Crop Profile for Lettuce in Arizona

Prepared February, 2000

General Production Information

- Arizona ranks second in the country in head, leaf and romaine lettuce production. Arizona accounts for 25.4%, 15.4% and 18.1% of national lettuce production, respectively, for these three crops. (1)
- From 1994/5 to 1997/8 an average of 53,275 acres of head lettuce have been grown. 17,574,000 hundredweight were produced at an average value of over 275 million dollars. (1)
- From the 1994/5 to 1997/8 an average of 5,075 acres of leaf lettuce have been grown. 1,585 hundredweight were produced at an average value of almost 53 million dollars. (1)
- From the 1994/5 to 1997/8 an average of 7,800 acres of romaine lettuce have been grown. 2,287 hundredweight were produced at an average value of over 49 million dollars. (1)
- 1998 Arizona vegetable crop budgets estimate that land preparation and growing expenses range from $1.50 to $2.57 for an 18-30 head, 47 pound carton of head lettuce. Total harvest and post-harvest costs are $3.33 per carton.(2)
- Land preparation and growing expenses for leaf lettuce in Yuma county are estimated at $1.79 for an 18-30 head, 47 pound carton while total harvest and post-harvest costs are $3.95 per carton. (2)
- Land preparation and growing expenses for romaine lettuce in Yuma county are estimated at $2.38 for an 18-30 head, 47 pound carton while total harvest and post-harvest costs are $4.35 per carton. (2)
- Arizona head lettuce is shipped direct to the U.S. retail market and to bulk lettuce processors. For the period between late December and early March, Arizona provides as much as 85% of the head lettuce for the U.S. market.(3)

Production Regions

Western head lettuce, grown in Yuma and La Paz counties, accounts for 95.7% of the head lettuce grown in Arizona by acreage. Lettuce is primarily grown along the Colorado and Gila rivers at elevations less than 100 feet. Average temperatures are 87 degrees in the summer and 55 degrees in winter. Summer daily maximums average 104 degrees while winter daily minimums average 40 degrees.

Cochise county in eastern Arizona and Maricopa, Pinal and Pima counties in central Arizona also have lettuce acreage.(4)

Cultural Practices

Head lettuce production in Arizona spans the fall and spring seasons. Planting can start as early as late August and continue through December. Depending on market conditions, planting may continue into February. Harvest begins in early November and will continue into April.(5)

Fields are usually deep chiseled and laser-leveled before beds are formed. Lettuce is seeded into 8 to 10 inch high beds on 40 to 42 inch centers. Beds are almost always oriented North-South to minimize light differences between the two rows per bed. Soil type is important in planting date, bed height and irrigation scheduling decisions. Planting rates vary because lettuce seed is temperature sensitive but fields are thinned 10" to 14" apart after plants show two true leaves.

At harvest, heads are stripped of outer leaves and boxed for shipping in the field. Lettuce to be sold unprocessed is packed in cartons of 24, naked or film-wrapped, for shipment from the field direct to retailers. Pre-packaged lettuce, the fastest growing segment of the leafy vegetable market, is bulk harvested for shipment to processing plants where heads are shredded for packaging. Because most lettuce undergoes little processing, great emphasis is place on producing a high quality product, free of pest damage and contamination at harvest. This is particularly important for "ready-to-eat" pre-packaged products.

Insect Pests

Field Crickets (*Gryllus* spp.)
Darkling Beetles (*Blapstinus* spp.)
Ground Beetles (Carabids)
Rove Beetles (Staphylinids)

These insects are annual pests in early planted sprinkler irrigated lettuce fields in the low desert. When they occur, they can quickly destroy most of a field. Problems are usually most severe in fields planted closely to cotton or Sudan grass in August and September. Moving out of cotton, Sudan grass and desert flora, large numbers will migrate to seedling lettuce if it is available. Most damage occurs at night. They hide during the day in soil cracks, ditches, weeds, and under irrigation pipes.

Cricket and darkling beetles will destroy a crop by eating the newly emerged seedlings. Although ground beetles and rove beetles do not feed on the plants and are usually considered beneficial insects, they often damage fall vegetable crops by digging and rooting up the seed and small seedlings.

Controls

These insects are difficult to monitor. Early planted lettuce in close proximity to cotton or Sudan grass should be considered high risk for damage and preventative controls are recommended.

Cultural

Destroy previous crops thoroughly and allow plant material to decompose thoroughly before planting lettuce. Because these insect species migrate readily into fields from outside sources, if possible avoid planting adjacent to cotton and Sudan grass.

Biological

There are no effective biological control alternatives available in head lettuce for controlling these pest species

Chemical
Under high risk conditions, preventative insecticide applications should be initiated as soon as seeds begin to germinate. Baits applied near field edges can suppress migrating populations. Chemigation of insecticides through sprinkler pipe during stand establishment can also be effective.

Arizona insecticide use on head, leaf, romaine and all lettuce (including unspecified) for the 1997-98 season. Information on Arizona pesticide use reporting is essential to interpreting use statistics.

Striped Flea Beetle (*Phyllotreta striolata*)
Potato Flea Beetle (*Epitrix cucumeris*)
Western Black Flea Beetle (*Phyllotreta pusilla*)
Western Striped Flea Beetle (*Phyllotreta ramosa*)

Flea beetle adults occasionally infest lettuce seedlings, directly consuming plant foliage. They are most common in spring and fall but may occur any time, especially in fields that are weedy or surrounded by weeds. Flea beetle adults primarily move into lettuce fields from surrounding crops and weeds. They feed on the underside of leaves causing numerous small, round or irregularly shaped holes or pits. Large populations of beetles can kill or stunt seedlings. If populations are high enough, flea beetles can cause severe loss just after thinning. Once plants have five leaves, they can tolerate five flea beetles per plant without any damage. Older plants are even more tolerant to feeding and will not be damaged unless populations achieve extreme densities. Beetles on plants at harvest are considered contaminants if found in the wrapper leaves or heads.

