2013

Landa Park Golf Course

Integrated Pest Management Plan

City of New Braunfels

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Introduction

Landa Park Golf Course recognizes the importance of sound environmental stewardship and the sensitivity to surrounding areas. That is why we are committed to optimizing the golf course management practices to protect the environment within, and surrounding the golf course. The epicenter of environmental stewardship at Landa Park Golf Course is the philosophy of Integrated Pest Management (IPM).

Several examples of cultural methods to control pests include optimizing turf health through best management practices to enhance natural plant resistance to pest infestations, optimizing plant health and vigor, and minimizing turf damage resulting from routine golf course operations. When cultural practices are not fully effective at controlling pests that exceeds established pest threshold levels, the use of pesticides to minimize and manage pest damage may be required. An essential part of an Integrated Pest Management is to coordinate the use of cultural practices and pest management to minimize the amounts of pesticide applications.

Included in this plan, you will find defined managements areas, cultural practices, anticipated pests and their timing, monitoring practices, pest damage threshold levels, anticipated actions and control measures, and an explanation of control measures with their benefits. The plan also serves as an anticipated operational management plan that contains details regarding management practices on and around the course. As a result, this document is to be viewed as a functional document that will evolve over time and one that will be updated on an annual basis, to ensure updated environmental concerns and industry standards continue to be exceeded as we provide the highest quality product possible to our golfing clientele and the City of New Braunfels.

Integrated Pest Management Definition

There are numerous definitions of Integrated Pest Management. In detail, we believe the best summarized definition is provided by the Golf Course Superintendents Association of America.

"Integrated pest management is a continuous system by which pests (weeds, diseases, insects or others) are identified, action thresholds are considered, all possible control options are evaluated and control(s) are implemented. Control options – which include biological, chemical, cultural, manual and mechanical methods – are used to prevent or remedy unacceptable pest activity or damage. Choice of control option(s) is based on effectiveness, environmental impact, site characteristics, worker/public health and safety, and economics."

"The goal of an IPM system is to manage pests and the environment to balance benefits of control, environmental quality, costs, public health and site specific requirements. IPM takes advantage of all appropriate pest management options."

IPM Objectives

- Minimize potential hazards to human and environmental components
- Providing optimal course playing conditions
- Minimizing the amount of chemical applications while optimizing application efficacy
- Enhance communication with co-workers, golfers, golf course management, and outside agencies regarding agronomic and pest management practices
- Control operating costs and maximize budget restrictions with proper planning and execution
- Provide site specific planning to develop a detailed plan on specific management sites
- Easy access to essential information on pest biology, control, agronomic guidelines, and monitoring tools and references

IPM Structure

The outline of the Integrated Pest Management plan is structured such that it targets specific management zones and the anticipated pests in those zones. It targets those pests that pose the largest threat to the overall agronomic health of the golf course and its environment. The structure of the IPM plan is outlined below:

- Define the Management zones that requires specific maintenance and monitoring intensity in each specific area
- Identify likely pests that will be encountered and anticipated timeline those pests are expected
- Cultural practices that increase turf health and vigor, increasing pest tolerance and resistance
- Establish threshold levels for each pest while outlining corrective action if thresholds are exceeded
- Outline all possible preventative and corrective actions that addresses maintenance practices, chemical application options, and explanation of chemical selection based on efficacy and environmental impact
- Document monitoring, treatments, and treatment results

Area Definition

The Landa Park Golf Course is a municipal golf course originally opened in 1938 and consisting of a nine hole layout confined to the west side of the railroad tracks that currently splits the golf course. The second nine holes was added and opened in 1971 and expanded the course by creating another nine holes to the east of the railroad track division. The golf course was constructed using native soil used for fairways, roughs, and tees which consists of a silty clay (heavier soil). Based on cup cutting operations as well as aerification outcomes… it is expected that a sand material was used or supplemented in the use of the push up greens when they were renovated and/or constructed in the 70's.

The course in located in the town of New Braunfels, Texas and sits between the 8th and 9th plant hardiness zones as outlined by the USDA. By most estimates, this locates the course south, of what is perceived, as the turfgrass transition zone. The management zones of this course consist of turfgrass areas, non-turfgrass areas, aquatic areas, and native areas.

A. Turfgrass Areas

The turfgrass areas are broken into three to four different management sub-zones that consist of greens, tees/fairways, rough, and native areas. The greens consist of a combination of highly mutated turfgrass varieties, believed to originate from either Tifgreen 328, or Tifdwarf. The turfgrass on the tees, fairways, and rough consists of common bermuda with little to no consistency found in stand or variety. The turfgrass in the native areas also consists of common bermuda can include wildflowers, shrubs, trees, and a variety of other mixes depending on location. Many of these areas are in non-mown surrounds of the course and provide a buffer between the course and its bordering features.

