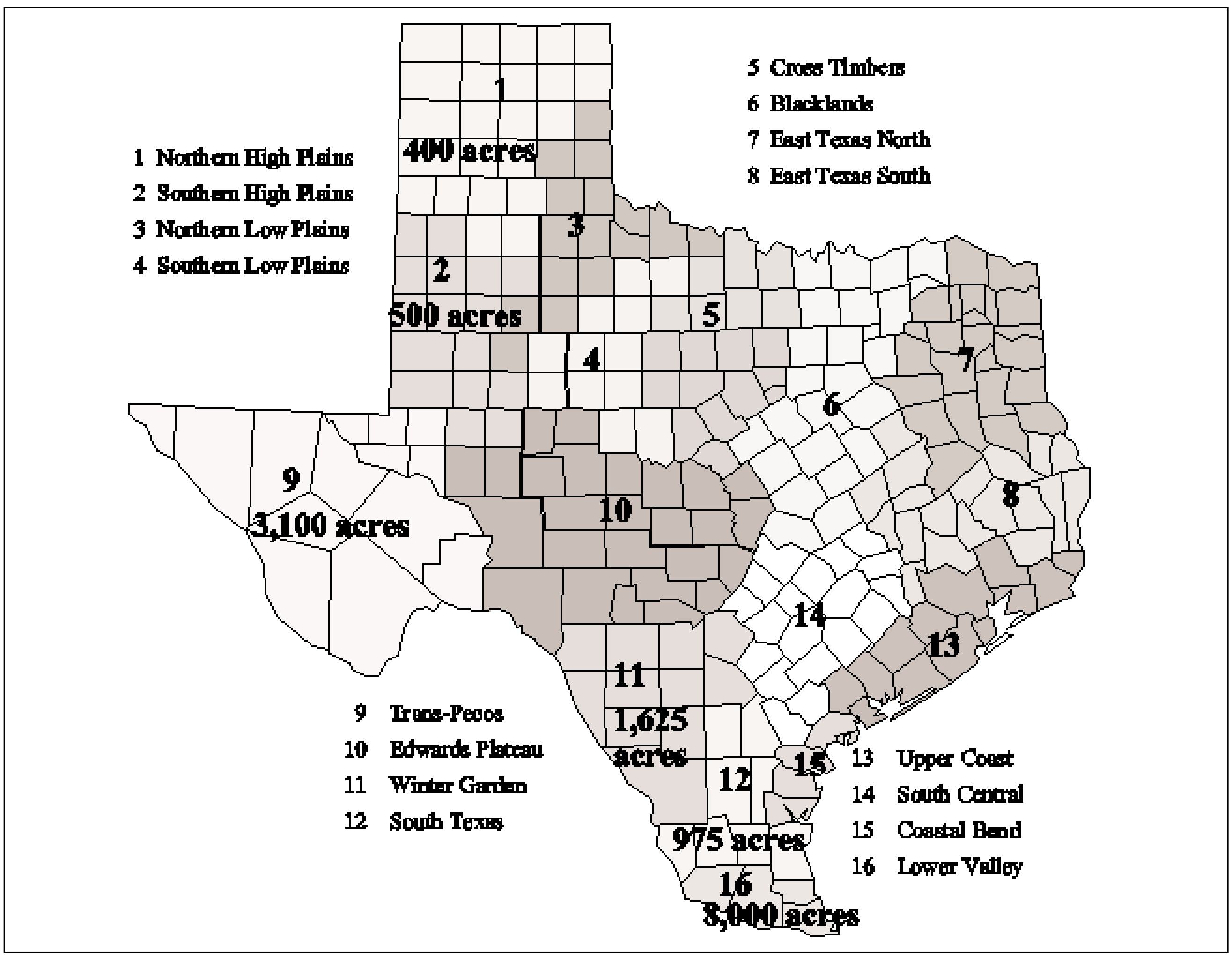
(bulb initiation at 12 to 13 hours of sunlight per day) varieties are Cimarron Y, Mid Star W, Spano Y, Dessex, Yula Y, Sunre 1462 R and Alabaster W. Long day (bulb initiation at 14 to 16s hour of sunlight per day) varieties are Armada, El Charo Y, Vaquero Y, Seville Y, Tango R, Blanco Duro W and Sweet Perfection Y.

Optimum growing conditions: Onions grow best under cool, moist-to-dry conditions from planting through early growth (mean temperature of 60 degrees F), and warm, dry conditions during maturity (bulbing favored by 70 degrees to 80 degrees F in combination with correct day length). No bulbing occurs below 50 degrees F regardless of day length.

Fertilization: In general, an acre of onions requires about 120 pounds of nitrogen, 80 pounds of phosphorus and 80 pounds per acre of potassium. Phosphorus is banded 2 inches below the seed at planting at a rate of 60 to 80 pounds per acre. In season, split nitrogen fertilization applications are recommended, applying 20 pounds preplant and 25 to 40 pounds side-dressed (banded, knifed or injected into irrigation water) on 3-week intervals until 40 days prior to maturity. If needed, 60 to 80 pounds per acre of potassium can be applied but this is normally not needed in most areas of Texas.

Chemical applications: In Texas, approximately 50 percent of the onion chemical pest control applications are made by air and 50 percent by ground.