Controls

Cultural
Because these insect species migrate readily into fields from outside sources, cultural management is most successful when practiced on an area-wide basis. Remove weeds along field margins and deeply disk plant debris in infested fields after harvest. Some flea beetles have a wide range of hosts, so choose rotation crops carefully.

Biological
Flea beetles found in lettuce have every few natural enemies. There are no effective biological control alternatives available in head lettuce for controlling these pest species.

Chemical
Treat if you find several damaged rows. Baits are not effective. When pesticides are necessary, one treatment is usually sufficient, unless beetles are continually migrating into fields. Insecticides are most effective when temperatures are warm and the beetles are active.

Arizona insecticide use on head, leaf, romaine and all lettuce (including unspecified) for the 1997-98 season. Information on Arizona pesticide use reporting is essential to interpreting use statistics.

Lepidopterous Complex

Beet Armyworm (*Spodoptera exigua*)
Cabbage Looper (*Trichoplusia ni*)
Tobacco Budworm (*Heliothis virescens*)
Corn Earworm (*Helicoverpa zea*)

These lepidopterous species are key pests of lettuce. In Arizona, they are most prevalent from August through November on fall-planted lettuce, but can be found on lettuce throughout the season. The larvae feed on many field crops, including cotton and alfalfa, weed species and ornamentals. The adults migrate from these crops onto lettuce in the fall. The life cycles for these species are very similar.

Armyworms may severely stunt or kill seedlings. Damage to lettuce is usually not economically damaging between thinning and heading unless populations are high. However, once cupping begins larvae may bore into the head, rendering it unmarketable. Armyworm larvae enter heads from the bottom and often the damage cannot be seen without removing frame leaves and cutting the head open.

Cabbage loopers damage plants by eating ragged holes in leaves, boring into heads, and contaminating heads and leaves with their bodies and their frass. High populations can chew seedlings severely enough to kill them or slow growth enough to inhibit uniform maturing of the crop, but most economic damage occurs after heading. Young plants between thinning and heading can tolerate substantial feeding by loopers and other caterpillars without loss of yield or quality. Heads contaminated with loopers or tunneled into by loopers are not marketable.

Budworm/bollworm damage to seedlings is similar to that caused by the beet armyworm. Larvae feed in the plant's crown, and sometimes killing the growing point. Potential for damage decreases as the seedlings grow. Economic damage is not common between thinning and head formation. Once heads form, larvae may bore into the head. Once inside the head, Budworm/bollworm are protected and difficult to control with insecticides.

Controls

Monitoring for lepidopterous larvae on lettuce should begin before seedlings emerge. Control of beet armyworms on seedling lettuce is essential for stand establishment. Check weeds on ditch banks and field borders for larvae and egg masses as fields are being seeded. As soon as seedlings emerge, check for budworm and corn earworm eggs. Guidelines for monitoring lepidopterous larvae should be followed throughout the season.

Cultural

Cultural controls can help suppress armyworm populations. Disc field immediately following harvest to kill larvae and pupae. Sanitation along field borders is important; armyworms often migrate from weedy field edges into newly planted fields. Delaying lettuce planting until after nearby cotton is defoliated may help in reducing bollworm/budworm pressure.

Biological

There are several predators, parasites and viral diseases which may kill lepidopterous larvae, however, they can not be expected to provide economic control of populations because of the migratory nature of the pest, short cropping cycles, high crop quality standards, and intolerance for contaminated heads.

Chemical

Many growers have reported difficulty controlling beet armyworms with insecticides, and resistance to Lannate (methomyl) has been documented in Yuma County.(4) Proper timing targets the small larvae which are easier to control with insecticides. Addition of B.t to conventional insecticdes will usually increase control for beet armyworm and cabbage looper

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Black Cutworm (*Agrotis ipsilon*)
Variegated Cutworm (*Peridroma saucia*)

Granulate Cutworm (*Feltia subterranea*)

Cutworms include several species of moth larvae that clip plant stems near or just below the soil. They are often a problem in crops following Sudan grass or alfalfa. Large cutworms, up to almost 2 inches (5 cm) long, can destroy several plants each night; heavy infestations can remove most of a stand. Cutworms occasionally bore into lettuce heads causing damage similar to that caused by other caterpillars that enter the head. Some species may also damage leaves.

Controls

Cultural

Remove weeds from field margins and plow fields at least 10 days before planting to destroy cutworm larvae, food sources, and egg-laying sites.

Cutworms often recur in the same fields and in the same parts of fields >from year to year. Areas that have had a dense stand of weeds, crop debris disked in soon before planting, or located near an alfalfa field often have high populations.

Chemical

Baits containing insecticides are available for control of most species, but they will not control subterranean species. Baits are more effective when food is limited, so check for cutworms and get the baits out before the crop emerges, especially where cutworms have caused damage before. Once seedlings are up, treat as soon as you find several severed plants in the same row.

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Saltmarsh Caterpillar (*Estigmene acrea*)

Saltmarsh caterpillars are not normally a pest of fall grown vegetables but will often migrate in as larvae from neighboring cotton or alfalfa. Large populations can be extremely damaging to seedling lettuce. Large populations of larvae will move out of newly defoliated cotton and devour the young plants. After thinning, saltmarsh caterpillars are generally not a problem. However, they should be included in counts for Lepidopterous larvae. On older plants damage is distinctive. They prefer to feed in groups and will completely skeletonize several plants adjacent to each other.