TABLE 1> Landa Park Municipal Golf Course Turfgrass Area Maintenance Requirements

Area	Total Acreage	Fertilizer Requirement	Irrigation Requirement	Mowing Frequency	Cultural Frequency
Greens	2.5	High	High	High	High
Tee Surface	3	Medium	Medium	Medium	Low
Fairway	21	Medium	Medium	Medium	Low
Rough	60	Low	Low - N/A	Low	Low
Native	18	N/A	N/A	N/A	N/A

B. Non-Turfgrass Areas

These areas consist of bunkers, flower beds, aquatic areas, and natural areas. These will play a less significant role in the overall environmental health of the property. However, they play a significant role in the overall aesthetic and operational aspects of the course.

Bunkers
Green-side bunkers are all that currently exist numbering a total of eight, all found on the first six holes here on the course. Bunker maintenance will involve routine maintenance that includes hand raking, edging, and removal of debris.

Flower Beds
A number of flower beds exist around the clubhouse grounds and hitting cages. These areas are aesthetically significant and grab the eye of patrons upon approach to the property. Highly standards of maintenance will be expected and performed in these areas.

Aquatic areas
One large pond used for irrigation holding and two aesthetic ponds exist on the back nine portion of the course. All three play an important role in the playability and design of the current course layout.

Buffer Zones
Buffer zones currently exist adjacent to the waterways and watershed locations that will receive no fertilizer, fungicides, or broadleaf herbicides. Currently we strive to maintain a minimum of 25 foot buffer zone at all points that surround the course with the exception of island greens that lie within the 25 foot boundary. In these areas, special care and consideration are given when making fertilizer and fungicide applications.

Cart Paths and Service Roads
The entire course has an infrastructure of cart path that includes a continuous concrete path that extends from tee to green and back to tee of the next hole.

Turfgrass Management Practices

Turfgrass area management involves the largest demand on the labor force, requiring greater than the 90% of the resource allocation. The primary objective of the IPMp is to optimize turfgrass quality and health utilizing best management practices to reduce pest infestation and turfgrass resistance to stress. The primary cultural practices include mowing, fertilization, and irrigation. Secondary cultural practices include practices such as aeration, topdressing, verticutting, and overseeding.

A. Primary Cultural Practice

1. Mowing

   Mowing is performed as needed based on growth conditions and playability needs. During peak growing season, mowing of greens will occur daily, tees, collars, approaches and fairways twice weekly, and rough areas will be mowed once a week. Mowing heights are expected to vary from .110 - .156 on greens, .400 - .600 on Tees & Fairways, and 1-2 inches in the rough.

2. Fertilization

Management of nutrient availability is crucial in maintaining turfgrass health and vigor. Management of turf fertility involves the understanding of soil composition, plant nutrient requirements, fertility management history, use of soil test information, and applications of the appropriate fertilizer with the proper application timing. The objective of the fertilizer program is to provide optimal nutrient availability to the turf while simultaneously avoiding the application of excess nutrients to avoid nutrient runoff/leaching, disease development and weed infestation. Accordingly, every effort will be made to minimize fertilizer application in an effort to find a balance between optimizing turf quality and preventing nutrient runoff.

a. Soil Testing
Testing for proper soil nutrient levels will be conducted on a minimum of a bi-annually basis to insure that current practices are providing adequate and proper soil nutrient levels key for optimized turf quality. This also gives insight to specialized nutrient applications that can minimize blanket applications and provide a focused approach to any deficiencies that may occur.

b. Turfgrass Nutrient Requirements
The major nutrients for turfgrass health are nitrogen, phosphorus, potassium (NPK) along with calcium, magnesium, and sulfur. Essential minor nutrients include iron, boron, copper, manganese, molybdenum, zinc, chlorine, and nickel. The availability of nutrients to turfgrass is influenced markedly by the pH of the soil. Consequently, maintenance of the appropriate pH is an important component of the fertilization program. Whenever possible, slow release fertilizers will be used as the primary source of nutrients, with adjustments being made for special needs and conditions. Greens fertilization programs may also include light applications of soluble foliar-adsorbed applied on a frequent basis.

Major Nutrients

1) Nitrogen
The management of nitrogen levels is critical owing to the high turf demand for this nutrient and the potential for excess nitrogen to enter into surface water and/or groundwater. As a result, the amount of nitrogen delivered to turfgrass will be the minimum amount necessary to promote turf vigor. In general, nitrogen rates and formulations will be determined based on turf condition, soil test results, season, weather, and other information. In certain instances when turf and/or climate conditions dictate, rates of application will be adjusted (either higher or lower) at the discretion of the Superintendent.

