

# **Pest Management Strategic Plan for Turfgrass in the Low Desert Regions of Arizona, Southern California, and Southern Nevada-Southern Utah**

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**Turf PMSP Workgroup Invited Participants**  
**July 16, 2008**  
**Grace Inn, Phoenix, AZ**

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## **Executive Summary**

Turfgrass in the low desert regions of the southwest United States is grown and managed in residential and commercial landscapes, recreational and school facilities, golf courses and professional sports complexes. High intensity management practices and strategies are required for professional sports stadium turfgrasses and highly desirable for private and resort golf courses for optimal performance and playability. Streetscapes and municipal parks generally may have less maintained turf for aesthetic and general purpose uses. Professionally trained golf course superintendents, sports turf managers, commercial lawncare operators, and homeowners have subjectively different expectations for turfgrass quality. Each of them has different tolerance levels for weed infestations and insect or disease damage. Everyone employs cultural turf management techniques when they mow, irrigate, or fertilize turfgrasses but the frequency and amounts may vary significantly among them to achieve desirable quality turf. When cultural practices are not sufficient to reduce or minimize weeds, insect pests, or diseases, pesticides are commonly used on turfgrasses. This document describes the weeds, insect pests, and diseases that are commonly encountered in turfgrasses in the desert region. It will reveal many herbicides, insecticides, and fungicides that are readily available to provide measures of control to help achieve desirable turfgrass quality. However, there is a deficiency in the knowledge of insect pest species identification, lifecycles, and economic threshold levels for determining effects on turfgrass quality. Many weeds, insects, and diseases in the southwest behave differently under the very arid desert climatic conditions compared to other regions of the U.S. There is also limited locally-derived experience for informed pesticide use against weeds, insect pests, or diseases. Focused efforts against key insect pests, difficult to control weeds, and emerging and evolving diseases have enabled turf managers to maintain desirable quality turfgrasses in the desert regions.

## Summary of Critical Needs for Research, Regulatory, and Education

### Research:

- Develop and expand sound efficacy data against white grubs for insecticide use patterns specific to the desert (i.e. research needed on timing of application).
- Improve understanding of biology of white grubs species in the desert.
- Degree-day model development may aid in predicting emergence of white grub adult beetles.
- Develop economic threshold levels for white grub incidence and populations in the desert turfgrasses.
- Conduct research to determine specific timing of appearance of adults and immature stages and the types grasses affected by different species of billbugs.
- Species identification, biology, and population thresholds are needed for billbugs.
- Evaluation and validation of control methods for billbugs.
- Timing of applications of neonicotinoids for billbugs and grubs may coincide and needs to be substantiated through research.
- Chlorantraniliprole (Acelepryn) appears to be effective against grubs, billbugs and possibly other pests so research is needed to validate observations.
- Indoxacarb (Advion) is labeled for crickets and research is needed to evaluate efficacy against grasshoppers.
- Conduct appropriate efficacy field trials under local conditions as new control measures develop for lepidopteran pests.
- Evaluate and determine the distribution (dispersal and migration) and impacts of mole cricket on desert turf.
- Insecticides need to be evaluated for efficacy against mole cricket control in desert turf.
- Improve understanding of biology of pearl scale. Determine how widespread pearl scale is in desert region.
- Identify effective insecticides for pearl scale control.
- Determine level of tolerance of resistant varieties to pearl scale.
- Determine turf fertility inputs and sulfur effects on pearl scale.
- Identify effective management strategy for rove beetle utilizing mechanical management implements.
- Understand the biology of and identify specific types of fairy rings.
- Evaluate and determine control measures for fairy ring.
- Evaluate new chemistries of fungicides against rapid blight organism.
- Evaluate desirable turfgrass species for specific uses and sites to overcome rapid blight. Develop disease tolerant and resistant species of turfgrasses against rapid blight.
- Determine control strategies integrating fungicides with tolerant grass species and cultural practices against rapid blight
- Conduct fungicide efficacy and comparison research with current management options in desert turf.
- Conduct research and develop disease prediction models.
- Seek methyl bromide alternatives for sod production and golf greens renovation.
- Identify, assess, and quantify nematodes that are detrimental to turfgrasses.
- Understand and assess the distribution of nematode species in desert turfgrasses.
- Identify effective control products or management techniques, especially finding a NemaCur (fenamiphos) replacement.
- Explore resistant turfgrass varieties for nematodes.

- Conduct research on effective biological controls against nematodes and other pests, e.g. Nortica (*Bacillus firmus*) has not been investigated sufficiently in desert turf.
- Continue research on managing hard-to-control weeds, e.g. purple nutsedge, *Poa. annua*, mat chaff-flower.
- Continue field evaluations of new herbicides and re-evaluate combinations of herbicides for difficult to control weeds.
- MSMA replacement will be needed after 2012 for grass weed and purple nutsedge control strategies.
- Initiate or continue research on new weeds of economic concern.

#### **Regulatory:**

- Continue monitoring and surveillance to exclude red imported fire ant.
- Seek registration of chemical insecticides and biological control agents to control mole cricket in desert turf.
- Seek registration of new insecticides for pearl scale.
- Seek registration of insecticides that are effective for rove beetle control.
- Seek special local need (SLN) registration for 1,3-dichlorpropene (Curfew) for nematodes
- Extend registration of MSMA for all turfgrass uses when regulatory actions limit uses after 2012. Only spot treatment allowed on golf courses.

#### **Education:**

- Continue education programming to promote adoption of integrated pest management (IPM) strategies based on knowledge of pest identification and biology for more precisely timed insecticide applications against white grubs.
- Any new information about billbugs that is generated from research needs to be passed on to turf managers.
- Any new information that is generated from studies of biology and ecology of mole crickets and insecticide efficacy research needs to be transferred to turf managers.
- Any new information that is generated from insecticide efficacy research against pearl scale and rove beetles needs to be transferred to turf managers.
- Transfer fungicide research findings to turf managers to manage fairy ring and rapid blight.
- Improved education materials for problem solving and disease identification.
- Enhanced education on resistance management of fungicides, insecticides, and herbicides.
- Develop web-based disease identification tools.
- Nematode education needed to demonstrate how to sample and where to send samples for proper identification.
- Increase support for diagnostic labs that can facilitate pest and disease identification for clientele.
- Transfer weed control new technologies to end-users

## **Desert Turfgrass Production Overview**

Turfgrass in the low desert regions of Arizona, Southern California, and Southern Nevada-Southern Utah is utilized in landscapes, recreational and school grounds, golf courses and professional sports facilities. The region may be characterized as being arid with very little rainfall, high summer temperatures that are generally accompanied by monsoonal rains, and winters that will experience frosts. The similar climate in the region provides for transition zone turfgrasses of both warm- and cool-season grasses.

Over 775,000 residents and thousands of tourists play nearly 12 million rounds of golf annually on 300 golf courses in Arizona to support a \$3.5 billion industry (Schmitz, 2006). In the Palm Springs/Coachella Valley area of Southern California, there are about 120 golf courses. About 25 Golf courses have proliferated in the Las Vegas/Southern Nevada region.

Arizona is home to fifteen major league baseball teams in the Cactus League so there are ten professional baseball stadium complexes in the metropolitan Phoenix area. These stadium complexes have multiple (4 to 6) practice fields for each team and there are two additional facilities in Tucson (Table 1). The Cactus League during March each year generates over \$300 million at over 200 games that draw nearly 1.7 million fans.

There are three professional and university football stadiums, about twenty community colleges and private universities and about 150 public school districts with sports field complexes and playgrounds with turfgrass.

Turf enhances residential, homeowner association greenbelts, multi-family complexes, and commercial property landscapes. Active children and athletes play on turf in municipal parks and on privately managed sports fields. Cemeteries, churches, and other institutions and streetscapes (run-off retention basins and street medians) include turf in the landscape.

There are about four sod producers in Arizona that devote acreages to agronomic production of multiple species and varieties of warm- and cool-season grasses around the state (Table 2).

Allied businesses include turf management equipment sales and rental companies for mowers, sod-cutters, aerifiers, vertical mowers, sprayers, spreaders, sprinkler irrigation parts and supplies.

Fertilizers and plant protection products are necessary ingredients to maintain varying degrees of turfgrass quality. Management of weeds, insect pests, nematodes and plant diseases on landscape and recreational turf represents a significant amount of urban pesticide use with potential impacts on human health and a fragile desert environment. Therefore, presenting justification for this document.

In the desert, turfgrass production and management are extraordinarily challenged by the limited quantity and inferior quality of water. The limits imposed by water and subsequent influence on soils and fertility are intricately interwoven to impact pest management strategies and practices for desert turfgrasses.