Harvest: Onions are an 85-day to 210-day crop. Direct seeded production is harvested 120 to 210 days after planting. Transplants generally will be ready to harvest in 85 to 95 days. Harvest begins when 50 to 80 percent of the tops have fallen over. Normally, onions are dug mechanically and then picked up and bagged by hand. At the beginning of the harvest process, soil is loosened below the onion plants with wing sweeps or a rod weeder run several inches below the bulbs. After they are dislodged from the soil and roots and tops are clipped, the bulbs are sacked. Bags are allowed to field dry



Texas Onion Production–Number of acres harvested by production region, 1997-98 average.

prior to grading and packaging in 50-pound sacks or fiberboard cartons. Bulbs can be forced air dried at 90 degrees to 93 degrees F for 8 to16 hours. Grades are based on bulb diameters ranging from 1 inch (boilers/prepacks) to over 4 inches (colossal). Packed onions can be stored at 32 degrees F and 65 to 70 percent relative humidity for up to 8 months. However, most Texas onions are sold soon after harvest.

Pest Information

A wide variety of insects feed on onions. Sucking insects are onion thrips, western flower thrips, and spider mites. Soil insects are cutworm, wireworm, white grub, and onion maggot. Chewing insects include flea beetle, beet armyworm, and fall armyworm.

Fungi that impact onion production are blast, downy mildew, and purple blotch and pink root also can be a problem.

Nematodes cause root and bulb damage.

Common broadleaf weeds are lambsquarter, pigweed, purslane, London rocket, wild mustard, nightshade, ragweed, sunflower, sow thistle, barnyard daisy, croton, ironweed, prostrate spurge, spotted spurge, ground cherry, henbit, and field bindweed.

Grasses and sedges that impact production include johnsongrass, bermudagrass, Texas panicum, yellow nutsedge, and purple nutsedge.

Sucking Insects

Onion thrips (*Thrips tabaci*), **western flower thrips** (*Frankliniella occidentalis*), and **spider mites**

Frequency of occurrence: Thrips are present in onions on an annual basis and spider mites are occasional pests.

Damage caused: Thrips puncture plants and then suck the juice. This causes the formation of whitish blotches that first appear as dashes on leaves. Severely attacked plants develop a gray or silver appearance and may become distorted. Damage may be found first in the leaf sheaths and stem or on the undersides of a cupped leaf. Spider mites cause browning and stippling in the onion leaves and eventually cause the leaves to die.

Percent acres affected: Thrips can affect 100 percent of the onion production in Texas. Only a minimal percentage is bothered by spider mites.

Pest life cycles: The minute eggs of thrips are inserted into leaves or stems. Eggs hatch in 2 to 10 days and the subsequent larval stages last from 5 to 30 days. Adult females can reproduce regularly without mating with the rarely found males. All stages can be found during the summer but during colder months only adults and larvae are evident. It is probable that five to eight generations occur per year, but there may be more in the warmer parts of the state. Adult spider mites lay eggs on the leaf underside and spin webs beneath, where the eggs hatch and most mite feeding occurs. Spider mites reproduce rapidly during hot, dry weather.

Timing of control: The first chemical application is made when one thrips per plant is observed. Subsequent applications should be made when five thrips per plant are counted. Applications to control spider mites usually are not justified unless populations are extremely high.

Yield losses: Estimated yield loss from onion thrips and western flower thrips if not controlled is 40 percent from each. Estimated loss from spider mites is 10 percent.

Regional differences: Thrips are a problem in all onion growing regions of the state. Mites are more likely to threaten onion fields in the Winter Garden, South Texas and the High Plains.

Cultural control practices: Heavy rain or overhead irrigation can reduce thrips and mite populations. Some of the older onion varieties with more open canopy tend to support fewer thrips.

Biological control practices: Thrips on onions have few natural enemies. However, a biological agent's effectiveness can be improved by applying insecticides judiciously. If present, predatory mites can help curtail spider mite populations.

Other issues: Identification is crucial for adequate thrips control. It is important to determine if the thrips are onion or western flower so the proper control can be applied. Treatment is made at low levels of infestation rather than waiting for the population to build up.

Chemical controls: (See Table 1.)

Onion thrips – Cypermethrin, lambda-cyhalothrin, lindane, malathion, methyl-parathion and permethrin control onion thrips with varing degrees of effectiveness. (Pyrethroids have been used frequently for onion thrips control. Synthetic pyrethroids such as cypermethrin and lambda-cyhalothrin have been shown to lose their effectiveness within a growing season. For this reason, it is critical to have a number of insecticides from different classes registered in order to minimize resistance to pyrethroids.)

Table 1: Chemical Controls for Insect Pests of Onions.						
Pesticide	% Acres Treated	Type of Appl.	Typical Rates	Timing	# of Appl.	Target Insects
Lambda-cyhalothrin (Karate®, Warrior®)	100	foliar	3.2 oz.	cutworm[1], onion and western flower thrips[2]	3	Cutworm, onion maggot, beet army-worm and onion thrips. Suppresses western flower thrips.
Methomyl (Lannate®)	100	foliar	1.5 pts.	cutworm[1], western flower thrips[2]	2.4	Cutworm, beet armyworm and western flower thrips
Permethrin (Ambush®, Pounce®)	7	foliar	8 fl. oz. Ambush® 2E	cutworm[1], onion and western flower thrips[2]	2.5	Cutworm, beet armyworm, onion maggot, leafminer, western flower thrips and onion thrips
Cypermethrin (Ammo® 2.5 EC)	100	foliar	2.5 fl. oz. cutworms, 4 fl. oz. thrips	cutworm[1], onion thrips[2]	1	Cutworm and onion thrips
Methyl-parathion (Pencap®-M 2FL)	65	foliar	1.3 pts.	1 thrips/plant 1st app., 5 thrips/plant succeeding apps.	1.3	Onion thrips and western flower thrips
Oxamyl (Vydate®)	40	foliar	1.6 pts.	1 thrips/plant 1st app., 5 thrips/plant succeeding apps.	1.2	Western flower thrips

[1] Apply from emergence to three leaves.