Nitrogen formulation consists of water insoluble (slow release) and water soluble (quick release) types. Slow release nitrogen sources include methylene urea, sulfur-coated urea, IBDU, polymer coated fertilizers, and organic fertilizers processed and formulated as slow release products. Examples of quick release nitrogen sources include ammonium sulfate, ammonium nitrate, potassium nitrate, and urea. "Bridge" fertilizers combine the best qualities of synthetic and organic fertilizers providing both quick and slow release of nutrients. Where appropriate, organic formulations will be considered for providing sustainable slow release nutrients, soil organic matter, and potentially higher soil biological activity. To maximize plant uptake and minimize nitrogen leaching or storm water runoff (e.g., nitrate), slow release nitrogen sources and/or light applications of soluble nitrogen ("spoonfeeding") will be used whenever possible.

2) Phosphorus
Turf requirements for phosphorus are relatively low and phosphorus is relatively immobile in soil. As a result, application rates tend to be correspondingly low, which minimizes the possibility of leaching or storm water runoff carrying residual phosphorus off-site.

3) Potassium
Turf requirements for potassium are intermediate to high in relation to nitrogen and phosphorus levels. Although applied to maximize efficiency of uptake, potassium does not pose the extent of environmental risk that excess nitrogen and phosphorus levels represent. Proper levels of potassium are an important component of plant disease resistance and contribute to the ability of turf to withstand wear and traffic.

Minor Nutrients
In general, turfgrass requirements for the minor nutrients iron, boron, copper, manganese, molybdenum, and zinc are substantially lower than those for nitrogen, phosphorus, and potassium. Minor nutrients are essential for optimal turf performance and are typically available in soils in sufficient quantities to support healthy turf. However, when turf conditions or soil testing results indicate deficiencies, these nutrients will be applied at the discretion of the Superintendent.

pH
Maintenance of the proper soil pH is essential in optimizing the availability of nutrients, and also is important in minimizing overall turfgrass stress. When the soil pH requires adjustment to the more alkaline pH, lime will be added until the targeted pH is obtained. When soil requires adjustments to a more acidic pH, ammonium sulfate or another acidifying product will be added until the targeted pH is obtained.

c. Fertilizer Treatment Areas
The rate and frequency of fertilizer application is area and situation dependent. A typical area-specific fertilizer application frequency, and corresponding total yearly nitrogen applied (lbs/1000 ft^2) is shown in Table 2. Fertilizer application is most frequent on greens with less frequent applications being made to tees and fairways, and the least frequent application being made to the rough.

TABLE 2> Landa Park Municipal Golf Course:
Fertilizer Application Areas and Typical Yearly Applications

Area	Total Acreage	Applications per Year	Total Nitrogen per Year
Greens	**2.5**	**8-12**	**4 - 5 lbs**
Tee Surface	**3**	**3-4**	**2 - 3 lbs**
Fairway	**21**	**3-4**	**2 - 3 lbs**
Immediate Rough	**25**	**2-3**	**2 - 3 lbs**
Secondary Rough	**35**	**1-2**	**1 - 2 lbs**

d. Fertilizer Application
Fertilizer application equipment will be calibrated prior to use to ensure proper rate of application. Fertilizer will not be applied if heavy rain is forecasted following the potential application event.

e. Fertilizer Storage
All fertilizer will be maintained in a dedicated moisture free, well ventilated, approved storage area.

f. Fertilizer Documentation
All fertilizer applications will be documented on a fertilizer application form. Information recorded will include date of application, location of application, total area treated, formulation of fertilizer, rate of application expressed as lbs. of N/1000 ft2, total quantity of product applied, and the applicator name.

3. Irrigation

The distribution of adequate water onto turf via irrigation without over-watering is essential to turf health. In addition to providing optimal moisture levels for turf, irrigation practices are designed to conserve water whenever possible. Wetting agents will be used when necessary to improve water infiltration for localized dry spots and other hydrophobic areas of turf. Wetting agents will be applied in accordance with label rates and recommendations.

a. Water Source
Landa Park Municipal Golf Course currently has 300 acre feet of water diversion rights from the old channel of the Comal river. Irrigation water is currently diverted from a point that is adjacent to number sixteen fairway and pumped to our holding pond currently located adjacent to number 13 fairway.