Controls

Cultural

Scout adjacent cotton fields prior to crop emergence. It is best to control saltmarsh caterpillars before they enter the field. If possible, treat the population in the cotton field when it's defoliated.

Physical barriers are effective at preventing larvae from entering a field. Saltmarsh caterpillars do not like to cross fence type barriers of aluminum sheeting or irrigation pipe. These devises can be used to herd populations into holes containing cups of oil. Ditches filled with water containing liquid detergent or oil are also effective.

Chemical

Saltmarsh caterpillars are particularly sensitive to Bacillus thuringiensis.

Carbaryl can be sprayed around cotton fields or along ditches to kill migrating populations.

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Green Peach Aphid (*Myzus persicae*)
Potato Aphid (*Macrosiphum euphorbiae*)
Lettuce Aphid (*Nasonovia ribis-nigri*)

The green peach aphid is considered the most economically important aphid pest on lettuce. The green peach aphid is generally a pest in the spring. The potato aphid is similar to the green peach aphid in appearance and habit. The lettuce aphid has only appeared in desert lettuce production in the last year, and its impact under desert conditions remains unknown. It resides inside the lettuce head and is thus more difficult to detect and treat.

Large populations of aphids can be destructive to lettuce by stunting growth, delaying harvest and contaminating harvestable portions. Green peach aphids also serve as vectors for alfalfa mosaic virus, lettuce mosaic virus, and beet western yellows virus that affects lettuce. The potato aphid is not known to transmit viruses to lettuce.

Controls

Check fields twice weekly, but most intensely beginning mid-January. Always protect seedling plants, because they are most susceptible to stunting. Once lettuce nears head formation, green peach aphids cannot be tolerated. Adequate control is often difficult and follow-up scouting should be performed to determine if further control is necessary.

One instance of lettuce aphid infestation in romaine lettuce treated with soil-applied imidacloprid has been reported. Otherwise, lettuce aphid has responded to the soil-applied imidacloprid treatment approach. The Foxglove aphid, another newcomer to the area has so far only been found infesting organic lettuce.

Cultural
Green peach aphids are often most numerous in fields containing weedy mustards and members of the goosefoot family. Control of these weeds may help prevent buildup of green peach aphid.

Biological
There are several predators which feed on aphids including the convergent lady beetle (*Hippodamia convergens*) and syrphid flies (Family: *Syrphidae*). They can not be expected to provide economic control of populations because of the migratory nature of the pest, short cropping cycles, high crop quality standards, and intolerance for contaminated heads

Chemical
Lettuce planted so that harvest will occur during February and March, should be prophylactically treated with a soil-applied systemic insecticide at planting. Imidicloprid (Admire) is widely used and also controls for whiteflies. Despite low reported acres, anecdotal evidence puts usage at greater than 75% of lettuce acres (10).

Arizona insecticide use on head, leaf, romaine and all lettuce (including unspecified) for the 1997-98 season. Information on Arizona pesticide use reporting is essential to interpreting use statistics.

Sweet Potato Whitefly (*Bemisia tabaci*)
Silverleaf Whitefly (*Bemisia agentifolii*)(9)

Since the early 1990s, whiteflies have moved from an occasional pest and virus vector to a major, direct pest of lettuce. A new strain, *B. Agentifolii*, removes plant sap while feeding causing damage to the crop. Damage can be particularly severe in seedlings of fall planted lettuce because large populations can move from cotton and alfalfa with defoliation or cutting. Damage can include reduced head size, delayed harvest and leaf chlorosis. Contamination associated with the insects themselves, honeydew and sooty mold accumulation can cause severe economic damage.

Whiteflies are present year round in the primary vegetable growing areas in Arizona. Populations

peak in July and are at their lowest level during the winter months. The preferred plant host appears to be melons but a variety of crops, including cotton, alfalfa and lettuce, play a role in the seasonal dynamic. Because whiteflies are a year round problem on so many different crops, population management focuses on a system wide approach. Successful management of whiteflies involves preventing colonization of plants. Adult populations are managed so as to avoid establishment of immature whiteflies.

Controls

Cultural

The most important aspect of whitefly control for fall lettuce is the transition from alfalfa and cotton to fall crops. Planting lettuce away >from these host crops can minimize the possibility of migration when they are defoliated and harvested. Delaying plantings of fall vegetable crops until after most cotton has been defoliated and harvested can achieve the same end.

Proper crop management may allow lettuce seedlings to withstand greater whitefly pressure.

Sanitation, clean culture and rapid post-harvest destruction of host crops may reduce the magnitude and duration of whitefly movement.

Trap crops of melons have been used commercially for management of whiteflies in cole crops. Melon plants as the preferred host attract the whiteflies before they colonize cauliflower seedlings. Proper timing of treatment and removal of melons is essential.

Biological

Natural enemies and fungal pathogens have both shown a degree of efficacy on whiteflies but are not sufficient for necessary levels of control in vegetable crops.

Chemical

Soil applied imidacloprid is the industry standard for whitefly control in vegetable crops. It can provide up to season long protection against whiteflies and aphids. Expert opinion puts the usage at greater than 75% of planted acres(10) in general and greater than 90% for lettuce planted >from late August until October(15). Acres reported are low because Admire 2F (imidacloprid) is likely to be producer applied.