[2] Make first application when one thrips/plant is observed and make succeeding applications when five thrips/plant are observed.

Western flower trips – Diazinon, lindane, malathion, methomyl, methyl-parathion, oxamyl and permethrin control western flower thrips with varying degrees of effectiveness.

Spider mites – Dicofol and dimethoate can be used to control spider mites when they are a problem.

Alternative chemicals: A new material, chlorfenapyr (Alert®), has shown promising results in recent field trials in New York. Spinosad (Conserve®SC) applied at the 0.178 pound active ingredient per acre rate has provided good thrips control in field trials in New York as well. The Interregional Project No. 4 (IR-4), a U.S.D.A. program that helps producers of minor crops obtain registered pesticides, scheduled residue trials on spinosad in onions in 1999. Thiamethoxam (Adage™), a new insecticide from Novartis, may be an effective alternative.

Pest management: The Texas Agricultural Extension Service coordinates a producer Integrated Pest Management (IPM) program in which thrips identification, economic thresholds and rotation of chemicals are used to manage thrips in onions.

Soil insects

Cutworm (*Agrotis ipsilon, Peridroma saucia, Feltia subterranea*) **wireworm, white grub** (*Phyllophaga* spp.), and **onion maggot** (*Hylemya antigua*)

Frequency of occurrence: These insects are rarely a problem in Texas onions. Cutworms and wireworms occur more frequently than white grubs and onion maggots.

Damage caused: Most species of cutworms sever the seedling just above or below the soil line and pull the plant into the ground as they feed. Wireworm damage to planted seeds and plant roots results in poor stands or complete loss. Wireworms also will bore into large roots, stems and tubers, reducing yields and quality. Growing the same crop on the same land year after year tends to increase wireworm populations. The onion maggot can be a serious pest of onions but rarely attacks other vegetable crops. Their larvae tunnel into onion bulbs, which subsequently may turn yellow and die before maturity. The onion maggot often will move from plant to plant, thus damaging several bulbs and thinning stands of young onions. Cull onions left piled on the ground are a source of insect infestation.

Percent acres affected: An estimated 40 percent of the state's onion acreage experiences cutworm problems and 12 percent has wireworm problems. White grubs and onion maggots seldom cause economic loss in Texas.

Pest life cycles: Cutworms deposit eggs singly or in small batches on low leaves or stems. There may be four or more generations in a year and overwintering occurs as larvae or pupae. Wireworms may be found at all times of the year. Adults lay eggs in the soil and a generation is completed in 1 to 6 years depending upon the species. White grub life cycle varies with species, ranging from 1 to 3 years. Eggs are deposited in the soil and larvae will migrate up and down through the soil with seasonal changes in temperature. The adults, which are beetles, emerge from the soil during the spring when mating and egg laying take place. Onion maggots deposit their eggs in leaf axles or in the soil near the base of the plant. Upon hatching, larvae crawl down the plant and feed for 2 to 3 weeks. They overwinter as pupae in the soil and may have two to three generations a year. Cool, wet weather favors development of serious onion maggot infestations.

Timing of control: Treat for cutworms when feeding damage is observed. When they are a problem, onion maggots are treated from planting through harvest. Wireworms and white grubs are controlled with preplant insecticide applications based on counts and field history.

Yield losses: Cutworms, wireworms, white grubs and onion maggots can cause an estimated 30 percent, 20 percent, 35 percent and 20 percent loss in yield, respectively, if not controlled.

Regional differences: Cutworms are more of a problem in the Lower Valley than the High Plains and the Winter Garden and South Texas. Wireworms, white grubs and onion maggots are more often a problem in the Winter Garden and South Texas than in the other onion growing areas of the state.

Cultural control practices: Cultivation to destroy weeds and other vegetation 10 to 30 days before planting may reduce the number of cutworm larvae in onions. Crop rotation is important in reducing wireworm activity. Keep fields clean and fallow for a period of time for white grub control. Crop rotation can be very effective for onion maggot control, but must provide at least 1 mile of separation between new seedlings and previous crops or cull piles. Because adult maggots (flies) are attracted to damaged onions, minimizing herbicide or mechanical damage can be helpful. Growers sometimes increase seeding rates to compensate for losses, but this can lead to nonuniform stands and bulb size because seedling loss occurs in patches, not uniformly over a field.

Biological control practices: Cutworm larvae have several natural enemies. Avoid unnecessary sprays to conserve these natural enemy populations. The fungus *Metarhizium* spp. is being tested as a natural enemy of white grubs. Onion maggots have several natural enemies that can be protected with the judicious use of insecticides. Knowledge is lacking about the effectiveness of natural enemies and on ways to increase their efficacy.

Postharvest control practices: Keep fields clean and free of weeds to assist in control of cutworms, wireworms and white grubs. Cleaning up all cull and volunteer onions before planting can make a field less attractive to onion maggot adults.

Other issues: Cutworms are often found in low lying areas of the field where there is moisture. New insecticides are being screened, cultural controls tested, and resistance patterns tracked for onion maggot control. Efforts are underway to locate genetic resistance to onion maggots in the onion and its relatives, but this type of control strategy is still years, perhaps decades, away. Foliar sprays for onion maggot control are of questionable efficacy since they must contact the adult, and flies migrate in and out of fields.