Table 1. Sports facilities in Arizona

<u>Organization</u>	<u>Baseball</u>	<u>Football</u>	<u>Other</u>
Arizona Diamondbacks	Chase Field		
Arizona Cardinals		University of Phoenix Stadium	
University of Arizona	Sancet Stadium	Arizona Stadium	Hillenbrand Stadium (softball) Mulcahy Stadium (soccer) Drachman Stadium (track and field)
Arizona State University	Packard Stadium	Sun Devil Stadium	Farrington Stadium (softball) Sun Devil Soccer Stadium Sun Angel Stadium (track and field)
Cactus League	Glendale Goodyear Mesa Peoria Phoenix (2) Salt River Scottsdale Surprise Tempe Tucson (2)		

Table 2. Common turfgrasses and their uses

<u>Grass species</u>	<u>Cultivars</u>	<u>Brand name</u>	<u>Use</u>
Common bermudagrass	Arizona Common		Residential Parks Commercial Landscapes Golf fairways and roughs
Hybrid bermudagrass	Tifway 419 Tifgreen 328 MS Choice MidIron TifSport, TifDwarf Ultradwarf varieties	BobSod EZ Turf  Champion MiniVerde TifEagle Emerald	Golf fairways Golf fairways, greens Residential, sports fields Residential, sports fields Golf greens, sports fields Golf greens
Zoysiagrass			Residential
St. Augustinegrass			Residential, commercial
Seashore paspalum			Golf fairways
Perennial ryegrass			Overseed winter turf
Bentgrass			Golf greens
Roughstalk bluegrass Fine fescues			Overseed golf greens

## Desert Turfgrass Management Activities

Installation, renovation, and establishment are processes to begin growing turfgrasses and are followed by regular maintenance practices that include mowing, irrigating, fertilizing, and cultivating. Foremost in the desert, an automated sprinkler irrigation system must be designed and installed to adequately and uniformly deliver water on demand in a timely manner. Initial installation requires rough earth-moving and finer grading to achieve the desirable landscape or recreational/sport surface. The native soil should be adequately fertilized with starter fertilizer containing phosphorus to ensure rooting. The soil should be tilled to provide a uniform surface without large clods or rocks. Golf course greens and many of the newer baseball and football stadium fields are constructed with a drainage system on a uniform sand base medium.

Renovation provides an opportunity to correct or modernize an inadequate irrigation system. Changing one grass species to another or replacing a variety offers an opportunity to improve drainage on golf greens and other turfgrass sites.

Establishing turf from sod, sprigs, or seed is optimal for warm-season grasses during the early summer. Ideally, there should be adequate time for the roots of bermudagrasses to establish and grow rhizomes to survive through winter dormancy and then re-grow in the following spring.

Establishing a winter turf by overseeding a cool-season grass into the bermudagrass ensures year around lush green turfgrasses for aesthetic, recreational, and sports uses. Typically, perennial ryegrass provides the acceptable rapid time to establishment in the fall, desirable dark green color, fine leaf blade texture, traffic tolerance, and heat tolerance for establishment and maintaining qualities through the spring. Golf greens will often have a mixture of cool-season grasses that include roughstalk bluegrass, fine fescues, or seaside bentgrass with or without the perennial ryegrass.

Fall overseeding is ideally accomplished during October when daytime temperatures range in the 80°F's and nighttime temperatures are 55°F. However, overseeding begins in mid-September during the latter part of a still hot summer and extends to frost-threatening days in December. Many extended sports seasons and events often dictate actual timing of seeding. Commercial and residential landscape turf overseeding may be extended because of the volume and acreage of properties that have to be serviced.

Prior to overseeding, the bermudagrass should be in a non-stressed condition prepared for winter dormancy. Fertilization and irrigation should be reduced and mowing heights raised and lowered to remove the turf canopy to allow soil contact with the cool-season grass seed. Water should then be applied as frequently as possible throughout the daytime hours to maintain adequate moisture for the germinating seed. After seedling establishment, water applications can be reduced after a week or so and then first mowing can be done in another week or two.

Golf courses typically apply preemergence herbicides about 6 to 8 weeks before overseeding for *Poa annua* control. During the hot days in September, a few days before overseeding, an herbicide or plant growth regulator might be applied to reduce the competitiveness of the bermudagrass against the establishing ryegrass. The excessive irrigations may be conducive for seedling diseases that may necessitate fungicide applications. After the first mowing PGR's may be applied to suppress bermudagrass again and to encourage ryegrass to tiller and fill-in more rapidly.

Turfgrass that is desirable for specific use should be mowed regularly at designated heights of cut (Table 3). Sites where management intensity level is low, turf should be mowed at a weekly interval at a higher height of cut to avoid scalping and injury to the grass. Generally, no more than one-third of the height of the grass should be cut at any single mowing event. If scalping occurs, the mower height should be raised or frequency of mowing should be increased. Higher levels of management intensity require daily or more frequent mowings per week to maintain shorter heights of cut such as on golf course greens, tees, fairways, or sports fields. Golf greens may be cut at heights as low as 0.09 inch. Mowing heights are usually adjusted seasonally or when growing conditions affect grass vigor and growth rate.

During spring transition to bermudagrass from the overseeded cool-season grass, mowing heights are lowered to cause stress on the cool-season grass and to encourage the bermudagrass to resume growth coming out of dormancy and become competitive against the overseeded grass.

Table 3. Turfgrass mowing schedules

<u>Management level</u>	<u>Height of cut</u>	<u>Frequency</u>
High intensity	~ 0.1 to 0.18 inch golf greens ~ 0.5 inch golf fairways, sports fields	daily
Medium intensity	0.5 to 1.0 inch sports fields, golf course roughs	multiple during week
Low intensity	> 1 inch residential and commercial landscape, parks and schools	weekly

Irrigation is required for turfgrasses in the desert. Seasonal rainfall only in the winter and during the monsoons in the summer is not sufficient to maintain year around turf. Automated sprinkler irrigation systems for turfgrasses in residential and commercial landscapes, golf courses, parks, and sports fields deliver water on demand. Many golf courses and professionally managed sports turf are precisely irrigated based on evapotranspiration information and daily weather reports.

Golf courses, sports field complexes, and municipal parks are increasingly irrigating with reclaimed water. Non-potable water is recycled from water treatment plants and directed for industrial use or on to turfgrasses. Reclaimed water usually has high salt content, especially sodium that is detrimental to plant growth. Leaching sodium out of the rootzone is important to reduce harmful effects on turfgrass. In addition to cultivation practices and use of soil amendments such as gypsum, effective drainage systems are necessary to move salts down and away from turfgrass roots.

Cultivation in turf includes aerifying, vertical-mowing (verticut), and other activities that till the soil under the grass. Improving the soil profile in the rootzone alleviates compaction and provides for opening the pore space to allow air and water for root growth. Tine aerifying punches holes into the turf to create pore space. Core aerifying physically creates large pores several inches deep by removing cores of soil. Verticutting is a slicing action near the surface of the turf to cut through the thatch to allow air and water movement. Removing cores and verticutting helps remove organic materials that build up and restrict water movement to the roots. Topdressing with sand usually follows cultivation events with the coarser sand refilling the pores.

Fertilizing established turfgrass in landscapes is generally done economically with application of nitrogen. An early summer application should suffice as bermudagrass comes out of dormancy. If not overseeding for the winter, a fall application should prepare the bermudagrass for winter dormancy. Overseeded turf should be fertilized during establishment and iron applications can help maintain desirable color during the winter. Turf on sand-based golf greens or sports fields are fertilized precisely with balanced fertilizers that include critical micronutrients. Slow-release fertilizers are applied once or twice per year to turf so that required elements are made available in a timely manner when the grass is actively growing. Fertilizers can be spread on to turf as a dry granule or pellet. Additionally, many products can be solubilized in water and broadcast through the irrigation system.

Seasonally, preemergence herbicides are applied to turf to prevent emerging winter or summer weeds. These herbicides may be liquids applied with conventional broadcast sprayers or they may be granules or coated on to fertilizers to be spread with a broadcast spreader. Postemergence herbicides, most insecticides and fungicides are applied in water with a broadcast sprayer. Some insecticides may be applied as a granular formulation and then water into the soil to be activated. Specific information about herbicides, plant growth regulators, insecticides, and fungicides are further described in this document.

## **Integrated Pest Management Strategies in Desert Turf Production**

Within the unique desert environment are many microenvironments where turfgrasses are used for landscapes, recreational, and sports facilities. Residential and commercial landscapes that integrate turfgrasses, parks, schools, and golf courses are commonly situated adjacent to the undeveloped desert or may be located within a heavily urbanized neighborhood. Arthropod, disease, and weed invasions may vary depending on available corridors for movement between favorable environments. Baseball or football stadiums are significantly smaller acreages and surrounding walls, adjacent buildings and developments can exclude or limit potential pest problems. Managed turfgrass growing adjacent to native deserts is frequently prone to migrations of arthropod pests when the rainfed vegetation dries in the summer. Rolling and tumbling dried out weeds from the open desert commonly blow on to turfgrasses and deposit seeds.

Turfgrasses are grown on native soils in most residential or commercial landscapes, schools, and municipal parks. Desert soils can be rocky decomposed granite surfaces in the mountainous areas that surround the low desert. The low desert riverbed areas generally have loamy soils with sand that provide adequate drainage or may have loamy soils with clay to restrict water and air drainage. Most of the soils have about pH 8 and may have high salinity. Significant earth-moving activities during construction such as on golf courses and retention basins around HOA's (homeowner associations) can give variable soil textures for variable turf growth.