b. Irrigation System
The irrigation system is a computer integrated automated system that operates fourteen irrigation satellite boxes in the field. The system is old and outdated, using a hydraulic control system for control of sprinkler stations from satellite boxes. Daily water use is determined using resources such as local weather stations that determine sports turf ET rates, as well as, on site scouting for any additional needs.

c. Irrigation Water Quality
No irrigation quality problems are anticipated with the use of the water from current irrigation sources. However, continued testing to evaluate any changes in water quality will be performed. It is recommended to take water samples from the sprinkler head to get an accurate reading of water quality landing on the turf and not taking from source water in the pond.

d. Water Conservation
The irrigation system and program is designed to prevent over-application of water as a means of optimizing turf vigor and conserving water. The area needing the most frequent irrigation will be the greens. Because it does represent a larger area of coverage, fairways and roughs will be irrigated using a deeper, more infrequent method to help increase water efficiency. A large majority of rough areas currently do not hold irrigation capabilities and therefore, rely on rainfall for water needs.
The primary means of determining turfgrass irrigation requirements will be the evapotranspirational losses determined by computer supplemented with daily observations and monitoring by the Superintendent and staff. Data obtained from a local weather station is entered into the computer controlled irrigation system to establish site-specific irrigation duration and frequencies.

B. Secondary Cultural Practice

1. Aerification

   Aerification is the practice of removing soil cores from turf and is performed to reduce turf compaction. This practice enhances the movement of air, water and nutrients in the soil and is a useful technique to manage thatch layers. Aerification will occur primarily on greens and tee surfaces on a regular basis, at least twice a year. Aerification will be typically performed during periods of active turf growth in the mid-spring thru early fall. Additional aeration may occur at the discretion of the Superintendent. Aerified greens will be topdressed with sand to fill aerification holes and improve water infiltration.

2. Thatch Management

   Thatch is a layer of organic debris and the roots, crowns, and stems of grass that exist between the soil and the turf canopy. In the absence of cultural management, this layer becomes thicker over time, resulting in sub-optimal turf growth. This also has a negative effect on ball roll and greens conditions which make playability suffer and condition to deteriorate. It can also cause the turfgrass to be more susceptible to disease. Thatch management will include hollow core aerification, topdressing, and vertical mowing.

3. Topdressing

   The practice of topdressing consists of the application of a layer of sand to greens and is used to assist in the thatch layer management. It also assists in maintaining a smooth and fast putting surface. Topdressing applications typically follow the aerification or verticutting of greens, and will also be made in the absence of aerification ("light" topdressing). Light brushing may be used after topdressing to work sand into the turf surface.

4. Overseeding

   Overseeding in late fall provides a course that is playable and green year-round. Fall overseeding consists of poa trivialis on the greens surface and perennial ryegrass on tees, fairways, and collars. Rates may vary depending on playing surface desirability and quality necessary.

Tree Management

A wide variety of trees are located at Landa Park Golf Course that require routine maintenance. Best management practices will be performed and are listed below. Many of these assessments will be performed with the assistance of the Urban Forester to ensure proper technique and evaluation.

A. Tree Maintenance

Routine evaluation and monitoring for influence on playing characteristics, overall health, influence on turfgrass and surrounding environment, and any safety concerns. Current tree populations that are established on the golf course do not require supplemental irrigation except for special considerations during periods of extreme drought. Trees will be pruned during the late fall and winter months to avoid potential for disease and pest encroachment on open wounds. They will be pruned to optimize health, allow passage of light, minimize hazard, and manage pests. The use of pruning paint and wound treatment will be adhered to on sensitive trees to promote health while performing pruning practices.

B. Tree Removal

With the consultation of the urban forester and the golf course superintendent, the need for tree removal may be necessary based on disease, age, and potential safety issues. Upon the determination that tree removal is necessary, the tree will be removed by staff at Landa Park Golf Course, or when necessary, by a commercial tree service.

C. Tree Planting

Trees will be planted in planting holes appropriate for the root ball/root mass and planting holes will be backfilled with native material. The planting area will be mulched and receive irrigation as required through the first two-three growing seasons. Whenever possible, planting will occur during the fall.

Composting and Organic Materials Management

A. Grass Clippings and Aerification Cores

Grass clippings and/or aerification cores will be spread on site as a mulch type product. Materials will be spread thin as to not damage any underlying plants and will be kept clear of any buffer zones to ensure runoff is not a threat.

B. Woody Brush

Tree limbs and other woody material will be processed through a chipper and mulch produced will be stockpiled for use in flower beds, tree wells, steep slopes, and natural areas as desired.