Chemical controls: (See Tables 1 and 2.)

Cutworm – Lambda-cyhalothrin, methomyl and permethrin are used to control cutworms.

Wireworms – Diazinon and lindane are used to control wireworms.

White grub – Soil applications of diazinon, chlorpyrifos and imidacloprid are effective in controlling white grubs.

Table 2: Chemical Controls for Soil Insects.

Pesticide	% Acres Treated	Type of Appl.	Typical Rates	Timing	# of Appl.	Target Insects
Chlorpyrifos[1] *(Lorsban 4E)*	50	in-furrow treatment	1.75 pts.	Apply at planting.	1	Onion maggot. Efficacy of Lorsban is becoming compromised because of resistance problems.
Diazinon (Diazinon AG500)	65	soil and foliar	1.7 pts.	Onion maggot and wireworm–apply just before planting. Western flower thrips–apply as thrips appear.	1	Onion maggot, wireworm and western flower thrips

[1] The onion maggot has displayed a marked ability to develop resistance to insecticides. Resistance to chlorpyrifos has been documented in a number of onion growing areas, and while it is still at relatively low levels, the problem is becoming more widespread.

Onion maggot – Chlorpyrifos, cypermethrin, diazinon, lambda-cyhalothrin, lindane, malathion and permethrin are used to control onion maggot.

Alternative chemicals: Imidacloprid (Admire®) may also be effective but it is currently not registered for use on onions. The onion industry is in dire need of effective alternatives to chlorpyrifos and, until at least one other effective insecticide is registered and available for use, producers must depend on chlorpyrifos for onion maggot control. While diazinon is labeled for use, it does not provide commercially acceptable levels of control. Federal registration of cyromazine seed treatment would be a first step, but more options are needed. Cyromazine (an insect growth regulator) can be very effective, but is somewhat weather dependent. Fipronil (applied as a seed treatment at 0.04 pound active ingredient per acre) appears to be highly effective against this pest. A new material, thiomethoxam (Adage™) from Novartis, may also prove to be a useful alternative.

Chewing insects

Flea beetle, beet armyworm (*Spodoptera exigua*), and **fall armyworm** (*Spodoptera frugiperda*)

Frequency of occurrence: These insects are seldom a problem in onions.

Damage caused: Flea beetles scrape the surface of the leaves. Armyworm larvae may defoliate the onion plant.

Percent acres affected: Only a small portion of the Texas onion acreage is affected by chewing insects.

Pest life cycles: Flea beetle adults hibernate in soil or crop remnants. They become active in spring, feeding on new plant growth. Eggs are laid on or in soil near the plant base and hatch in about a week. Larvae feed on plant roots or tubers for 2 to 3 weeks, followed by pupation and adult emergence. Life cycle from egg to adult may be completed in 6 weeks or less. One to four generations develop each year depending on species. Adult feeding may extend over 2 months. In the southern part of Texas, all stages of the beet armyworm may be found throughout the year. In colder areas, the insect overwinters as an adult. Eggs are deposited in irregular masses of about 80 eggs that hatch in 2 to 5 days and larvae feed about 3 weeks before pupating in the soil. Egg-to-adult stage requires 24 to 36 days and there may be four generations per year.

Timing of control: Apply treatment for flea beetle control from emergence to two leaves. Based on larval counts, start treatment for armyworms at the first true leaf stage.

Yield losses: Estimated yield loss caused by flea beetles, if present and not controlled, is 5 percent. Loss caused by armyworms is 10 percent.

Regional differences: Beet armyworms are a problem more frequently in the Lower Valley and fall armyworms are a problem more frequently in the Winter Garden and South Texas.

Cultural control practices: Avoid planting onions close to other crops that are host plants for these insects.

Postharvest control practices: Keep fields clean of weeds and fallow after harvest.

Chemical controls: Diazinon can be applied to control flea beetles when they are a problem. Cypermethrin, lambda-cyhalothrin, methomyl and permethrin are used to control beet armyworms. (See Table 1.)

Fungi

Botrytis leaf blight (*Botrytis squamosa*), **downy mildew** (*Peronospora destructor*), and **purple blotch** (*Alternaria porri*)

Frequency of occurrence: Botrytis leaf blight occurs every year on most Texas onion acreage. Infestation ranges from very low to severe depending upon weather conditions and management. Purple blotch occurrence can be predicted by counting the number of hours that free moisture is present on the leaf surface. When 10 to 12 continuous leaf-wetness hours occur, purple blotch will develop. Downy mildew occurs sporadically but is serious when epidemics occur. It becomes less active as the season progresses into warmer weather.

Damage caused: Botrytis leaf blight is frequently associated with small whitish spots occurring along the entire length of an infected leaf. Most spots have greenish halos that at times appear to be water soaked. When the spots are numerous, the tip of the leaf may die back, giving the field a blasted appearance.

Purple blotch affects leaves, stems and bulbs. It appears, at first, as small whitish, sunken lesions with purple centers. These spots later enlarge and eventually encircle the leaf, progressing to darkened zones that sometimes retain the characteristic purple color. Bulbs can be infected during harvest, curing, storage and transit and the disease can spread rapidly to other bulbs causing extensive damage. The bulb rot is semi-watery and yellow at first with the color gradually turning wine-red and finally to a dark brown or black.