Imidacloprid is considered at risk for resistance problems. Imidacloprid is registered in melons and cotton as well as lettuce and thus whiteflies are potentially exposed to it year round. There is evidence of whitefly resistance to imidacloprid in California. Resistance problems in Spain in a growing region very similar to southwestern Arizona have resulted in field failures.(13)

When the risk of whitefly damage does not justify prophylactic treatment, responsive foliar treatments are available. Foliar treatments include imidacloprid(Provado) as well as synthetic pyrethroid/organophosphate mixes.

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Western Flower Thrips (*Frankliniella occidentalis*)
Onion Thrips (*Thrips Tabaci*)

Thrips have recently become a more important pest in lettuce production in Arizona. Thrips cause damage on outside leaves of head lettuce and can contaminate the inside of heads at harvest. Grower tolerance for thrips damage and contamination has recently become very low in naked and film wrapped head lettuce.(11)

Thrips are present year round but populations increase with the temperature >from January

through March. They migrate into lettuce from weeds and other host plants. Because thrips can move through the developmental cycle rapidly as temperatures increase and usually feed on the underside of leaves and in complex plant parts, control is difficult. Identification of species is important because western flower thrips are generally more difficult to control. Present control methods are only capable of maintaining pest population levels not reducing them making timing critical.(12)

Controls

Cultural

Thrips enter lettuce from weeds, native vegetation and other crops. Cultural methods do not provide effective control of thrip populations during the critical spring months.

Biological

Thrips appear to have few natural enemies.

Chemical

Because chemical controls only maintain present population levels, treatment is recommended while populations are still low. Coverage of underside of leaves is easier when plants are smaller. Afternoon treatment when adults are more active is also recommended. Frequency of application will depend on levels of insecticide residue and new migration of thrips into field.

Arizona insecticide use on head, leaf, romaine and all lettuce (including unspecified) for the 1997-98 season. Information on Arizona pesticide use reporting is essential to interpreting use statistics.

Vegetable Leafminer (*Liriomyza sativae*)*Liriomyza trifolii*

Liriomyza leafminers occasionally cause economic damage to seedlings and leaves of lettuce. The principal leafminer species in Arizona include *L. trifolii* and the vegetable leafminer, *L. sativae*. Problems with leafminers are most often attributed to nearby cotton fields.

Mining of leaves by the larvae is the principal cause of plant injury. The mines reduce plant photosynthesis, render leafy vegetables unmarketable, and provide an access for pathogens. When populations are high, plants may be killed or stressed to the point where pathogen can easily infect.

Controls

Monitor young seedlings regularly for the presence of leafminers. In lettuce, most mines occur on the cotyledons and first true leaves. After thinning, sample leaves from the middle portion of the plant. If leafminer populations build to high levels when seedlings have only four or five leaves, chemical treatment may be necessary. The threshold for leafminers in lettuce is an average of one or more active mines per leaf except on the marketable portions where damage is less tolerable.

Biological

Natural enemies, primarily parasitic wasps in the *Diglyphus*, *Opius* and *Chrysocharis* genera, usually maintain leafminer population below economic injury levels. Parasitoids are often killed by insecticides applied to control other pests such as beet armyworm. This results in a secondary outbreak of leafminers. Use of selective insecticides for control of worms will often preserve leafminer parasitoids so that treatment will not be necessary.

Chemical

Sticky traps can assist in determining when early migration takes place and also help in species composition. It is important to identify the leafminer species and what portion of your population is L. trifolii. This leafminer species is hard to control chemically.

Arizona insecticide use on head, leaf, romaine and all lettuce (including unspecified) for the 1997-98 season. Information on Arizona pesticide use reporting is essential to interpreting use statistics.

Trash bugs

False Chinch Bug (Nysius raphanus)
Lygus Bug (Lygus hesperus)
Threecornered Alfalfa Hopper (Sissistilus festinus)
Potato Leafhopper (Empoasca fabae)

Trash bugs is a term used to describe transitory insects that are often found in lettuce and leafy green produce crops. Because of the diversity of this class of insect pest it is impractical to describe the life history of each pest. Trash bugs are usually most severe during wet years when desert vegetation is plentiful, or in fields planted near alfalfa or ditch banks with cruciferous weeds.

Because of their transitory nature, trash bugs rarely cause direct damage to lettuce or leafy green vegetables. However, they can act as contaminates. When left untreated in head lettuce, they will often move under the cap leaf where they can not be easily detected or removed.

Controls

Cultural

Trash bugs can be culturally managed by controlling weed inside and near the field, and by avoiding cutting nearby alfalfa until after the produce is harvested.

Chemical

Although these cultural practices will help control the occurrence of trash bugs, insecticides are often required to prevent crop contamination. Before the appearance of harvestable portions, high populations of trash bug can be tolerated.

Arizona insecticide use on head, leaf, romaine and all lettuce (including unspecified) for the 1997-98 season. Information on Arizona pesticide use reporting is essential to interpreting use statistics.