Golf course tees and greens as well as most of the baseball and football stadium fields have turfgrasses growing on uniform, well-constructed, and draining sand base systems. These turf surfaces can be spoonfed optimal quantities of nutrients and irrigated more precisely to gain advantages against potential pests, diseases, or weeds.

Optimal amounts of uniform irrigation generally will provide high quality managed turfgrass surfaces. Decreasing amounts of water and/or less uniformity will lead to less quality turf that can be prone to more stress and potential pest, diseases, or weed infestations.

Additional stressors that contribute to decreased quality turf are poor water quality that adds growth-restricting sodium to the soil, excessive traffic, thatch, and shade. Many golf courses use reclaimed water that is typically high in sodium. Countermeasures to reduce sodium effects on turf or other plant growth are to physically manipulate or cultivate the soils so that water can leach the undesirable salts out of the turfgrass rootzone. Chemically enhanced means are to apply amendments to the soil or treat water sources to enable conversion of sodium to be leached with the water.

Traffic on turfgrasses compact the soil root-growing zone and prevent water and air movement for adequate root and rhizome development. Golf carts and mowing equipment are obvious causes of constant pressure being placed on turfgrass soils. Turfgrass wear is commonly visible in the middle and sidelines of football fields, baseball outfields, turf facilities where marching bands practice daily, or any convenient walking corridor. Excessive wear is typically symptomatic of soil compaction.

Thatch buildup between the soil and growing foliage of the turfgrass can lead to weakened roots and rhizomes that may cause imbalances in irrigation and fertilizer applications. An increase in organic matter can create havens for diseases, nematodes, and insect pests or alter the beneficial or detrimental microbial populations in the rootzone.

Bermudagrasses in the desert environment generally suffer and become weakened under shaded conditions. Trees in landscapes and surrounding golf course fairways, tees, and greens block sunlight and prevent vigorous growth. Less obvious shade or cooler growing conditions on north-facing slopes in undulating parks or golf course sites are conducive for less optimal turf growth. In the early summer, overseeded ryegrass can shade out bermudagrass during spring transition as it comes out of winter dormancy.

The general desert environment and all of the microenvironments where turfgrasses are grown can be habitats and hosts for arthropod pests, diseases, nematodes, and weeds. The climate in the arid desert is unique with limited rainfall and extreme high temperatures, relatively low humidity, and intense solar radiation. Most insect pests behave differently in the desert compared to other parts of the country. Diseases, in general, occur less frequently but dramatic changes in daily weather patterns paired with irrigation problems can spur unexpected outbreaks. Weeds in the summer and winter can be predictable but availability and/or use patterns of herbicides combined with cultural practices can cause population shifts over time.

There are many levels of pest management strategies for turfgrasses depending on aesthetic qualities (color, texture, density), performance expectations (traffic), and management inputs (lesser managed to high intensity managed). A professional turf manager's expectations, interpretations, and attitudes may influence the level of attention given to pest management strategies. Economic considerations for financial inputs or limitations and manpower availability often determine the difference between lesser and high intensity pest management.

For most desert turfgrasses, knowledge and information that is applied in a calculated and methodical manner towards cultural practices complemented with judicious chemical applications can result in effective integrated pest management strategies. Understanding the behavior, biology, and ecology of key pests can offer optimized timing of practices to deter the pest from causing economic injury or damage to the turfgrass. In the desert, many of the turfgrass pests' identification and lifecycles have yet to be elucidated as fully as they have in other parts of the country. In the desert, expectations are for year around lush green turf that requires a bermudagrass base that is established in the summer and overseeded with a cool-season winter grass that is commonly perennial ryegrass. Herbicides and plant growth regulators offer means to manipulate the coming and going of the seasonal grasses but also require optimally timed applications for preemergence or postemergence weed control.

All professional turfgrass managers should have accurate record-keeping to monitor all of the activities on their turfgrasses. Better understanding of weed infestations can be recorded seasonally by properly identifying chronic populations in turf sites or shifts and development of new species occurring in turf. Insect populations can be surveyed by using monitoring techniques such as blacklight for flying pests or placement of pitfall traps in turf for crawling insects. Knowledge of the site and its soils, weather patterns, irrigation system and water quality, turfgrass varieties, surrounding environments, turf management equipment, and fertilizers and soil amendments in concert with a practical and applied understanding of this document will provide for effective pest management strategies.

# Outline of Desert Turf Pests

## **I. Arthropod pests**

### **A. Key insect pests**

1. White grubs complex

### **B. Important arthropod pests**

1. Ants
2. Billbugs
3. Grasshoppers
4. Lepidopteran pests - Armyworm/Cutworm/Sod webworm
5. Mites
6. Mole cricket
7. Pearl scale
8. Rove beetle

## **II. Diseases**

A. Cyanobacteria and Algae

B. Ectotrophic Root Infectors (ETRI)

C. Fairy ring

D. Pythium diseases

E. Rapid blight

F. Rhizoctonia patch diseases

G. Rust

H. Leaf and crown rot diseases

## **III. Nematodes**

A. Sting nematode

B. Root knot nematodes

## **IV. Weeds**

A. Winter and summer

B. Broadleaved and grass

C. Difficult to control

# Desert Turf Pests and Management Options

## Arthropod Pests

### Key Insect Pests

#### White Grubs Complex

masked chafers (*Cyclocephala* spp.)

black turfgrass ateniens (BTA) (*Ataenius spretulus*)

These most abundant and consistently occurring economic pests can be observed from May through September (adult beetle flights are observed beginning in May, while grubs are observed throughout summer). They can affect all bermudagrasses and creeping bentgrass greens. BTA looks very similar to *Aphodius* spp. beetles that do not damage turf.

White grubs are root-feeding insect pests that can directly injure or damage roots that cause visible symptoms that resemble drought stress and may result in loss of turf. Damage to roots can indirectly encourage disease development. Grub infestations frequently attract vertebrate pests that damage turf. Birds are attracted and feed on grubs on golf course greens and cause damage, as do javelinas, skunks, and other animals that tear and destroy turf to find the beetle grubs.

#### Sites affected:

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	yes	yes
Consistently a pest problem in all sites.						
Tolerance depends on turf maintenance level, location of infestation, and history of occurrence.						
No economic threshold level established.						

#### Preventive control measures:

Apply a preventive soil insecticide prior to or at time of egg-lay. The need to treat preventively may depend on turf tolerance of infestation and history (i.e. historical mapping of known damaged areas). Precision timing of soil insecticide application is improved with adult beetle flight monitoring (i.e. blacklight traps)

#### Chemical control:

- carbaryl (Sevin and other brands): Limited efficacy against grubs feeding on shallow surface roots.
- chlorantraniliprole (Acelepryn): Newest preventive soil-applied product available for grubs and billbugs. Reduced risk product with no signal word. Good for resistance management programs. Use pattern is similar to neonicotinoids.
- halofenozide (Mach 2): Timing of application is critical for efficacy. Very limited use mostly due to ineffective timing of application. Provides variable control dependent on proper timing directed to site of grub feeding. Requires direct feeding by larvae.
- neonicotinoids: Generally soil applied and systemic. Timing of application affects efficacy that is critical against small grubs. Typically just one application is needed annually. Timing of applications of neonicotinoids targeting grubs may coincide with billbug control.

- clothianidin (Arena)
- imidacloprid (Merit and other brands),
- thiamethoxam (Meridian),
- neonicotinoids + bifenthrin: The rate of neonicotinoid component in pre-mix product should be sufficient to control grubs. Bifenthrin provides control of surface insects. Pre-mix products with pyrethroids may be restricted use pesticides (RUP).
  - clothianidin + bifenthrin (Aloft)
  - imidacloprid + bifenthrin (Allectus)
- trichlorfon (Dylox): Contact insecticide provides curative results. A single application is typically adequate during the latter part of the season. Organophosphate (OP) chemistry subject to regulatory review. Not registered in CA. Chemistry in spray tank susceptible to degradation. Must be watered into turf; which impacts its efficacy. Broadcast apply on greens and tees only, spot treat in fairways.

**Biological control:** Arid conditions are generally not conducive for the use of biological agents. They are currently more expensive than conventional insecticides. Efficacy depends on biotic and abiotic factors. Bacteria (*Bacillus thuringiensis* [Bt] insecticides) and entomopathogenic nematodes generally require favorable environmental conditions that do not exist in the desert regions.

**Cultural control:**

- Use blacklight traps for monitoring adult populations to improve timing of insecticides.
- Promote healthy turfgrass that will generally tolerate infestations by grubs.
- Mowing height might influence populations as taller grasses may provide more roots for feeding.
- Irrigation management to reduce wet soils as drier soil conditions are less conducive for grub infestations.
- Thatch management may improve penetration of soil-applied insecticides.

**Critical Needs for White Grub Management in Turf:**

**Research:**

- Develop and expand sound efficacy data for insecticide use patterns specific to the desert (i.e. research needed on timing of application).
- Improve understanding of biology of white grubs species in the desert.
- Degree-day model development may aid in predicting emergence.
- Develop economic threshold levels for white grub incidence and populations in the desert turfgrasses.