Downy mildew infection that produces local lesions and may be systemic generally occurs on leaves greater than 10 inches in length. The older, outer leaves often become infected with the disease first. It appears as pale-green, oval to elongate slightly sunken lesions on leaves and seed stalks. In moist weather, these areas may be covered with a fuzzy, pale, purplish mold. Later the whole leaf may turn a dull pale green and then yellow. Bulbs produced by affected plants are often smaller than normal.

Percent acres affected: Botrytis leaf blight and purple blotch affect 100 percent of the states onion acreage and downy mildew affects 8 percent.

Pest life cycles: The Botrytis leaf blight fungus survives on plant refuse as mycelium and in the soil as small black bodies called sclerotia. During cool, humid weather, plant debris and sclerotia give rise to airborne spores that lodge on wet onion foliage, germinate, and enter the plants. Foliage may be severely damaged with substantial reductions in yield. Onions appear to be highly susceptible to Botrytis leaf blight during the early stages of bulbing. Botrytis can proliferate in storage and cause botrytis leaf blight neck rot.

Purple blotch fungus overwinters as mycelium in diseased plant debris and produces spores under favorable conditions in the winter and spring. Onions may be infected at harvest or in storage through the bulb neck or through wounds in the bulb scales.

Table 3: Chemical Controls for Fungi.

Pesticide	% Acres Treated	Type of Appl.	Typical Rates	Timing	# of Appl.	Target Diseases
Chlorothalonil (Bravo® Ultrex)	100	foliar	1.5 lbs.	Apply mid to late in the season.	1.5	Botrytis leaf blight and purple blotch. Provides suppression of downy mildew.
Mancozeb/Maneb (Manzate® 80WP, Dithane® WSP, Dithane® M-45, Maneb 75DF, Manex® IIF)	80	foliar	Manzate® 80WP 2.1 lbs., Dithane® WSP 1.5 lb., Dithane® M-45 3.5 pts., Maneb 75DF 2.5 lbs., Manex® IIF 2 qt.	Apply early season when disease first reported in area; repeat at 7-day intervals until diseases decrease.	2	Botrytis leaf blight, downy mildew and purple blotch
Fosetyl-aluminum (Aliette® WDG, Alliette® WSP)	*5*	*foliar*	*2 - 3 lbs.*	Apply as a preventative if conditions of high humidity and cool evening temperatures that favor fungal development occur.	2	Downy mildew
Copper sulfate (Basic Copper)	*1*	*foliar*	*2 qts.*	Apply when plants are 4 to 6 inches high; repeat at 7 to 10 day intervals.	2	Downy mildew
Iprodione (Rovral® 4F, Rovral® F)	*30*	*foliar*	Rovral® 4F 1.5 pts., Rovral® F 1.5 lbs.	Apply when conditions favor disease development.	2	Botrytis leaf blight and purple blotch. The effectiveness of iprodione is improved when mixed with maneb, mancozeb or chlorothalonil at half the normal rates.
Mefenoxam + Chlorothalonil (Ridomil® Gold Bravo®)	*40*	*foliar*	*2 lbs.*	Apply when conditions favor disease development, but before infection.	2	Botrytis leaf blight, downy mildew, purple blotch

Note: These pesticides are used in rotation throughout the season.

Chlorothalonil note: Addition of surfactant will improve performance. Do not apply to exposed bulbs. Do not allow spray or drift to contact bulbs after lifting from soil.

Fosetyl-aluminum note: Apply in sufficient water for good coverage. Do not apply less than 10 gals./A by air (20 gals./A by ground). May be tank mixed with other foliar-applied fungicides and insecticides registered for use on onions except copper materials or acid type compatibility adjuvants. Do not apply more than seven applications per season.

Iprodione note: May be tank mixed with another fungicide. Do not make more than five applications per season (10 applications if tank mixed). Do not drench.

Downy mildew is a potentially serious disease of onions, particularly when onions are grown under cool, moist and humid conditions. The fungus over-summers as mycelium in infected onion bulbs left in the field after harvest and in cull piles. It may also persist in the soil to infect seedlings planted in the following season. Spores produced during the winter are carried by wind to infect new plants. Infection can spread very rapidly under cool, damp conditions.

Timing of control: Treat for Botrytis leaf blight and purple blotch throughout the season. Begin applications when 10 to 12 continuous leaf-wetness hours occur. Fungicide applications should begin for downy mildew when weather conditions are favorable.

Yield losses: When present and not controlled, Botrytis leaf blight, purple blotch, and downy mildew damage can reach estimated yield losses of 45 percent, 55 percent and 65 percent, respectively.

Regional differences: Botrytis leaf blight is more of a problem in the Winter Garden and South Texas and the Lower Valley than in the High Plains. There are no regional differences in frequency of occurrence of purple blotch and downy mildew.

Cultural control practices: Crop rotation (every 2 to 3 years) is helpful in managing Botrytis leaf blight, purple blotch and downy mildew but is not often practical. Avoiding damage to onions during harvest is helpful. Removal and destruction of cull and volunteer onions and planting only mildew-free transplants can reduce downy mildew problems

Postharvest control practices: Curing onions will help reduce purple blotch rots in storage. Remove onion debris and host plants that may harbor the fungus after harvest.

Other issues: It is important to correctly identify the disease before applying treatment.

Chemical controls: (See Table 3.)