C. Logs, Stumps, and Large Woody Debris

These items will be stockpiled in a suitable location and periodically processed with a wood grinder to generate wood fiber landscape mulch. The goal is to mulch this stockpile on an annual basis, whenever possible.

Pest Population Definition

A summary of the potential pests at Landa Park Golf Course is shown in Table 3.

Table 3> Expected Pest Outline at Landa Park Golf Course

Category	Pests
Fungal Disease	*Cyanobacteria* (Algae)
	Sclerontinia homoeocarpa (Dollar Spot)
	Rhizoctonia solani (Large Patch)
	Ophiosphaerella korrae/herpotricha (Spring Dead Spot)
	Gaeumannomyces graminis var. graminis (Bermuda Decline and/or Take-all patch)
Insects	Fire Ants
	Nuisance Ants
	Cutworms
	Fall Armyworms
Weeds	Poa Annua
	Goosegrass
	Nutsedge/Killinga
	Dallisgrass/Crabgrass
	Broadleaves
Other	Localized Dry Spots

Pest Threshold Levels

The damage threshold levels for specific pest types are shown in Table 4. Damage threshold level is defined as the number of pests detected within a specified area that may lead to corrective action to reduce the density of the specific pest below the damage threshold level.

Table 4> Damage Threshold Limits for Specific Pest Categories

Pest	Greens	Tees	Fairways	Rough
Fungal Disease	0.1%[a,b]	15%[a,b]	25%[a]	N/A
Weeds	1/1000ft^2	3-5/1000ft^2	10-20/1000ft^2	20/1000ft^2
Insects				
Fire Ants	Any	1/1000ft^2	1/1000ft^2	3-5/1000ft^2
Worms[c]	5-10/1000ft^2	10-30/1000ft^2	N/A	N/A
Other				
LDS	5-10%[a,b]	25%[a]	N/A	N/A

a % of area affected

b when condition dictate, preventative measures will be considered

c Includes Armyworms and Cutworms

Pest Monitoring and Pest Control

All golf course staff will be trained in golf course IPM to monitor for evidence of pest infestation. The intensity and frequency of monitoring will be adjusted based on the likelihood or presence of pest infestation (i.e. seasonal) or in situational/site specific instances. All monitoring observation of potential pest infestation will be reported directly to the Superintendent on the same day of the observation. The IPM process and strategies will be implemented continuously and appropriate corrective action will be implemented as necessary.

The pest control strategy is sequential and consists of using cultural practices as the first line of defense. Pest control strategy will be developed on a case by case basis with all potential control options given consideration. The decision to implement chemical pest control measures beyond cultural, biological, or mechanical practices will be based on the review of relevant safety, scientific, economic, and environmental information. All products used for pest control will be those approved for use by the Environmental Production Agency for the specific indication.

A. Fungal Disease

Within the overall spectrum of pest management, fungal disease represents the most serious and consistent threat to turfgrass health at Landa Park Golf Course, and is of concern primarily on greens and tees. Greens and tees will be inspected regularly for symptoms of fungal disease. The primary means of identifying fungal disease will be diagnosis by the Superintendent. However, in some instances symptoms consistent with fungal disease may have alternative causes (nutrient deficiency, insects, etc.) When uncertainty regarding potential fungal disease is encountered, samples will be sent to a plant pathology laboratory for confirmation of the presence of fungal pathogens. More frequent monitoring of greens and tees will occur when conditions know to favor the development of these pathogens occur.

An essential aspect of preventing the development of fungal disease is the optimization of turf vigor through routine cultural practice. In addition, fungal disease control is dependent on the understanding of disease cycle and conditions that promote disease development, the correct recognition of disease symptoms, and the selective use of the appropriate fungicide agents when necessary. Specific cultural practices will be employed to minimize the potential for fungal disease, which are described below. In general, if these measures fail and symptoms of fungal infestation exceeds defined damage thresholds, fungicide applications may be necessary to control disease. Numerous factors including season, weather, and turf health/vigor contribute to the determination whether fungicide treatment may or may not be implemented o reduce resistance of fungal pathogens to specific products.

A description of conditions favoring disease development, symptoms of disease, and specific control measures for each type of fungal disease that requires pest management follows:

1. **Algae**[1]
[Cyanobacteria]

SYMPTOMS

Although they do not infect grasses, blue-green algae are a significant pest problem in the turfgrass industry. These organisms contain chlorophyll just like plants, but they grow by producing chains of thread-like cells similar to fungi. Symptoms of algae appear in areas where the turf canopy has been thinned by poor growing conditions or other pest activity. In these areas, a green or black mat of fuzzy growth is evident in the turf canopy or on the surface of the thatch. During periods of dry weather, this algal growth forms a dry, cracking crust on the thatch surface that repels water and impedes turf recovery.