**Regulatory:**

- None.

**Education:**

- Continue education programming to promote IPM strategies based on improved knowledge for identification and biology for more precisely timed insecticide applications when they are necessary.

## Important Arthropod Pests

### Ants

Southern fire ant (*Solenopsis xyloni*)

Harvester ant (*Pogonomyrmex* spp)

Ants can affect all types of bermudagrasses and overseeded winter turf. They are most common and active in the summer months. Ants damage turf by pushing up soils and creating small mounds, which can interfere with putting on golf course greens.

### Sites affected:

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	yes	yes
An intermittent pest problem in all sites, if present.						
No specific economic threshold level established.						

### Chemical control:

- fipronil (TopChoice) only registered for use in Coachella Valley, CA
- hydramethylnon (Amdro), insecticide bait most commonly available
- pyrethroid insecticides: bifenthrin (Talstar), cyfluthrin (Tempo), deltamethrin (Deltagard), lambda-cyhalothrin (Scimitar)
- chlorpyrifos (Dursban products labeled differently for golf courses and sod production)
- indoxacarb (Advion) labeled for specific ant species

### Biological control:

None.

### Cultural control:

Avoid excessive moisture.

### Critical Needs for Ant Management in Turf:

**Research:** None

### Regulatory:

- Continue monitoring and surveillance to exclude red imported fire ant.

**Education:** None

## **Billbugs**

Hunting billbug (*Sphenophorus venatus vestitus*)

Phoenician billbug (*S. phoeniciensis*)

Denver (Rocky Mountain) billbug (*S. cicatristriatus*)

Bluegrass billbug (*S. parvulus*)

Billbugs damage the stem and root of turfgrasses, which causes stress from lack of water and nutrients, eventually killing the grass. There is very little knowledge and understanding of specific billbugs that affect desert turfgrasses. Adults have been observed during most months of the year but which species and when larvae feed on turf is unknown.

### **Sites affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
primary emphasis	occasional	rarely, only if high populations	rarely, only if high populations	rarely, only if high populations	no	occasional to rarely
More of a pest problem on high maintenance turf, high populations in low to moderate maintenance turf may require attention. Tolerance depends on maintenance level, location of infestation, and history of occurrence. Adults observed most of the year, immatures observed during summer feeding on turf roots. No specific economic threshold level established.						

### **Chemical control:**

Adult control: Pyrethroids can be used for knockdown. Many products in different formulations from granules to sprayable liquids offer control. Most are restricted use pesticides (RUP) for golf courses and must use caution near bodies of water. Pyrethroids are highly toxic to bees and fish.

- bifenthrin (Talstar)
- cyfluthrin (Tempo)
- deltamethrin (Deltagard)
- lambda-cyhalothrin (Scimitar) bluegrass billbug only
- carbaryl (Sevin and other brands) carbamate chemistry is an effective non-pyrethroid for adult bluegrass billbug control only.
- chlorpyrifos (Dursban products labeled differently for golf courses and sod production)

Larval control: Timing of application is not defined for desert region (billbug biology and lifecycle not known).

- chlorantraniliprole (Acelepryn): Newest preventive product available for billbugs. Use is similar to neonicotinoids. Reduced risk product with no signal word. Good for resistance management programs.
- halofenozide (Mach 2): Timing of application is critical for efficacy. Not used much probably due to ineffective timing of application. Provides variable control dependent on proper timing directed to site of grub feeding. Requires direct feeding by larvae.
- neonicotinoids: Generally soil applied and systemic. Timing of application affects efficacy that is critical against small white grubs. Typically just one application is needed annually. Timing of applications of neonicotinoids targeting billbugs may coincide with white grub control.
  - clothianidin (Arena)
  - imidacloprid (Merit and other brands),

- thiamethoxam (Meridian),
- neonicotinoids + bifenthrin: The rate of neonicotinoid component in pre-mix product should be sufficient to control grubs. Controls surface insects along with soil insects. Pre-mix products with pyrethroids may be RUP.
  - clothianidin + bifenthrin (Aloft)
  - imidacloprid + bifenthrin (Allectus)

**Biological control:**

- Beneficial entomopathogenic nematodes are commercially available, however, not commonly used in arid conditions.

**Cultural control:**

- Promote healthy turf (i.e. fertility and irrigation management, mowing, etc.), as healthier and vigorous turf will generally tolerate higher populations of billbugs. The effect of specific cultural management activities on billbugs has not been determined for desert conditions.

**Critical Needs for Billbug Management in Turf:**

**Research:**

- More research is needed on the specific timing of appearance of adults and immature stages and types grasses affected by different species of billbugs.
- Species identification, biology, and population thresholds are needed for billbugs.
- Evaluation and validation of control methods for billbugs.
- Timing of applications of neonicotinoids for billbugs and grubs may coincide and needs to be substantiated.

**Regulatory:** None

**Education:**

- Any new information that is generated from research needs to be passed on to turf managers.

**Grasshopper** (various unknown spp)

Grasshoppers affect all bermudagrasses and overseeded winter turf. Overseeded seedling grasses are susceptible at emergence/establishment period, and newly sprigged or seeded bermudagrasses can be at risk during grow-in period.

**Sites affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	yes	yes
No specific economic threshold level established.						
Problematic on golf courses and turf sites surrounded by desert.						

**Chemical control:**

- carbaryl (Sevin and other brands): As bait formulation.
- chlorpyrifos (Dursban products labeled differently for golf courses and sod production)
- indoxacarb (Provaunt)

**Biological control:**

- Effective biological controls are available in other parts of the U.S., but not in the arid southwest region.

**Cultural control:**

- None.

**Critical Needs for Grasshopper Management in Turf:**

**Research:**

- chlorantraniliprole (Acelepryn) appears to be effective and research is needed to validate observations.
- indoxacarb (Advion) is labeled for crickets and research is needed to evaluate efficacy against grasshoppers.

**Regulatory:** None

**Education:**

- Any new information that is generated from insecticide efficacy research needs to be transferred to turf managers.

## **Lepidopteran Pests**

armyworm (*Spodoptera* spp.)

cutworm (*Agrotis* spp.)

sod webworm (family *Pyralidae*)

These intermittent pests can affect all warm- and cool-season turfgrasses and are typically a problem only golf course greens. Larval feeding reduces leaf tissue. Larvae also tunnel into turf that causes damage and death.

### **Sites affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	no	no	no	no	no	occasional

If on greens, occasional pest problem.  
No specific economic threshold level established for any caterpillar pest.

### **Chemical control:**

- chlorantraniliprole (Acelepryn): Newer product available for preventative control of lepidopterans. Good for resistance management programs. Reduced risk product with no signal word.
- indoxacarb (Provaunt): Effective product with good environmental profile. Different active ingredient with different mode of action that fits resistance management programs. Also effective against ants and other nuisance pests.
- pyrethroids are commonly used. Many products with many different formulations offer broad-spectrum control. RUP and caution must exercised near large bodies of water. Pyrethroids can be highly toxic to bees and fish.
  - bifenthrin (Talstar)
  - cyfluthrin (Tempo)
  - deltamethrin (Deltagard)
  - lambda-cyhalothrin (Scimitar)
  - permethrin (available generically)
- spinosad (Conserve) available. Too slow-acting and too short-lived to be effective in turf.
- chlorpyrifos (Dursban products labeled differently for golf courses and sod production)

**Biological control:** Some products available but generally too slow-acting and short-lived to be effective in turf.

- *Bacillus thuringiensis* (Bt)
- baculoviruses
- entomopathogenic nematode products
- neem seed oil extract products

### **Cultural control:**

- Proper disposal of clippings (away from greens or affected areas).

### **Critical Needs for Lepidopteran Pest Management in Turf:**

#### **Research:**

- Conduct appropriate efficacy field trials under local conditions as new control measures develop.

**Regulatory:** None

**Education:**

- Any new information that is generated from insecticide efficacy research needs to be transferred to turf managers.

## Mites

Mite damage causes a “witches broom” effect: a stunting, yellowing, fellodious condition. Most commonly occurring is bermudagrass mite, Eriophyidae.

### **Sites affected: Golf course – fairways and roughs only**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
no	no	yes	yes	yes	rarely	rarely
Occasional pest problem						

### **Chemical control:**

- Chlorpyrifos (Dursban products labeled differently for golf courses and sod production)
- dicofol (Kelthane): Not labeled for residential use. Effective on all life stages. Danger signal word.
- Pyrethroids: Need to add a surfactant or use a spreader-sticker.
  - bifenthrin (Talstar)
  - cyfluthrin (Tempo)
  - deltamethrin (Deltagard).
  - lambda-cyhalothrin (Scimitar).

### **Biological control:**

- None.

### **Cultural control:**

- Remove clippings.
- Fertilization can mask the symptoms.
- Mites favor dryer areas, so irrigation management is important.
- Use resistant varieties.

### **Critical Needs for Mite Management in Turf:**

#### **Research:**

- Conduct appropriate efficacy field trials under local conditions as new control measures develop.