Alternative chemicals: The following are used in combinations with, as alternatives to, or in rotation with chlorothalonil (their effectiveness varies compared to chlorothalonil alone): iprodione/fosetyl-aluminum, mancozeb/maneb, mefenoxam, copper and sulfur. A new pesticide not yet registered on onions is azoxystrobin; it is effective to some degree in controlling pink root, downy mildew, purple blotch and Botrytis leaf blight.

Fosetyl-aluminum, vinclozolin, copper, chlorothalonil, dicloran, and mancozeb/maneb can be used as alternatives or in rotation with iprodione with varying degrees of effectiveness.

Sulfur, sulfur + copper, copper, iprodione, chlorothalonil, and fosetyl-aluminum can be used as alternatives to or in rotation with mancozeb/maneb with varying degrees of effectiveness.

IR-4 scheduled residue trials on dimethomorph (Acrobat®) in onions in 1999. Dimethomorph is an alternative to fosetyl-aluminum and mefenoxam/chlorothalonil on downy mildew.

Tebuconazole (Folicur®) may be an effective alternative for Botrytis leaf blight control. IR-4 scheduled residue trials for tebuconazole in 1999. In recent trials, good levels of control have been achieved with the use of RH-141647 (experimental) and propiconazole (Tilt®). Fluazinam (Altima) has also shown good efficacy against Botrytis, but the company has not been interested in pursuing a label for onions.

Pink root (*Phoma terrestris*)

Frequency of occurrence: Occurrence is variable among fields within a region and between production areas, but is increasing in frequency and severity.

Damage caused: Pink root is a root disease resulting from soil-borne pathogens. The disease turns roots pink, then they eventually shrivel and die. Affected plants are usually not killed, but will have small, poor quality bulbs. The disease affects only roots. Infected plants often develop leaf tip die back and have a higher incidence of Fusarium basal rot.

Percent acres affected: An estimated 100 percent of Texas onion acreage is affected by pink root.

Pest life cycle: Pink root fungus is present in cultivated soils because it has a wide range of hosts including pepper, tomato, oats, wheat, squash, cantaloupe, cucumber, corn, sorghum, spinach and carrot. The fungus remains in the soil indefinitely. Soil fumigation has been shown to be effective for the control of this disease. The cost, however, is high.

Timing of control: Apply fumigant before planting, if cost effective, to control pink root. Fungicide soil and seed treatments are ineffective. Soil steaming and soil sterilization before planting reduce losses.

Yield losses: Estimated yield loss as a result of pink root is 10 percent in severe problem fields.

Regional differences: Pink root is more of a problem in the Lower Valley, the Winter Garden and South Texas than in the Texas High Plains.

Cultural control practices: The use of onion varieties resistant to pink root is the best control for this disease. Crop rotation (3 to 6 years) will also reduce losses. Avoid planting when soil temperatures are greater than 75 degrees F. Avoid plant stress.

Biological control practices: Some experiments have been conducted with a *Streptomyces* species bacterium for pink root control.

Chemical controls: (See Table 4.)

Nematodes

Frequency of occurrence: Occurrence is variable among fields within a region and between production areas, but is increasing in frequency and severity.

Damage caused: Nematodes feed on plant roots or injure the bulbs. Yields may be reduced and plant growth slowed. Maturity may be delayed, causing storage and other disease problems. Damage is especially apparent during dry periods when injured plants wilt prematurely. Damage can be severe but patchy.

Percent acres affected: An estimated 5 percent of Texas onion acreage is affected by nematodes.

Pest life cycles: Nematode species pathogenic to onions include the root knot nematode (*Meloidogyne* spp.), onion bloat nematode (*Ditylenchus dipsaci*), root lesion nematode (*Pratylenchus penetrans*), and stubby root nematode *(Paratrichodorus* spp.). The root knot and lesion nematodes are most important but low soil temperatures in winter limit their activity and reproduction. Root knot nematodes feed on and/or in roots of a wide range of plants. Nematodes can oversummer in a dormant state in the soil and maintain populations on susceptible crops and weeds. They cannot travel through the soil to any extent, but are rapidly spread by running water and con-taminated equipment, transplants, sets and bulbs. The mature female root knot nematode inside the root is immobile. Mature females lay eggs outside their body in a gelatinous matrix.

The onion bloat nematode also has a wide host range but is rare in Texas. They are spread in a similar manner to root knot nematodes. Onion bloat nematodes grow and develop in the leaf, neck and bulb tissues. They grow to maturity within 3 to 4 weeks and several generations may occur each season.

Timing of control: Fumigant application to control nematodes can be made before planting. However, fumigation is costly and rarely used.

Yield losses: Nematodes can cause yields to decline as much as 10 percent if not controlled.

Regional differences: Nematodes are more of a problem in the Winter Garden, South Texas and the Lower Valley than in the High Plains.

Cultural control practices: Rotate with poor-host crops (principally grain crops) for 2 years. Avoid the introduction of nematodes to clean fields from infected bulbs or from infested soil on equipment.

Chemical controls: Dichloropropene chloropicrin (Telone® C-17) is the only registered product. (See Table 4.)

Alternative chemicals: Chloropicrin and metham-sodium are alternatives.

Broadleaf weeds

Lambsquarter (*Chenopodium album*), **pigweed** (*Amaranthus* spp.), **purslane** (*Portulaca oleracea*), **London rocket** (*Sisymbrium irio*), **wild mustard** (*Brassica kaber*), **nightshade** (*Solanum* spp.), **ragweed** (*Ambrosia* spp.), **sunflower** (*Helianthus annuus*), **sow thistle** (*Pyrrhopappus* spp.), **barnyard daisy** (*Verbesina encelioidoes*), **croton** (*Croton capitatus*), **ironweed** (*Vernonia* spp.), **prostrate spurge** (*Euphorbia prostrata*), **spotted spurge** (*Euphorbia maculata*), **ground cherry** (*Physalis* spp.), **henbit** (*Lamium amplexicaule*), and **field bindweed** (*Convolvulus arvensis*)

Frequency of occurrence: Broadleaf weeds are present in onion fields every year.