Host grass species: all turfgrasses; most problematic on putting green turf

FACTORS AFFECTING DISEASE DEVELOPMENT

Algae may develop whenever thinning of the turf canopy permits sufficient air, light, and water to reach the thatch surface. Algal growth is most aggressive during the late spring, summer, and early fall when warm, humid conditions are conducive to algae growth and turf thinning. Low mowing heights, shady conditions, poor soil drainage, and frequent irrigation also encourage algal growth in the turf canopy.

Algae have historically been thought of as secondary colonizers, meaning that they only fill-in areas where turf density has been reduced by some other problem. However, mounting evidence indicates that high levels of algae activity can directly cause thinning of putting green turf, possibly by production of toxins or competition for air, water, and nutrients. An aggressive algae management program can greatly increase the density and overall quality of putting greens during periods of warm and humid weather.

CULTURAL CONTROL

Maintenance of dense, healthy turf is the most effective way to prevent algae invasions. Avoid establishing turf in areas that are heavily shaded or poorly drained, or take steps to correct these problems in established turf. Mow at the recommended height for each turfgrass species, and increase mowing heights in shady areas to compensate for the reduced light levels. Irrigation should be applied deeply and infrequently; apply sufficient water to wet the entire root zone, and then reapply as needed when the turf shows signs of wilt. Putting greens and other heavily trafficked areas must be cultivated regularly to maintain soil drainage and aeration.

[1] Disease profile information provided by NC State University's Turf files at **www.truffiles.ncsu.edu**

CHEMICAL CONTROL

Ammonium sulfate, hydrated lime, or other materials can be applied to "burn" the algae in infested areas. Extreme caution is needed when doing this, especially on golf course putting greens, as these materials can also burn the turf or cause nutritional imbalances in the soil.

The fungicides chlorothalonil and mancozeb are also effective algaecides. These products will control algae on a preventative or curative basis, but preventative applications are much more effective. Repeat applications on a 10 to 14 day interval during warm, humid weather, provides excellent algae control and significantly increases the density of putting green turfgrasses. Note that chlorothalonil and mancozeb are not approved for application to residential lawns. Fludioxonil (Medallion) provides moderate algae suppression and may be useful in areas where chlorothalonil and mancozeb cannot be applied.

Fungicides containing copper hydroxide should be used with caution, as copper can accumulate in the soil to toxic levels after repeated applications. For this reason, copper hydroxide should only be used under extreme circumstances to bring severe algae infestations under control.

Once a severe algae infestation has occurred, fungicide applications alone will not provide acceptable control. Additional steps must be taken to physically break-up the mat of algal growth so that the turf can recover. Spiking, aerification, verticutting, topdressing, or combinations thereof are effective ways to accomplish this.

2. **Dollar Spot**[2]
[Sclerotinia homoeocarpa]

SYMPTOMS

On putting green turf, dollar spot appears as small spots, approximately the size of a dollar coin, that are bleached-white or light tan in color. On turf mowed at heights greater than 0.5", the spots may expand in size up to 6" or more in diameter. The affected leaves typically remain upright and are characterized by having white or light-tan lesions with light reddish-brown margins. As the lesions expand, the leaves are girdled and the upper part of the leaves dies slowly. Distinct lesions are sometimes not evident on close-cut turfgrasses; instead, the leaves die back from the tip and turn white or light tan in color. The grass in the spots may be killed to the soil surface if the disease continues to develop, and many spots may merge to produce large blighted areas. Short, fuzzy white mycelium is often observed on affected turf in the morning when dew is present.

<-dollar spot leaf lesions on Kentucky bluegrass

Characteristic	Description
Host Grass Species	all
Month(s) with symptoms	February to November
Stand Symptoms	spots, patches (4 to 12 inches)
Foliar Symptoms - Location/Shape	round leaf spots, leaf lesions
Foliar Symptoms - Color	tan or white
Root/Crown Symptoms	none
Fungal Signs	mycelium or none

[2] Disease profile information provided by NC State University's Turf files at **www.truffiles.ncsu.edu**

FACTORS AFFECTING DISEASE DEVELOPMENT

The dollar spot fungus begins to grow and infect susceptible grasses in the spring when night temperatures exceed 50°F, even though symptoms of the disease may not appear until later in the spring or early summer. In addition, the pathogen requires extended periods of leaf wetness, 10 to 12 continuous hours. Heavy dews that often form during cool nights in the late spring or early summer are most conducive to the disease. Extended periods of wet, overcast weather can also lead to severe dollar spot epidemics on susceptible grasses. Dollar spot remains active throughout the summer in many areas, but disease activity typically slows when high temperatures consistently exceed 90°F.