Insecticide Use in Head Lettuce in Arizona, 7/1/97 to 6/30/98

Active Ingredient(AI)	Reports	Acres Treated	Mean Rate	% Acres		APH	LC	SE	LM	THR	WF
Methomyl	1,574	54,183	0.69	99.2%		X	X	X		X	
Cypermethrin	1,055	37,434	0.09	68.6%			X	X	X	X	
Permethrin	1,066	36,036	0.17	66.0%			X	X	X		
Spinosad	1,019	33,797	0.09	61.9%			X		X	X	
Zeta-cypermethrin	729	22,625	0.05	41.4%			X	X			
Bt (*Bacillus thur.*)	391	14,474	0.15	26.5%			X				
Lambdacyhalothrin	361	13,215	0.03	24.2%			X	X		X	
Tebufenozide	412	12,964	0.12	23.7%			X				
Diazinon	235	7,465	0.57	13.7%		X		X	X		
Acephate	218	6,478	0.84	11.9%		X	X		X	X	X

Endosulfan	123	4,482	0.91	8.2%		X	X			X	X
Imidacloprid	130	3,976	0.18	7.3%		X					X
Thiodicarb	89	3,099	0.67	5.7%			X				
Dimethoate	92	3,052	0.23	5.6%		X			X	X	
Disulfoton	34	1,207	1.13	2.2%		X				X	
Avermectin	14	436	0.01	0.8%					X		
Tralomethrin	13	344	0.02	0.6%		X	X	X			
Neem oil	16	161	0.87	0.3%							
Esfenvalerate	5	157	0.04	0.3%			X				
Cyromazine	5	155	0.10	0.3%					X		

APH - Aphids
LC - Lepidoperous complex -- beet armyworm, yellowstriped armyworm, cabbage looper, corn earworm, tobacco budworm and saltmarsh caterpillar
SE - Stand establishment pests -- Crickets, ground dwelling beetles, flea beetles, seed-corn maggot
LM - Leafminers
THR - Thrips
WF - Whiteflies

Insecticide Use in Leaf Lettuce in Arizona, 7/1/97 to 6/30/98

Insecticide use in leaf lettuce reflects the lack of registered uses of acephate, avermectin, cypermethrin and oxydemeton-methyl. Not as clear in use statistics are the effects of label restrictions increasing preharvest intervals and/or decreasing number of applications that affect active ingredients like dimethoate, disulfoton and endosulfan.

Active Ingredient(AI)	Reports	Acres Treated	Mean Rate	% Acres		APH	LC	SE	LM	THR	WF
Permethrin	1,093	22,571	0.18	322.4%			X	X	X		
Methomyl	547	12,267	0.67	175.2%		X	X	X		X	
Spinosad	423	8,342	0.09	119.2%			X		X	X	
Tebufenozide	150	3,554	0.11	50.8%			X				
Imidacloprid	154	3,147	0.11	45.0%		X					X
Bt (Bacillus thur.)	114	2,650		37.9%			X				
Dimethoate	72	1,539	0.24	22.0%		X			X	X	
Endosulfan	47	1,251	0.81	17.9%		X				X	X
Diazinon	46	840	0.54	12.0%		X		X	X		
Disulfoton	17	531	1.02	7.6%		X				X	
Neem Oil	4	271	2.30	3.9%							
Pyrethrins	13	252	0.02	3.6%						X	
Rotenone	6	122	0.01	1.7%							

Azadirachtin	6	113	0.01	1.6%					X		
Tralomethrin	3	91	0.02	1.3%		X	X	X			
Thiodicarb	5	87	0.64	1.2%			X				
Piperonyl butoxide	3	54	0.36	0.8%							

APH - Aphids
LC - Lepidoperous complex -- beet armyworm, yellowstriped armyworm, cabbage looper, corn earworm, tobacco budworm and saltmarsh caterpillar
SE - Stand establishment pests -- Crickets, ground dwelling beetles, flea beetles, seed-corn maggot
LM - Leafminers
THR - Thrips
WF - Whiteflies

Insecticide Use in Romaine Lettuce in Arizona, 7/1/97 to 6/30/98

Insecticide use in romaine lettuce reflects the lack of registered uses of acephate, avermectin, cypermethrin and oxydemeton-methyl. Not as clear in use statistics are the effects of label restrictions increasing preharvest intervals and/or decreasing number of applications that affect active ingredients like dimethoate, disulfoton and endosulfan.

Active Ingredient(AI)	Reports	Acres Treated	Mean Rate	% Acres		APH	LC	SE	LM	THR	WF
Permethrin	557	12,807	0.18	130.7%			X	X	X		
Methomyl	313	6,912	0.68	70.5%		X	X	X		X	
Spinosad	151	3,081	0.09	31.4%			X		X	X	
Tebufenozide	66	1,633	0.13	16.7%			X				
Dimethoate	49	1,281	0.24	13.1%		X			X	X	
Endosulfan	34	1,175	0.83	12.0%		X				X	X
Imidacloprid	28	1,035	0.05	10.6%		X					X
Diazinon	22	963	0.45	9.8%		X		X	X		
Bt (Bacillus thur.)	49	937	0.14	9.6%			X				
Pyrethrins	7	283	0.02	2.9%						X	
Thiodicarb	9	271	0.59	2.8%			X				
Rotenone	3	219	0.00	2.2%					X		
Azadirachtin	7	148	0.01	1.5%					X		
Neem Oil	5	49	1.70	0.5%							
Piperonyl butoxide	3	39	0.47	0.4% /td>							

APH - Aphids
LC - Lepidoperous complex -- beet armyworm, yellowstriped armyworm, cabbage looper, corn earworm,

tobacco budworm and saltmarsh caterpillar
SE - Stand establishment pests -- Crickets, ground dwelling beetles, flea beetles, seed-corn maggot
LM - Leafminers
THR - Thrips
WF - Whiteflies

Insecticide Use in All Lettuce (including "unspecified") in Arizona, 7/1/97 to 6/30/98