Table 4: Chemical Control for Pink Root and Nematodes.

Pesticide	% Acres Treated	Type of Appl.	Typical Rates	Timing	# of Appl.	Target Pests
Dichloropropene/ chloropicrin (Telone® C-17)	*4*	Do not apply through any type of irrigation system.	10.8 - 30 gals. product per acre	Preplant soil treatment. Apply whenever soil conditions permit.	1	Pink root and nematodes

Alternative chemicals: Chloropicrin and metham-sodium.

Damage caused: Onions are very sensitive to competition from weeds and require almost 100 percent weed control for commercial production. Yield and bulb size are reduced by weed competition for moisture, fertility and sunlight. When grown from seed, onions are very slow to emerge, which gives weed seedlings a chance to become established before the crop emerges and weed pressure before bulb formation significantly reduces yields. Later in the season, weeds may shade the bulbs and keep onions from properly drying. Weeds that germinate later in the season have less impact on yield but can interfere with mechanical harvesting equipment.

Percent acres affected: One hundred (100) percent of onion fields are affected by broadleaf weeds.

Pest life cycles: Seeds can germinate throughout the season if adequate moisture is present. In the absence of regular moisture, flushes of seed germination often coincide with rainfall events or irrigation. Winter freezes help control freeze-sensitive broadleaf weeds in the Winter Garden and South Texas region.

Pigweed (*Amaranthus* spp.) is a vigorous annual that produces a very large number of seeds that can survive in the soil for up to 40 years. Within the pigweed group, the most serious species is redroot pigweed (*Amaranthus retroflexus*). Fields with a history of redroot pigweed should be treated with preemergence or early postemergence herbicides.

Lambsquarters (*Chenopodium album*) is a very adaptable weed that sets thousands of seeds and, like pigweed, can remain in the soil for many

Table 5: Chemical Controls for Broadleaf Weeds.

Pesticide	% Acres Treated	Type of Appl.	Typical Rates	Timing	# of Appl.	Target Weeds
Bensulide (Prefar® 4E)	100	soil	5.5 qts. in 10-50 gal. water	Preplant	1	Lambsquarter, pigweed and purslane
Bromoxynil (Buctril® 4EC)[1]	12	foliar	10 fl. oz.	Postemergence. Soil and onion foliage should be dry at time of application; humidity should be low and dewshould be off the plants.	1	London rocket, lambs-quarter, wild mustard, night-shade, pigweed, ragweed, sunflower, sow thistle and croton
Oxyfluorfen (Goal® 2XL)	100	foliar	.75 pt.	Postemergence. Do not apply until at least two true leaves appear.	1.3	London rocket, black night-shade and sow thistle
DCPA[2] (Dacthal® W-75)	95	soil, preemergence	11 lbs. product per acre	Preemergence[3]	1	London rocket, lambs-quarter, nightshade, pig-weed, prostrate spurge, purslane, spotted spurge, ground cherry, henbit, johnsongrass and Texas panicum. Texas panicum, London rocket and henbit are difficult to control.
Trifluraline (Treflan® 4EC)	30	preplant incorporate	1 pt. product per acre	Incorporate once within 24 hours after application and again any time before planting.	1	Lambsquarter, purslane, pig-weed, sow thistle, henbit, johnsongrass, field bind-weed and Texas panicum
Paraquat (Gramoxone® Extra)	5	over the top of the weeds	1.5 pts. product per acre	Preplant, preemergence[4]	1	Kills emerged annual broad-leaf weeds and grasses; top kill and suppression of perennials and wild oats.

Note: Bensulide - Apply preplant incorporated at 1 inch to 2 inches, follow with immediate irrigation. Bromxynil – ground equipment or chemigation in at least 50 to 70 gal. water per acre. Bromoxynil is used more in the Winter Garden and South Texas than the High Plains and the Lower Valley.

[1] Bromoxynil is the only herbicide labeled on onions that will control sunflower. Therefore, it is important to have available when sunflower is a problem.

[2] DCPA is no longer in production and supplies are limited, therefore its use will be declining rapidly.

[3] Applied at seeding or transplanting and/or at layby. Layby applied either alone or in addition to preemergence treatment up to 14 days after planting. Preplant incorporation not recommended.

[4] Applied when weeds and grasses are succulent and growth is from 1 inch to 6 inches high (larger plants are less affected by treatment).

years. Most seeds germinate early in the growing season and control should be targeted for this time. Dense stands can smother onion seedlings.

Spurges (*Euphorbia* spp.) are annual broadleaf weeds that also present a large problem in onion fields. They have low growth habits and can go unnoticed until seed set has occurred. Mature plants may smother onion plants and pose a harvest problem.

Purslane, sunflower, sow thistle, barnyard daisy, croton and ragweed are annual warm season weeds native to Texas. London rocket, henbit and wild mustard are annual cool season weeds introduced to Texas. Nightshade is a warm season weed both native and introduced to Texas, annual and perennial. Ironweed, ground cherry and field bindweed are perennial warm season native weeds.