Turfgrasses that are deficient in nutrients, especially nitrogen, are more prone to dollar spot and also recover from the damage more slowly than well-fertilized turf. The disease is also encouraged by drought stress, low mowing, excessive thatch accumulation, frequent irrigation, and low air movement. Certain cultivars of creeping bentgrass, perennial ryegrass, and Kentucky bluegrass are very susceptible to dollar spot, while others are fairly tolerant.

CULTURAL CONTROL

Use of resistant cultivars is one of the most effective means of dollar spot management. This is particularly important for creeping bentgrass, perennial ryegrass, and Kentucky bluegrass, as cultivars vary widely in their susceptibility to the disease. Base turfgrass selection on University recommendations or regional cultivar trials operated by the National Turfgrass Evaluation Program or local universities. When planting cool-season grasses, use blends and mixtures of multiple species and varieties whenever possible..

Adequate nitrogen fertilization will help to prevent dollar spot, and will also encourage plants to recover quickly from the disease if it occurs. Select nitrogen sources, rates, and timings based on local University recommendations for your turfgrass species and climate. In general, golf course putting greens established with creeping bentgrass or annual bluegrass should be fertilized with 0.5 lb N/1000 ft^2 per growing month. More or less nitrogen may be required for your location depending on soil type, rainfall amounts, traffic intensity, and other management practices. Deficiencies in other nutrients that limit foliar growth may also exacerbate dollar spot problems. Use soil test results to apply the recommended amounts of phosphorus, potassium, lime, and micronutrients.

Dollar spot is encouraged by drought stress and leaf wetness. Proper irrigation timing is needed to balance these factors. Irrigate based on the moisture status of the soil, not on a calendar schedule. When irrigation is necessary, it should be applied early in the morning, between midnight and 6 AM, to keep leaf wetness periods as short as possible. Mowing, dragging, or whipping the turf in the morning to remove dew can help to prevent dollar spot, but these practices can spread the disease if it is actively developing. Improve air movement and reduce humidity by pruning trees, clearing unwanted vegetation, or relocating desirable plants.

Excessive thatch accumulations greatly encourage dollar spot activity. Remove excess thatch by vertical mowing or power raking. Golf course putting greens should be aerified regularly and topdressed with sand to reduce thatch buildup.

Dollar spot is readily spread in leaf tissue or clippings from infected areas. Avoid spreading the disease by washing equipment before entering an uninfected area, by encouraging golfers to clean their shoes between rounds, and by removing and disposing of clippings taken from infected areas.

CHEMICAL CONTROL

Many fungicides control dollar spot, but preventative applications are most effective. A preventative program should be implemented in the early spring when night temperatures consistently exceed 50°F. When applied on a curative basis, fungicides must be applied at high rates and short application intervals.

Uniform spray coverage is important for maximizing fungicide performance; even small gaps in coverage may allow dollar spot to develop. Nozzle type, nozzle pressure, and dilution rate have the greatest impact on the uniformity of fungicide applications. Nozzles that produce coarse to extremely coarse droplets, such as TurfJet or Raindrop nozzles, dramatically reduce the performance of fungicides for dollar spot control. Air-induction or flat fan nozzles that produce fine to medium droplets are recommended. In order to provide thorough coverage of the turfgrass foliage, fungicides should be applied in 2 gallons of water per 1000 ft^2; lower carrier volumes reduce the performance of fungicides for foliar disease control.

The fungus that causes dollar spot develops resistance to fungicides very quickly. To prevent or delay the onset of fungicide resistance, use integrated management to minimize fungicide use, rotate among fungicide classes after each application, and tank-mix systemic fungicides with a contact fungicide.

3. Large Patch[3]

[Rhizoctonia solani]

SYMPTOMS

Large patch is a new name for an old disease of warm-season turfgrasses. This disease was formerly called brown patch, the same disease that affects cool-season grasses during hot weather. Other than the fact that they affect different grasses, there are several important differences between brown patch and large patch that necessitated a name change: they occur at different times of the year, produce distinct symptoms, are caused by different strains of the fungus *Rhizoctonia solani*, and require very different control strategies.