Active Ingredient(AI)	Reports	Acres Treated	Mean Rate	% Acres		APH	LC	SE	LM	THR	WF
Methomyl	3,161	97,905	0.69	137.1%		X	X	X		X	
Permethrin	3,326	92,569	0.17	129.6%			X	X	X		
Spinosad	2,078	63,434	0.09	88.8%			X		X	X	
Cypermethrin	1,578	55,842	0.08	78.2%			X	X		X	
Zeta-cypermethrin	1,090	34,724	0.05	48.6%			X	X			
Bt (Bacillus thur.)	846	28,765	0.14	40.3%			X				
Tebufenozide	807	25,533	0.11	35.8%			X				
Lambdacyhalothrin	475	17,879	0.03	25.0%			X	X		X	
Endosulfan	358	12,892	0.84	18.1%		X	X			X	X
Diazinon	393	12,639	0.57	17.7%		X		X	X		
Imidacloprid	419	12,045	0.15	16.9%		X					X
Acephate	340	11,441	0.84	16.0%		X	X			X	
Dimethoate	260	7,817	0.24	10.9%		X			X	X	
Thiodicarb	121	4,023	0.67	5.6%			X				
Disulfoton	80	2,818	1.00	3.9%		X				X	
Neem Oil	41	1,264	1.41	1.8%							
Piperonyl butoxide	17	656	0.22	0.9%							
Pyrethrins	26	633	0.02	0.9%						X	
Azadirachtin	16	478	0.01	0.7%							
Tralomethrin	17	457	0.02	0.6%		X	X	X			
Avermectin	14	436	0.01	0.6%					X		
Rotenone	11	386	0.01	0.5%					X		
Cyromazine	7	372	0.11	0.5%					X		
Esfenvalerate	9	337	0.04	0.5%							
Carbaryl	8	272	1.61	0.4%		X		X			
Oxydemeton-methyl	5	232	0.37	0.3%		X					
Malathion	8	205	2.39	0.3%		X					

Oxamyl	7	177	0.65	0.2%							

APH - Aphids
LC - Lepidoperous complex -- beet armyworm, yellowstriped armyworm, cabbage looper, corn earworm, tobacco budworm and saltmarsh caterpillar
SE - Stand establishment pests -- Crickets, ground dwelling beetles, flea beetles, seed-corn maggot
LM - Leafminers
THR - Thrips
WF - Whiteflies

Diseases

Bottom Rot (*Rhizoctonia solani*)

Rhizoctonia solani is one of the most common soil borne pathogens in Arizona. It survives indefinitely in soils because of its ability to colonize soil organic matter in absence of a live host. It is carried wherever infested plant parts or soils are moved. Disease can occur over a fairly wide range of temperatures. Bottom rot is most widespread on early season lettuce that matures from mid to late autumn with disease developing on plants that have headed and are nearly mature.

Controls

Cultural
Planting lettuce immediately after other crops known to be susceptible to *Rhizoctonia*, such as alfalfa, should be avoided.

Chemical
Preventative application of fungicide, such as iprodione or vinclozolin, immediately after thinning.

Arizona fungicide use on head, leaf, romaine and all lettuce (including unspecified) for the 1997-98 season. Information on Arizona pesticide use reporting is essential to interpreting use statistics.

Leaf Drop(*Sclerotinia minor*) and (*Sclerotinia sclerotiorum*)

Leaf drop infects lettuce during cool, moist conditions causing a soft, watery decay of the plant tissue. The leaves wilt, shrivel and drop down rapidly. Both fungi produce sclerotia, hyphal structures that enable them to persist in soils for long periods of time, especially under dry conditions. *S. sclerotiorum* in particular has a very wide host range, including many vegetables and bedding plants.

Controls

Cultural
Leaf drop may be managed by avoiding excess irrigation, especially when the leaves cover the bed surface, complete turning or deep plowing of the soil to bury and promote rotting of sclerotia and rotation with resistant crops such as corn and grasses.

Chemical
Preventative application of fungicide, such as iprodione or vinclozolin, immediately after thinning.

Arizona fungicide use on head, leaf, romaine and all lettuce (including unspecified) for the 1997-98 season. Information on Arizona pesticide use reporting is essential to interpreting use statistics.

Downy Mildew (*Bremia lactucae*)

Downy mildew is a foliar disease caused by an obligate fungal parasite. Cool, moist conditions are necessary for disease development. Free moisture on the leaf surface is essential for spore germination and infection, but not growth of the pathogen within the leaf. Initial symptoms are pale yellow regions on the upper side of older leaves with corresponding white fluffy growth, the spores of the pathogen, on the lower leaf surface. Infected areas are limited by leaf veins. Infected tissue turns brown. Infection stops when temperatures rise above the disease optimum of 50-72 F and free moisture from rain, irrigation or dew is absent.

Controls

Cultural
Disease can be managed by planting varieties of lettuce with tolerance or resistance to downy mildew.

Chemical
Preventative application of fungicides should be applied when there is a period of cool, moist weather, such as those periods of winter storms in Arizona, before disease is detected. Available fungicides include maneb, fosetyl-Al and metalaxyl, however insensitivity to metalaxyl has been reported for some time. Azoxystrobin, Quadris Flowable, has been granted an emergency exemption pursuant to Section 18 of FIFRA from February 26, 1999 through February 19, 2000. It is very important to alternate use of different chemistries to avoid development of resistance to other fungicides.

Arizona fungicide use on head, leaf, romaine and all lettuce (including unspecified) for the 1997-98 season. Information on Arizona pesticide use reporting is essential to interpreting use statistics.