**Regulatory:** None

#### **Education:**

- Any new information that is generated from insecticide efficacy research needs to be transferred to turf managers.

**Mole cricket** (*Scapteriscus* spp.)

Mole crickets can affect all types of grasses, but commonly occur more on bermudagrass in sand-based soils. Mole crickets cause surface tunneling and can also cause significant bird feeding activity that damages turf.

**Sites affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	yes	yes
Emerging pest problem identified in Yuma, AZ, along Colorado River, and in Downey, CA						
No specific economic threshold level established.						

**Chemical control:**

- Effective insecticides are labeled in other parts of the U.S., but efficacy not known in the southwest region.

**Biological control:**

- Effective biological controls are available in other parts of the U.S., but would not seem to be applicable in arid southwest region.

**Cultural control:**

- None.

**Critical Needs for Mole Cricket Management in Turf:**

**Research:**

- Evaluate and determine the distribution (dispersal and migration) and impacts of mole cricket on desert turf.
- Effective insecticides need to be evaluated for mole cricket infestation control in desert turf.

**Regulatory:**

- Seek registration of chemical insecticides and biological control agents to control mole cricket in desert turf.

**Education:**

- Any new information that is generated from studies of biology and ecology of mole crickets and insecticide efficacy research needs to be transferred to turf managers.

**Pearl Scale** (*Eumargarodes laingi* or *Margarodes meridonalis*)

Pearl scale can affect all bermudagrasses, but common bermudagrass exhibits less damaging effects. The crawler stage is observed in May. Pearls can be observed on roots year around. Pearl scale can cause root damage and loss of turf in circular patches.

**Sites affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	yes	yes

No economic threshold level established.  
Occasional pest problem especially on residential and commercial landscape lawns.  
Not a problem in CA.

**Chemical control:**

- None.

**Biological control:**

- None.

**Cultural control:**

- Fertilization to promote fast turf growth.

**Critical Needs for Pearl Scale Management in Turf:**

**Research:**

- Improve understanding of biology of pearl scale. Determine how widespread pearl scale is in desert region.
- Identify effective insecticides for pearl scale control.
- Determine level of tolerance of resistant varieties to pearl scale.
- Determine fertility inputs and sulfur effects on pearl scale.

**Regulatory:**

- Registration of new management tools for pearl scale.

**Education:**

- Any new information that is generated from insecticide efficacy research needs to be transferred to turf managers.

## **Rove Beetle** (*Staphylinidae*)

This nuisance pest is only an occasional pest problem on golf course greens in AZ; rove beetle is not a pest in CA. Rove beetle affects bermudagrasses, bentgrass, and overseeded *Poa trivialis* and ryegrass. Surface mounding of soil is nuisance for putting greens.

### **Sites affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	no	no	no	no	no	no
Occasional pest problem primarily on golf course greens. No economic threshold level established.						

### **Chemical control:**

- None labeled.
- Pyrethroid insecticides labeled for the site rapidly knocks down adult rove beetles.
- Neonicotinoids have demonstrated efficacy

### **Biological control:**

- None.

### **Cultural control:**

- Use a greens whip or a brush attachment on the greens mower to knock down mounds.
- Reduce or minimize organic matter upon which rove beetle feeds.

### **Critical Needs for Rove Beetle Management in Turf:**

#### **Research:**

- Identify effective management strategy for rove beetle utilizing mechanical management implements.

#### **Regulatory:**

- Seek registration of products that are effective for rove beetle control.

#### **Education:**

- Any new information that is generated from insecticide efficacy research needs to be transferred to turf managers.

## Diseases

### Cyanobacteria and Algae

Cyanobacteria and algae can cause turf decline and thinning. Crust formation also decreases water infiltration.

#### Grasses affected:

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	yes	yes

Not necessarily a problem only in cool, moist, shady areas and may occur in all turf in all locations.  
Disease problem that needs to be monitored continuously. Not always easily controlled.  
Typically managed only on greens and occasionally managed in sports fields or high maintenance areas.

#### Chemical control:

- chlorothalonil (Daconil): A contact fungicide. Repeated treatments often necessary for control.
- mancozeb (Fore, Dithane, Pentathalon, Protect): A contact fungicide. Repeated treatments often necessary for control. Check label of individual products for registered uses on all sites.
- mancozeb containing products – Junction (mancozeb + copper hydroxide)

#### Biological control:

- None.

#### Cultural control:

- Mowing: avoid excessive low mowing.
- Irrigation management: irrigate less frequently
- Aerify affected areas using vertical mowing techniques and shade reduction if possible.

#### Critical Needs for Cyanobacteria and Algae Management in Turf:

**Research:** None

**Regulatory:** None

**Education:** None

## **Ectotrophic root infecting fungi (ETRI)**

Spring dead spot  
Take-all  
Bermuda decline  
Kikuyu decline

Multiple genera of fungi mainly affecting bermudagrass and bentgrass. A number of symptoms can be observed, including frog's eyes and multiple circular patches. Generally causes weakened and dying turf.

### **Grasses affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	seldom	seldom	rarely
Primarily a problem on golf course greens. Often an economic problem when and where present. Predominant on sand-based turf. Occurs in sod production						

**Chemical control:** Multiple applications are needed in the fall. Control is sporadic at best. Rotate chemistries to reduce potential for resistance.

- chlorothalonil (Daconil)
- mancozeb (Fore, Dithane, Pentathalon, Protect)
- thiophanate-methyl (Cleary 3336)

DMI's (demethylation inhibiting):

- fenarimol (Rubigan)
- metaconazole (Tourney)
- myclobutanil (Eagle)
- triadimefon (Bayleton)
- triflumizole (Terraguard)
- triticonazole (Triton, Trinity)

Strobilurins:

- azoxystrobin (Heritage)
- fluoxastrobin (Disarm)
- pyraclostrobin (Insignia)
- trifloxystrobin (Compass)

**Biological control:**

- None.

**Cultural control:**

- Fertility management: Apply acidifying fertilizers and soil amendments to reduce pH.
- Use good cultural practices in the fall.
- Thatch control.
- Some resistant varieties available.

**Critical Needs for Management of Ectotrophic Root Infecting Fungi in Turf:**

**Research:** None

**Regulatory:** None

**Education:** None

## **Fairy Ring** (various Basidiomycetes)

Over 60 species of fungi cause fairy rings. It is mainly an aesthetic problem but damage can result with visible discolored circular patches and occasional turf loss. A hydrophobic soil prevents water penetration and fruiting bodies (mushrooms) appear. Primarily treated with fungicides, wetting agents, and cultivation on greens and other high maintenance areas.

### **Grasses affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	yes	yes
Primarily a problem on golf course greens, tees, and fairways or other high maintenance turfs.						

**Chemical control:** Fungicides are more effective as a preventive treatment than when used after fairy rings appear. Multiple applications may be required. Some chemistries are more effective than others on specific species.

Preventive fungicides:

- triadimefon (Bayleton)

Curative fungicides:

- flutolinil (Prostar)
- azoxystrobin (Heritage)
- pyraclostrobin (Insignia)
- polyoxin D zinc salt (Endorse, Affirm)

**Biological control:**

- None.

**Cultural control:**

- Irrigation management: Wetting agents can be helpful. Use hand watering to prevent soil drying
- Fertility management: Nitrogen and iron help mask symptoms
- Cultivation: Deep tine or core aeration, verticutting for thatch management allows for water to penetrate hydrophobic layers.

### **Critical Needs for Fairy Ring Management in Turf:**

**Research:**

- Understand the biology and identify specific fairy ring species.
- Evaluate control and determine control measures for fairy ring.

**Regulatory:** None

**Education:**

- Transfer research findings to turf managers.

**Pythium Diseases**

This is a consistent disease problem under hot and humid conditions. *Pythium* diseases cause damping off and foliar blight and kills turfgrass seedlings.

**Grasses affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	yes	yes
Primarily a golf course greens problem. Primarily cool season turf, seedlings. Predominant on sand-based turf. Occurs in sod production.						

**Chemical control:**

- azoxystrobin (Heritage): Good rotation product.
- cyazofamid (Segway): good rotation product.
- fluopicolide + propamocarb hydrochloride (Stellar): Good rotation product.
- fosetyl-Al (Aliette, Chipco Signature)): Good rotation product.
- iprodione (Chipco): Check label for allowable sites.
- mancozeb (Fore, Dithane, Pentathalon, Protect, Junction): Good rotation product. Check label of individual products for registered uses on all sites.
- mefenoxam (Subdue Maxx, Apron seed treatment): used as a preventive and curative spray. Must be rotated.
- phosphorous acid (Phosphite): Contact material. Good rotation product. Reduced-risk product.
- propamocarb hydrochloride (Banol): Good rotation product. Not for sod production in AZ.
- pyraclostrobin (Insignia): Good rotation product.

**Biological control:**

- None.

**Cultural control:**

- Mowing: avoid mowing when mycelium are present.
- Irrigation management: avoid excessive irrigation and persistent wet conditions; enhance drainage and air movement.
- Fertility management: timing of nitrogen application is important so do not apply nitrogen during hot, humid conditions.
- There are some resistant/tolerant varieties for some species.