Timing of control: Most control occurs preemergence to the weed; occasionally postemergence control is necessary.

Yield losses: When the following weeds are present in the onion field and no effort is made to control them onion yields are estimated to suffer the indicated percent losses: lambsquarter, 55 percent; pigweed, 75 percent; purslane, 80 percent; London rocket, 40 percent; wild mustard, 50 percent; nightshade, 10 percent; ragweed, 100 percent; sunflower, 90 percent; sow thistle, 30 percent; barnyard daisy, 20 percent; croton, 40 percent; ironweed, 50 percent; prostrate spurge, 50 percent; spotted spurge, 25 percent; ground cherry, 40 percent; henbit, 20 percent; and field bindweed, 5 percent.

Regional differences: In the Lower Valley, common broadleaf weeds in onions include pigweed, ironweed, lambsquarter, purslane, sow thistle, wild mustard, ragweed, sunflower, London rocket, nightshade, barnyard daisy, croton, henbit, prostrate spurge, spotted spurge, ground cherry and field bindweed. Prominent weeds in the Winter Garden and South Texas include lambsquarter, pigweed, purslane, wild mustard, ragweed, sunflower, sow thistle and henbit. Pigweed and ironweed are problem broadleaf weeds in onions in the Texas High Plains.

Other issues: A 1992 report of 1989, 1990 and 1991 data gives estimates of crop losses from weeds. According to the report, weeds reduce onion yields in Texas an estimated 15 percent under best management practices. If no herbicides are applied, it is estimated that yields would be reduced by 50 percent.

Cultural control practices: Cultivate once or twice after planting. Hand hoeing is practical for light infestations.

Chemical control: (See Table 5.)

Alternative chemicals: Sulfuric acid, 5 gal. of 94 percent SA solution, will kill weeds with little onion damage.

Grasses and sedges

Johnsongrass (*Sorghum halepense*), **bermudagrass** (*Cynodon dactylon*), **Texas panicum** (*Panicum texanum*), **yellow nutsedge** (*Cyperus esculentus*), and **purple nutsedge** (*Cyperus rofundus*)

Frequency of occurrence: Grass and sedge weeds are present in onion fields every year.

Damage caused: Grass and sedge weeds reduce yield and bulb size through competition for moisture, fertility and sunlight.

Percent acres affected: One hundred (100) percent of onion fields are affected by grass and sedge weeds.

Pest life cycles: Grasses (*Gramineae* family) are serious pests in onion fields because of their vigorous growth and ability to produce copious amounts of seed. This group of weeds poses the greatest competition to onions. Grasses are also very tolerant to moisture and temperature extremes once they are established. All annual grasses should be controlled before they set seed. Winter freezes help control annual grass weeds in the Winter Garden and South Texas. Yellow and purple nutsedge (*Cyperus esculentus* and *Cyperus rofundus*) are extremely serious onion weed pests. Nutsedges are perennial monocots with grasslike foliage, but are not controlled with grass selective herbicides. Even light infestations can reduce onion growth and bulb size, and heavy infestations can force a producer to abandon entire fields. The plant reproduces by underground tubers called nutlets. These tubers can overwinter and survive soil temperatures of 20 degrees F. The nutlets sprout from May to late July and each sprouting tuber is capable of producing numerous plants. Johnsongrass and bermudagrass are warm season perennial grasses introduced to Texas. Texas panicum is a warm season annual grass native to the state.

Timing of control: Both preemergent and postemergent herbicides are used to control grasses and sedges. It is best to apply the herbicides when the weeds are small and more vulnerable.

Table 6: Chemical Controls for Grasses.

Pesticide	% Acres Treated	Type of Appl.	Typical Rates	Timing	# of Appl.	Target weeds
Metolachlor (Dual® 8E)[1]	60	foliar	1.5 pts.	Apply postestablishment to crop, preemergent to weeds.	1	Bermudagrass, johnsongrass, Texas panicum, other grasses and yellow nutsedge
Sethoxydim[2] *(Poast®)*	15	broadcast, band or spot spray	1.5 pts.	Apply postemergence.	1	Bermudagrass, johnsongrass, Texas panicum and other grasses
Fluazifop-P butyl (Fusilade® DX)	5	foliar	6-12 fl. oz.	Apply postemergence.	1	Bermudagrass, johnsongrass, Texas panicum and other grasses

[1] Dual® has a 24c registration. Dual Magnum will be replacing Dual 8E.

[2] Do not apply with any kind of irrigation system.

Note: No selective herbicide is available to control purple nutsedge in onions. Glyphosate (Roundup®) and Halosulfuron-methyl (Permit) will kill purple nutsedge but they will also kill the onions.

Yield losses: When present and not controlled, johnsongrass can depress yields by 45 percent, bermudagrass by 40 percent, Texas panicum by 33 percent, yellow nutsedge by 25 percent, and purple nutsedge by 25 percent.

Regional differences: Johnsongrass is a problem in onions grown in the Winter Garden and South Texas; bermudagrass is a problem in the Lower Valley and the High Plains; Texas panicum is a problem in the Lower Valley, the Winter Garden and South Texas; and yellow and purple nutsedge are problems in all three of these primary Texas onion growing regions.

Cultural control practices: Cultivate one to two times after planting.

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Produced by Agricultural Communications, The Texas A&M University System

Extension publications can be found on the Web at: http://agpublications.tamu.edu

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Chester P. Fehlis, Deputy Director, Texas Agricultural Extension Service, The Texas A&M University System.

New HORT 6-2, PP