Powdery Mildew (Erysiphe cichoracearum)

Powdery mildew is a foliar disease caused by the obligately parasitic fungus *Erysiphe cichoracearum*. Disease primarily affects plants approaching maturity. Unlike most foliar fungal diseases, it occurs in dry weather and develops in the absence of free water on leaf surfaces. Initial signs are small tufts of fungal growth on upper or lower leaf surfaces. As disease develops, much of the leaf may become covered by the fungal hyphae, giving it a powdery or dusty appearance. Masses of spores which are easily windborne are produced in chains from the hyphae. Low light intensity and high humidity seems to favor disease development.

Controls

Cultural
Powdery mildew can be managed if tolerant varieties of lettuce are available. Recent research indicates that Azoxystrobin has strong activity against powdery mildew as well downy mildew.(14)

Chemical
Preventative application of sulfur can be applied before disease begins.

Arizona fungicide use on head, leaf, romaine and all lettuce (including unspecified) for the 1997-98 season. Information on Arizona pesticide use reporting is essential to interpreting use statistics.

Viral Diseases

There are six viral diseases that have the potential of causing moderate to serious crop losses on southwestern Arizona lettuce plantings. They are Lettuce Infectious Yellows Virus, Lettuce Mosaic Virus, Beet Western Yellows Virus, Cucumber Mosaic Virus, Alfalfa Mosaic Virus and Big Vein. Of these diseases, big vein is the most common. For any of these viruses, there are no known chemical controls. Controlling insect vectors, eliminating other sources of host plant material, maintaining sound cultural and crop rotation practices and using only indexed seed are the only viable controls available to date for most of these viral diseases.

Fungicide Use in Head Lettuce in Arizona, 7/1/97 to 6/30/98

Active Ingredient(AI)	Reports	Acres Treated	Mean Rate #AI/Ac.	% Planted Acres		PM	DM	DAMP	LD	BR
Maneb	1,020	33,907	1.28	62.1%			X			
Fosetyl-al	331	11,767	2.53	21.6%			X			
Vinclozolin	237	6,639	0.96	12.2%					X	X
Mefenoxam	153	4,659	0.13	8.5%				X		
Iprodione	71	2,068	0.95	3.8%					X	X
Metalaxyl	17	452	0.23	0.8%			X			
Sulfur	1	76	2.25	0.1%		X				

PM Powdery mildew
DM Downy mildew
DAMP Damping off
LD Leaf drop
BR Bottom rot

Fungicide Use in Leaf Lettuce in Arizona, 7/1/97 to 6/30/98

Active Ingredient(AI)	Reports	Acres Treated	Mean Rate #AI/Ac.	% Planted Acres		PM	DM	DAMP	LD	BR

Maneb	402	10,040	1.27	143.4%			X			
Fosetyl-al	146	3,534	2.52	50.5%			X			
Mefenoxam	85	1,750	0.25	25.0%				X		
Iprodione	35	867	0.74	12.4%					X	X
Vinclozolin	38	859	0.88	12.3%					X	X
Metalaxyl	10	107	0.36	1.5%			X			
Sulfur	2	14	4.80	0.2%		X				

PM Powdery mildew
DM Downy mildew
DAMP Damping off
LD Leaf drop
BR Bottom rot

Fungicide Use in Romaine Lettuce in Arizona, 7/1/97 to 6/30/98

Active Ingredient(AI)	Reports	Acres Treated	Mean Rate #AI/Ac.	% Planted Acres		PM	DM	DAMP	LD	BR
Maneb	137	2,872	1.35	29.3%			X			
Fosetyl-al	77	1,844	2.46	18.8%			X			
Mefenoxam	23	786	0.12	8.0%				X		
Vinclozolin	21	369	0.89	3.8%					X	X
Metalaxyl	3	51	0.25	0.5%			X			

PM Powdery mildew
DM Downy mildew
DAMP Damping off
LD Leaf drop
BR Bottom rot

Fungicide Use in All Lettuce (including "unspecified") in Arizona, 7/1/97 to 6/30/98

Active Ingredient(AI)	Reports	Acres Treated	Mean Rate #AI/Ac.	% Planted Acres		PM	DM	DAMP	LD	BR

Maneb	2,156	70,037	1.31	98.1%			X			
Fosetyl-al	737	24,233	2.44	33.9%			X			
Vinclozolin	428	12,903	0.90	18.1%					X	X
Mefenoxam	311	9,349	0.16	13.1%				X		
Iprodione	156	4,618	0.84	6.5%					X	X
Metalaxyl	31	632	0.28	0.9%			X			
Sulfur	4	96	3.96	0.1%		X				

PM Powdery mildew
DM Downy mildew
DAMP Damping off
LD Leaf drop
BR Bottom rot

Weeds

Weeds can cause economic damage in lettuce production. They compete with lettuce seedlings for water, nutrients and sun. Weeds can also facilitate the introduction of insects and diseases into a lettuce crop. Since lettuce can be planted between August and December, a wide spectrum of weeds can be present during the vulnerable seedling stage. Summer annuals like pigweed (*Amaranthus* spp.), purslane (*Portaluc oleracea*), groundcherry (*Physalis wrightii*) and grasses, watergrasses (*Echinochloa crus-galli* and *E. colona*) and sprangletop (*Leptochola* spp.) can be a problems in August and September plantings. As the weather cools, lambsquarters (*Chenopodium* spp.), nettleleaf goosefoot (C*henopodiuim murale*), knotweed (*Polygonum* spp.) and cheeseweed (*Malva* spp.) are difficult to control. The later plantings are also likely to face competition from London rocket (*Sisymbrium irio*), shepherdspurse (*Capsella bursa pastoris*), canarygrass (*Phalaris* spp.) and wildoats (*Avena fatua*).