**Critical Needs for Management of *Pythium* Diseases inTurf:**

**Research:** None  
**Regulatory:** None  
**Education:** None

## **Rapid Blight** (*Labyrinthula* spp)

This disease occurs in the fall, immediately after overseeding, and lasts through spring. Rapid blight kills grass rapidly.

### **Grasses affected:** cool-season grasses

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	occasionally	occasionally

Associated with high salinity soils, poor water quality

### **Chemical control:**

- mancozeb (Fore, Dithane, Pentathalon, Protect, Junction): Need to be used preventively, based on history of occurrence, and water quality situation. Critical to resistance management programs. Check label of individual products for site registrations.
- pyraclostrobin (Insignia): Needs to be used preventively, based on history of occurrence and water quality situations. Offers some curative activity.
- trifloxystrobin (Compass): Need to be used preventively, based on history of occurrence and water quality situation.

### **Biological control:**

- None.

### **Cultural control:**

- Irrigation management is important: use good quality water as salinity level is critical, good drainage on sites prone to disease occurrence.
- Fertility management: Use low salt index fertilizers. Increase calcium levels.
- Reduce traffic over sites prone to disease occurrence.
- Tolerant turfgrass varieties when available should be used where possible.

### **Critical Needs for Rapid Blight Management in Turf:**

#### **Research:**

- Evaluate new chemistries of fungicides.
- Evaluate desirable turfgrass species for specific uses and sites.
- Develop disease tolerant and resistant species.
- Determine control strategies.

**Regulatory:** None

#### **Education:**

- Any new information that is generated from fungicide efficacy research needs to be transferred to turf managers.

**Rhizoctonia patch diseases** (including large patch)

These diseases cause dead turf in irregular patches.

**Grasses affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	occasionally	occasionally

**Chemical control:** Effective as a preventive treatment. Multiple applications may be required. Some chemistries more effective than others on specific species.

- azoxystrobin (Heritage)
- chlorothalonil (Daconil)
- flutolinil (Prostar)
- iprodione (Chipco 26GT)
- mancozeb (Fore, Junction)
- polyoxin D zinc salt (Affirm, Endorse)
- pyraclostrobin (Insignia)
- thiophanate-methyl (Cleary 3336): may make brown ring patch worse
- trifloxystrobin (Compass)

DMI's:

- fenarimol (Rubigan)
- metaconazole (Tourney)
- myclobutanil (Eagle)
- propiconazole (Banner Maxx)
- triadimefon (Bayleton)
- triflumizole (Terraguard)
- triticonazole (Triton, Trinity)

**Biological control:**

- None.

**Cultural control:**

- Fertility management: avoid excessive N fertility.
- Thatch control: good airflow is important.
- Some varieties are more tolerant.

**Critical Needs for Management of *Rhizoctonia* Patch Diseases in Turf:**

**Research:** None

**Regulatory:** None

**Education:**

- Any new information that is generated from fungicide efficacy research needs to be transferred to turf managers.

## **Rust**

Rust is primarily a problem in bermudagrass sod production. It is rarely treated for in the desert and is not an economic disease.

### **Grasses affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
no	no	no	no	no	no	no
Primarily a sod production problem.						

### **Chemical control:**

- None.

### **Biological control:**

- None.

### **Cultural control:**

- Mowing.
- Fertility management.
- Irrigation management.

### **Critical Needs for Rust Management in Turf:**

**Research:** None

**Regulatory:** None

**Education:** None

## **Leaf and crown rot diseases**

These diseases include anthracnose (*Colletotrichum* spp), *Bipolaris* spp, *Curvularia* spp, *Leptosphaerulina*, *Helminthosporium*)

### **Grasses affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	occasionally	occasionally

**Chemical control:** None

### **Biological control:**

- None.

### **Cultural control:**

- Avoid or reduce stresses that may be occurring on turfgrass
- Fertility management: avoid excessive N fertility.
- Thatch control: good airflow is important.
- Some varieties are more tolerant.

### **Critical Needs for Management of Leaf and Crown Diseases in Turf:**

**Research:** None

**Regulatory:** None

**Education:** None

## **Overall Critical Needs for Disease Management in Turf:**

### **Research:**

- Efficacy research on current management options in desert turf.
- Development of disease prediction models.
- Methyl bromide alternatives for sod production; golf course renovation.

### **Regulatory:**

- Seek methyl bromide alternatives.

### **Education:**

- Improved education materials for problem solving and disease identification.
- Continued education on resistance management.
- Develop web-based disease identification tools.

# Nematodes

## Sting Nematode

This nematode affects bermudagrass and overseeded cool-season grasses. Injury and damage includes turf decline and thinning with slow recovery and possible large dead areas.

### Sites affected:

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	no	no	no

Primarily a golf course problem with all parts of course affected.  
Always an economic problem when and where present. Predominant on sand-based turf.

### Chemical control:

- Formerly managed with methyl bromide

### Biological control:

- Neem tree seed oil products demonstrate some efficacy.

### Cultural control:

- Fertility management: accelerate turf growth to out-compete.
- Avoid transporting infested soil and plant material to healthy areas.

### Critical Needs for Sting Nematode Management in Turf:

#### Research:

- Research is being conducted with beneficial nematodes, however these are not commercially available and not currently used as a control measure.
- Further research needed for neem seed oil extract products.
- Further research needed to evaluate available fumigants

**Regulatory:** None

#### Education:

- Any new information that is generated from nematicide efficacy research needs to be transferred to turf managers.

## **Root Knot Nematode** (multiple species)

This nematode primarily affects bermudagrass. The nematodes are most active in warm, moist, sandy soils, and are most damaging on greens. Injury and damage includes turf decline, thinning, with slow recovery and possible large dead areas.

### **Sites affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	no	no	no	no	no	no

Primarily a golf course greens problem. Predominant on sand-based turf.  
Always an economic problem when and where present.  
Occurs in sod production

### **Chemical control:**

- None.
- Nematicur removed from the marketplace.
- Basamid used for fumigation.

### **Biological control:**

- None.

### **Cultural control:**

- Fertility management: accelerate turf growth to out-compete.
- Avoid transporting infested soil and plant material to healthy areas.

### **Critical Needs for Root Knot Nematode Management in Turf:**

#### **Research:**

- Identification of nematode species.
- Assessment of nematode damage on turf.
- Understand the distribution of nematode species.
- Identify effective control products or management techniques, including a Nematicur replacement.
- Explore resistant varieties.
- More research on effective biological controls.
- Nortica (*Bacillus firmus*) has not been investigated sufficiently in desert turf.

#### **Regulatory:**

- Seek special local need (SLN) registration for 1,3-dichlorpropene (Curfew).

#### **Education:**

- Education needed to demonstrate how to sample and where to send samples for proper identification.
- Increase support for diagnostic labs.

## Weeds

### Winter grass weeds

Annual bluegrass - *Poa annua*

Incidental weeds occurring on periphery of turf or invading low maintenance turf:

Red brome - *Bromus rubens*

Hare barley - *Hordeum leporinum*

Hardgrass – *Sclerochloa dura*

Rabbitfootgrass – *Polypogon monspeliensis*

### Winter broadleaved weeds

Black medic – *Medicago lupulina*

Burclover – *Medicago polymorpha*

Cheeseweed – *Malva parviflora*

Chickweed – *Stellaria media*

Common groundsel – *Senecio vulgaris*

Cudweed – *Gnaphalium* spp

Dandelion – *Taraxcum officinale*

London rocket – *Sisymbrium irio*

Nettleleaf goosefoot – *Chenopodium murale*

Plantain – *Plantago* spp

Prickly lettuce – *Lactuca serriola*

Redstem filaree – *Erodium cicutarium*

Saharan mustard – *Brassica tournefortii*

Shepherdspurse – *Capsella bursa-pastoris*

Sowthistle – *Sonchus oleracea*

Swinecress – *Coronopus didymus*

Wild celery – *Cyclospermum leptophyllum*

Wild carrot – *Daucus carota*

### Summer grass weeds

Barnyardgrass – *Echinochloa crus-galli*

Crabgrass – large and smooth – *Digitaria* spp

Dallisgrass – *Paspalum dilatatum*

Foxtails – *Setaria* spp

Goosegrass – *Eleusine indica*

Junglerice – *Echinochloa colonum*

Southwest cupgrass – *Eriochloa gracilis*

### Summer broadleaved weeds

Fleabane – *Conyza* spp

Mat chaff-flower (formerly khakiweed) – *Alternanthera caracasana*

Prostrate knotweed – *Polygonum aviculare*

Lambsquarters – *Chenopodium album*

Puncturevine – *Tribulus terrestris*

Purslane – *Portulaca oleracea*

Russian thistle – *Salsola tragus*

Spurges – prostrate and spotted – *Chamaesyce maculata*

### Difficult to control weeds

Creeping woodsorrel – *Oxalis corniculata*  
 Purple nutsedge – *Cyperus rotundus*

Incidental weeds occurring on periphery of turf:

Buffelgrass – *Pennisetum ciliare*  
 Desert broom – *Baccharis sarothroides*  
 Fountaingrass – *Pennisetum setaceum*  
 Malta starthistle – *Centaurea melitensis*  
 Salt cedar – *Tamarix ramosissima*  
 Silverleaf nightshade – *Solanum elaeagnifolium*

**Sites affected:**

golf course areas				sports turf	parks and recreation	commercial residential
greens	tees	fairways	roughs			
yes	yes	yes	yes	yes	yes	yes
Weeds are always an economic problem when and where present.						

**Chemical control:**

- Several herbicides provide adequate control of most weeds with preemergence or postemergence applications.
- 2,4-D and dicamba based combination products offer control of wide spectrum of most broadleaved weeds. High summer temperatures limit use of 2,4-D products.
- Proflam, pendimethalin, and dithiopyr provide preemergence control of most grass weeds and small-seeded broadleaved weeds.
- Sulfonylurea chemistry products provide nutsedge control and perform as transition-aid herbicides to remove overseeded winter grasses.
- Postemergence *P. annua* control is inconsistent and not proven safe with ethofumesate, bispyribac-sodium, amicarbazone, and PGR's.

**Biological control:**

- None

**Cultural control:**

- Fertility management: accelerate turf growth to out-compete weeds.
- Irrigation management: optimize distribution and minimize wet areas that can be conducive for weed encroachment.
- Mow regularly to prevent seedhead formation

**Critical Needs for Weed Management in Turf:**

**Research:**

- Continue research on hard-to-control weeds: purple nutsedge, *P. annua*, mat chaff-flower.
- Continue field evaluations of new herbicides and re-evaluate combinations of herbicides for difficult to control weeds.
- MSMA replacement will be needed after 2012 for grass weed and purple nutsedge control strategies.
- Initiate or continue research on new weeds of economic concern.

**Regulatory:**

- Extend use of MSMA for all turfgrass uses when regulatory actions limit uses after 2012. Only spot treatment allowed on golf courses.

**Education:**

- Transfer weed control new technologies to end-users

## Activity Tables for Desert Turf

### Cultural Management Activities for Desert Turf

Activity	J	F	M	A	M	J	J	A	S	O	N	D
irrigation management	X	X	X	X	X	X	X	X	X	X	X	X
fertility management	X	X	X	X	X	X	X	X	X	X	X	X
mowing	X	X	X	X	X	X	X	X	X	X	X	X
thatch management, aerification					X	X	X	X				
overseeding									X	X	X	
spring transition					X	X						
X= activity performed during month of the year												

## Insect, Disease, and Weed Seasonal Occurrences

	<b>J</b>	<b>F</b>	<b>M</b>	<b>A</b>	<b>M</b>	<b>J</b>	<b>J</b>	<b>A</b>	<b>S</b>	<b>O</b>	<b>N</b>	<b>D</b>
<b>Insect, disease, weed monitoring</b>	X	X	X	X	X	X	X	X	X	X	X	X
<b>Insects</b>												
Ants	X	X	X	X	X	X	X	X	X	X	X	X
Billbugs <sup>1</sup>	X	X	X	X	X	X	X	X	X	X	X	X
Grasshoppers								X	X	X		
Mites						X	X	X				
Mole cricket						X	X	X				
Pearl Scale <sup>2</sup>	X	X	X	X	X	X	X	X	X	X	X	X
Rove beetle						X	X	X	X	X		
Lepidopteran pests			X	X	X	X						
White grubs complex <sup>3</sup>					X	X	X	X	X			
<b>Diseases</b>												
Cyanobacteria and Algae	X	X	X	X	X	X	X	X	X	X	X	X
Ectotrophic Root Infection (ETRI)	X	X	X	X	X					X	X	X
Fairy Ring					X	X	X	X	X	X	X	
Pythium diseases									X	X	X	
Rapid blight	X	X	X	X							X	X
Rhizoctonia Patch diseases	X	X	X	X						X	X	X
Rust			X	X	X				X	X		
Leaf and crown rot diseases	X	X	X								X	X
<b>Nematodes</b>												
Root knot and sting	X	X	X	X	X	X	X	X	X	X	X	X
<b>Weeds</b>												
<i>Broadleaved</i>												
<i>Winter</i>	X	X	X							X	X	X
<i>Summer</i>			X	X	X	X	X	X	X			
<i>Grasses</i>												
<i>Winter</i>	X	X	X							X	X	X
<i>Summer</i>			X	X	X	X	X	X	X			
X = incidence of pest, disease, and weeds during month of the year <sup>1</sup> Billbug adults observed all months, larval infestations not known. <sup>2</sup> Pearl scale crawlers observed during May, "pearls" present at all times <sup>3</sup> White grubs incidence as larvae feeding on turfgrass												

### Pest Management Activities for Desert Turf

Activity	J	F	M	A	M	J	J	A	S	O	N	D
<b>Weed management</b>												
<i>Poa annua</i> preemergence herbicide application									X	X	X	X
<i>Poa annua</i> preemergence herbicide application prior to overseeding								X				
<i>Poa annua</i> postemergence herbicide/PGR application	X	X	X	X	X							X
Winter weed postemergence herbicide application	X	X	X	X								X
Summer weed preemergence herbicide application		X	X									
Summer weed postemergence herbicide application					X	X	X	X				
Purple nutsedge postemergence herbicide application							X	X	X			
<b>Insecticide and miticide application</b>												
Preventive white grub insecticide application						X	X					
Lepidopteran pest insecticide application		X	X	X	X	X						
<b>Fungicide application</b>												
Fairy ring					X	X	X	X	X			
Pythium diseases									X	X		
Rapid blight	X	X	X	X						X	X	X

### Weed Management Tools Labeled for Use in Desert Turf

MANAGEMENT TOOLS	Application timing*	Annual Winter Broadleaves	Annual Summer Broadleaves	Annual Winter Grasses	Annual Summer Grasses	Perennials	COMMENTS
<b>Registered Chemistries</b>							
Aminopyralid (Milestone)	PO					X	Non-crop for invasive brush and tree control
2,4-D products	PO	X	X				
2, 4-D combination products (Trimec and others)	PO	X	X				Most popular effective broadleaved weed control products
Benefin (Balan)	PE			X	X		
Bensulide (Betasan)	PE			X	X		
Bispyribac-sodium (Velocity)	PO			X			Inconsistent <i>P. annua</i> control
Carfentrazone (Quicksilver)	PO	X	X				Effective against moss
Carfentrazone combination products (Speedzone)	PO	X	X				Effective broadleaved weed control
Chlorsulfuron (Corsair)	PO			X			Transition-aide for winter overseeded grass removal; some annual weeds
Clethodim (Envoy)	PO			X	X		Selective grass weed control
Clopyralid (Lontrel)	PO	X	X				Effective broadleaved weed control
Clopyralid + fluroxypyr (Confront)	PO	X	X				Effective broadleaved weed control
DCPA (Dacthal and others)	PE			X	X		
Dicamba products	PO	X	X				Combined with broadleaf herbicides
Diclofop (Illoxan)	PO				X		Effective against goosegrass
Dimethenamid-P (Tower)	PE			X	X		Insufficient data; effective against <i>P. annua</i>
Diquat (Reward)	PO	X	X	X	X		Nonselective weed control
Dithiopyr (Dimension)	PE/PO	X		X	X		Effective against <i>P. annua</i> prior to overseed
Ethephon (Proxy and others)	PO			X			PGR against <i>P. annua</i>

Ethofumesate (Prograss, Poa Constrictor)	PO			X			Effective against <i>P. annua</i> ; limited due to potential bermudagrass injury at transition
Fenoxaprop (Acclaim)	PO			X	X		Potential bermudagrass injury
Flazasulfuron (Katana)	PO			X		X	Transition-aide for winter overseeded grass removal; purple nutsedge control, clumpy ryegrass and <i>P. annua</i> control
Fluazifop (Fusilade and others)	PO			X	X		Selective grass weed control
Fluroxypyr (Vista)	PO						Combined with Turflon ester for mat chaff-flower weed control
Foramsulfuron (Revolver)	PO						Transition-aide for winter overseeded grass removal; clumpy ryegrass and <i>P. annua</i> control
Glufosinate (Finale)	PO	X	X	X	X	X	Nonselective weed control
Glyphosate (Roundup and others)	PO	X	X	X	X	X	Nonselective weed control
Halosulfuron (SedgeHammer)	PO					X	Effective purple nutsedge control in warm and cool season grasses
Imazaquin (Image)	PO					X	Effective purple nutsedge control in warm season grasses
Indaziflam (Specticle)	PE/PO			X	X		<i>P. annua</i> control in dormant bermudagrass
Isoxaben (Gallery)	PE	X	X				Safe on turfgrasses
MCPP (combination products)	PO	X	X				Combined with broadleaf herbicides
MSMA (many brands)	PO				X	X	Effective against crabgrass, cupgrass, "burndown" of purple nutsedge; Regulatory removal in process
Mefluidide (Embark)	PO				X		PGR
Mesotrione (Tenacity)	PO						Insufficient data; slowly removes bentgrass from Kentucky bluegrass/ryegrass
Metribuzin (Sencor)	PO						Effective against goosegrass
Metsulfuron (Manor, Blade)	PO				X		Transition-aide for winter overseeded grass removal;
Oryzalin (Surflan and others)	PE			X	X		Effective against annual grass weeds and some small-seeded broadleaved weeds
Oxadiazon (Ronstar)	PE			X			Effective against goosegrass
Paclobutrazol (Trimmit and others)	PO				X		PGR suppresses <i>P. annua</i>
Pelargonic acid (Scythe)	PO	X	X	X	X		Nonselective weed control. Overseed prep.