Weeds related to lettuce such as prickly lettuce (*Lactuca serriola*) and sowthistle (*Sonchus oleraceous*) are not controlled by any lettuce herbicides. Other difficult to control weeds that may occur in lettuce include annual clovers (*Leguminosae*), filaree (*Erodium* spp.) and nutsedges (*Cyperus* spp.).

Because the greatest risk of damage is in the seedling stage, preemergence herbicides are commonly used. The most common preemergence herbicides used in lettuce are pronamide, benefin and bensulide. Pronamide and benefin used in combination control many of the weed problems. Bensulide is particularly effective against grasses and some small-seeded broadleaved weeds (ie. pigweeds and purslane).. All three carry with them a risk of lettuce injury under certain growing conditions.(8) Use of these herbicides at the proper rate for soil type and application is essential to minimize risk of crop damage.

Benefin is applied preplant and incorporated with a disk before bed formation. Traditionally pronamide was incorporated with furrow irrigation. With a shift to sprinkler irrigation from furrow irrigation, pronamide has been found to be more effective when applied by air after the sprinklers have started. This avoids moving of the active ingredient below the germinating weed seeds. Bensulide has also been used more effectively when incorporated this way when used with sprinklers.

Controls

Cultural

Hand weeding is done when stand is thinned and again later if needed. Mechanical cultivation is also used.

Chemical
Paraquat and glyphosate are used as contact herbicides on fallow land prior to preparation for planting lettuce. Sethoxydim can be used post emergence to control grasses.

Efficacy of Preplant and Preemergence Herbicides Against Commonly Occurring Weeds in Arizona Lettuce (4)

	Benefin	Pronamide	Bensulide
Summer Grasses	XXX	XX	XXX
Pigweed	XXX	XX	XXX
Purslane	XXX	XXX	XXX
Groundcherry	XX	X	XX
Goosefoot	XXX	XXX	X
Lambsquarters	XXX	XXX	X
London rocket	XX	XXX	XX
Shepardspurse	XX	XXX	XX
Sowthistle	XX	XX	XX
Knotweek	XXX	XXX	X
Cereals	X	XXX	XX
Wildoat	X	XXX	XX
Canargrass	XXX	XXX	XXX
Bluegrass	XXX	XXX	XXX

XXX Excellent
XX Partial
X Poor

Herbicide Use in Head Lettuce in Arizona, 7/1/97 to 6/30/98

AI	Reports	Treated acres	Mean rate	% planted acres
Pronamide	289	8,413	0.92	15.4%
Benefin	136	5,847	1.29	10.7%
Bensulide	167	4,627	3.57	8.5%
Paraquat	13	547	0.81	1.0%
Trifluralin	7	532	0.12	1.0%
Glyphosate	8	504	1.15	0.9%
Sethoxydim	15	484	0.25	0.9%

Herbicide Use in Leaf Lettuce in Arizona, 7/1/97 to 6/30/98

AI	Reports	Treated acres	Mean rate	% planted acres
Pronamide	160	2,666	1.01	38.1%
Bensulide	172	2,639	4.16	37.7%
Benefin	37	1,220	1.25	17.4%
Sethoxydim	17	398	0.28	5.7%
Paraquat	3	31	0.69	0.4%
Glyphosate	1	38	1.13	0.5%

Herbicide Use in Romaine Lettuce in Arizona, 7/1/97 to 6/30/98

AI	Reports	Treated acres	Mean rate	% planted acres
Pronamide	121	2,681	1.09	27.4%
Benefin	20	416	1.36	4.2%
Sethoxydim	9	225	0.31	2.3%
Bensulide	14	217	3.78	2.2%

Herbicide Use in All Lettuce (including "unspecified") in Arizona, 7/1/97 to 6/30/98

AI	Reports	Treated acres	Mean rate	% planted acres
Pronamide	971	25,556	0.98	35.8%
Benefin	426	16,958	1.30	23.8%
Bensulide	477	10,459	3.56	14.6%
Paraquat	46	1,575	0.80	2.2%
Sethoxydim	50	1,323	0.27	1.9%
Glyphosate	11	697	1.21	1.0%
Trifluralin	10	629	0.22	0.9%

Arizona pesticide use reporting

The state of Arizona mandates that records be kept on all pesticide applications. Submission to the Arizona Department of Agriculture (ADA) of these pesticide use reports is mandated for all

commercially applied pesticides, pesticides included on the Department of Environmental Quality Groundwater Protection List (GWPL) and section 18 pesticides.

- Commercial applicators licensed through the state must submit Arizona Department of Agriculture Form 1080 Pesticide Use Reports for **all** applications. The use of commercial applicators varies across crops. Aerial application is all done by commercial applicators.
- The GWPL is a list of active ingredients determined by the Department of Environmental Quality to potentially threaten Arizona groundwater resources. Enforcement of this list is difficult. Strictly speaking, only specific types of soil application of GWPL active ingredients must be reported. Inclusion on the GWPL should indicate a higher level of reporting but without further research no useful distinctions can be drawn.
- Section 18 active ingredients should have 100% reporting. There were no section 18s active in Arizona lettuce in the 1997-98 growing season.
- Voluntary reporting does take place. Anecdotal evidence indicates some producers submit records of all applications

Reported pesticide usage provides a solid lower bound of acres treated and a mean application rate of reported applications. Relative magnitude of reported acres is useful for rough comparison but could reflect a bias among commercial applicators or differing reporting rates as a result of inclusion on the GWPL. Finally, while the quality of data from the ADA 1080 forms has improved dramatically in recent years, there is still the possibility of errors.

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