Pendimethalin (Pendulum and others)	PE	X	X	X	X		Effective against annual grass weeds and some small-seeded broadleaved weeds
Prodiamine (Barricade and others)	PE	X	X	X	X		Effective against annual grass weeds ( <i>P. annua</i> at overseeding) and some small-seeded broadleaved weeds
Pronamide (Kerb)	PE/PO				X		Transition-aide for winter overseeded grass removal;
Pyraflufen (Octane)	PO	X	X				Not commonly used.
Quinclorac (Drive XLR8 and others)	PO			X			Effective against crabgrass, cupgrass
Rimsulfuron (TranXit and others)	PO				X		Transition-aide for winter overseeded grass removal;
S-metolachlor (Pennant)	PE			X	X		Reduces yellow nutsedge and grass weeds
Sethoxydim (Segment and others)	PO			X	X		Selective grass weed control
Siduron (Tupersan)	PO					X	Effective against bermudagrass encroaching on bentgrass greens
Simazine	PE	X	X	X	X		Nonselective weed control in dormant bermudagrass
Sulfentrazone (Dismiss)	PO	X	X			X	Burndown of purple nutsedge only
Sulfentrazone combination products (Surge)	PO	X	X				Effective broadleaved weed control
Sulfosulfuron (Certainty)	PO				X	X	Transition-aide for winter overseeded grass removal; effective against purple nutsedge
Thiencarbazone + iodosulfuron + dicamba (Celsius)	PO	X		X			New product; promising for winter weeds in dormant bermudagrass
Triclopyr (Turflon ester)	PO					X	Effective as PGR to suppress bermudagrass during overseeding
Trifloxysulfuron (Monument)	PO				X	X	Transition-aide for winter overseeded grass removal; effective against purple nutsedge
Trinexpac-ethyl (Primo and others)	PO				X		PGR
<b>Unregistered / New Chemistries</b>							
Amicarbazone (Xonerate, Arysta)	PO			X			Experimental for <i>P. annua</i> control
BAS-800 (BASF)	PO	X	X				Experimental new product to be determined
Cumyluron	PO			X			Experimental for <i>P. annua</i> control

Flumioxazin (Sureguard, Valent)	PO/PE	X	X	X			Experimental for <i>P. annua</i> control in dormant bermudagrass
Flucarbazone (Arysta)	PO			X			Transition-aide for winter overseeded grass removal
Imzasulfuron (V-10142, Valent)	PO			X		X	Experimental for purple nutsedge control
Metamifop	PO			X			Experimental for <i>P. annua</i> control
Methiozolin (Moghu Research Center)	PO			X			Experimental for <i>P. annua</i> control on bentgrass greens
*Application timing: PO=postemergence, PE=preemergence X=effective vs. weed							

## INSECT and MITE Management Tools Labeled for Use in Desert Turf

MANAGEMENT TOOLS	Ants	Billbug	Grasshoppers	Mites	Mole crickets	Pearl scale	Rove beetle	Lepidopteran pests	White grubs complex	COMMENTS
<b>Registered Chemistries</b>										
Acephate (Orthene)	X		X		X			X	X	Not registered in CA
Bifenthrin (Talstar)	X	X <sup>a</sup>	X	X	X		E	X	X <sup>c</sup>	<sup>a</sup> adult control; <sup>c</sup> BTA control only; experimental; high toxicity to bees and fish
Carbaryl (Sevin)	X	X <sup>a</sup>	X				E	X	X	<sup>a</sup> adult control; experimental
Chlorpyrifos (Dursban and others)	X	X	X	X	X			X	X	
Cloranthraniliprole (Acelepryn)		X <sup>b</sup>	E			E	E	X	X	<sup>b</sup> larval control; experimental
Clothianidin (Arena)	X	X <sup>b</sup>			X <sup>s</sup>	E	E	X	X	<sup>b</sup> larval control; <sup>s</sup> suppress only; experimental
Clothianidin + Bifenthrin (Aloft)	X	X	X		X			X	X	
Cyfluthrin (Tempo)	X	X <sup>a</sup>	X		X		E	X		<sup>a</sup> adult control; experimental; high toxicity to bees and fish
Cypermethrin (Demon and others)	X		X		X			X	X <sup>c</sup>	residential lawns; <sup>c</sup> BTA control only
Deltamethrin (Deltagard)	X	X <sup>a</sup>	X	X <sup>s</sup>	X		E	X	X <sup>c</sup>	<sup>a</sup> adult control; <sup>c</sup> BTA control only; <sup>s</sup> suppress only; experimental; high toxicity to bees and fish
Dicofol (Kelthane)				X						Not for residential use
Dinotefuran (Zylam)		E				E			E	experimental
Fipronil (Chipco Choice)	X				X					Use in Coachella Valley CA only
Halofenozide (Mach 2)		X <sup>b</sup>						X	X	<sup>b</sup> larval control
Hydramethylnon (Amdro)	X									
Imidacloprid (Merit and others)		X <sup>b</sup>			X	E			X	<sup>b</sup> larval control; experimental
Imidacloprid + Bifenthrin (Allectus)	X	X	X	X	X			X	X	
Indoxacarb (Provaunt)			X		X			X		
Lambda-cyhalothrin (Scimitar)	X	X <sup>a</sup>	X	X	X		E	X	X <sup>a</sup>	<sup>a</sup> adult control bluegrass only;

										experimental; high toxicity to bees and fish
Permethrin (Astro and others)	X							X		<sup>a</sup> adult control; high toxicity to bees and fish
Spinosad (Conserve)	X							X	X <sup>c</sup>	<sup>c</sup> BTA control only
Thiamethoxam (Meridian)	X	X <sup>b</sup>			X	E	E		X	<sup>b</sup> larval control; experimental
Trichlorfon (Dylox)					X		E	X	X	Experimental
<b>Biological</b>										
<i>Bacillus thuringiensis</i>								X		Not effective in arid desert
Baculoviruses (NPV)								X		Not effective in arid desert
Entomopathogenic nematodes		X						X	X	Not effective in arid desert
Fungi									X	Not effective in arid desert
Azadiractin (various products)								X		
X = effective vs. pest E=experimental investigations ongoing										

## DISEASE Management Tools Labeled for Use in Desert Turf

MANAGEMENT TOOLS	FRAC MOA Grouping*	Cyanobacteria and Algae	Ectotrophic Root Infectors (ETRI)	Fairy Ring	Pythium diseases	Rapid blight	Rhizoctonia Patch diseases	Rust	Leaf and crown rot diseases	COMMENTS
<b>Registered Chemistries</b>										
Azoxystrobin (Heritage)	11		X	X	X		X	X	X	
Boscalid (Emerald)	7								X	
Chlorothalonil (Daconil)	M4	X	X				X	X	X	Golf and sports turf, commercial use
Cyazofamid (Segway)	21				X					
Fenarimol (Rubigan)	3		X				X		X	
Fluoxastrobin (Disarm)	11		X	X	X		X		X	
Flutolanil (Prostar)	7			X			X			
Fosetyl-al (Aliette)	33				X					
Iprodione (Chipco 26GT)	2						X		X	
Mancozeb (Fore, Dithane, Protect, Pentathalon)	M2	X			X	X	X	X	X	Check label for non-residential use
Mefenoxam (Subdue Maxx, Apron)	4				X					Apron for seed treatment only
Metconazole (Tourney)	3		X	X			X			Not for use on bermudagrass
Myclobutanil (Eagle)	3		X				X		X	
Phosphorous acid (Fosphite)					X					Reduced risk
Polyoxin-D (Affirm, Endorse)	19			X			X		X	
Propamocarb hydrochloride (Banol)	28				X					
Propiconazole (Banner Maxx and others)	3		X				X	X	X	
Pyraclostrobin (Insignia)	11		X	X	X	X	X		X	
Thiophanate-methyl (Cleary's 3336)	1		X				X		X	
Triadimefon (Bayleton)	3		X	X			X		X	Golf course and sod production only
Trifloxystrobin (Compass)	11		X			X	X	X	X	

Triticonazole (Trinity, Triton)	3	X	X	X			X	X	X	
<b>Combination products</b>										
Fluopicolide + propamocarb hydrochloride (Stellar)	28/43				X					
Mancozeb + copper hydroxide (Junction)	M2	X			X	X	X	X	X	
*FRAC – Fungicide Resistance Action Committee Mode of Action Grouping for classes of fungicides X = effective vs. disease										

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