Large patch appears in roughly circular patches that are yellow, tan, or straw-brown. The patches are initially 2 to 3 feet in diameter, but can expand in size rapidly up to 10 feet or more in diameter, hence the name "large patch". Multiple patches may coalesce to encompass even larger areas of turf. When the disease is actively developing, the outer edge of the patches are often red, orange, or bronze in color. Close examination of individual plants reveals the presence of reddish-brown or gray lesions on the leaf sheaths. It may be necessary to peel away the older, dead leaves in order to reveal the lesions on the younger leaf sheaths below.

large patch sheath lesion in St. Augustinegrass

Characteristic	Description
Host Grass Species	bermudagrass, centipedegrass, seashore paspalum, St. Augustinegrass,zoysiagrass
Month(s) with symptoms	August to May
Stand Symptoms	patches (1 foot to greater than 3 feet)
Foliar Symptoms - Location/Shape	lesions on leaf sheaths
Foliar Symptoms - Color	tan, yellow, orange, red
Root/Crown Symptoms	None
Fungal Signs	None

FACTORS AFFECTING DISEASE DEVELOPMENT

Large patch begins to develop when soil temperatures decline to 70°F in the fall, but the symptoms do not necessarily appear at this time. The symptoms of large patch are most evident during periods of cool, wet weather in the fall and spring. In many cases, symptoms may not become evident until early spring when the warm season grasses are greening up.

[3] Disease profile information provided by NC State University's Turf files at **www.truffiles.ncsu.edu**

Large patch is favored by excessive nitrogen in the fall and spring, poor soil drainage, over-irrigation, excessive thatch accumulations, and low mowing heights. Centipedegrass and seashore paspalum are most susceptible to large patch, followed by zoysiagrass, and then St. Augustinegrass. Bermudagrass, rarely affected by large patch, recovers very quickly when the disease does occur.

CULTURAL CONTROL

Establishment of a disease-resistant turfgrass species is the most effective means for management of large patch. Bermudagrass rarely sustains significant damage from large patch, and grows of out the symptoms quickly when the disease does occur. In contrast, centipedegrass, seashore paspalum, St. Augustinegrass, and zoysiagrass often sustain serious damage and recovery can take several weeks or months. Fescues and bluegrasses are immune to large patch and are also an option in areas where cool-season turfgrasses can be maintained.

Do not apply nitrogen to warm-season grasses in the fall and spring. These grasses are growing slowly during this time and do not require a significant amount of this nutrient. In general, nitrogen should not be applied to the warm-season grasses within 6 weeks before dormancy in the fall or within 3 weeks after green-up begins in the spring. Warm-season grasses vary in their fertility requirements, so refer to local University recommendations for more specific recommendations for timing and rates.

Avoid establishing warm-season grasses in low lying areas that remain saturated for extended periods of time from surface runoff. If this is unavoidable, install subsurface drainage to remove excess water from the soil. Irrigate only as needed to prevent severe drought stress in the fall and spring. Control traffic patterns to prevent severe compaction, and aerify as needed to maintain soil drainage and aeration. Mow at recommended heights, and power rake or vertical mow as needed to control thatch accumulations.

CHEMICAL CONTROL

Fungicides are available for large patch control, but must be applied on a preventative basis. Applications should be initiated in the fall when soil temperatures decline to 70°F, regardless of when symptoms have appeared in the past. One or two well-timed applications provide season-long control of large patch in many situations. In severely affected sites, repeat applications should be made on 4 to 6 week intervals as long as soil temperatures are between 40°F and 70°F. Mapping of affected areas in the spring for spot-treatment in the fall can substantially reduce fungicide expenditures.

4. **Spring Dead Spot**[4]
   [Ophiosphaerella korrae & Ophiosphaerella herpotricha]

SYMPTOMS

Spring dead spot symptoms appear in circular patches from 6 inches to several feet in diameter that remain dormant as the turf greens up in the spring. These patches eventually die and collapse to the soil surface. The roots, stolons, and rhizomes are dark and rotten in affected areas. Spring dead spot patches recur in the same spot each year and increase in size by up to several inches each season. As the patches expand, the centers are sometimes re-established with bermudagrass or weedy species, resulting in a ring-like appearance. Recovery of the patches occurs by spread of the bermudagrass from the outside. This process is very slow, taking the entire growing season in severe situations. The spring dead spot patches greatly detract from the uniformity of the playing surface and are frequently invaded by weeds. Spring dead spot may also occur in certain varieties of zoysiagrass, such as ‘Meyer’ and ‘El Toro’.

FACTORS AFFECTING DISEASE DEVELOPMENT

Spring dead spot is most evident on intensely managed bermudagrass, such as athletic fields and golf courses. The disease typically takes 3 to 5 years to become established in a new bermudagrass stand.

[4] Disease profile information provided by NC State University’s Turf files at **www.truffiles.ncsu.edu**

Unlike take-all patch, spring dead spot does not decline in severity as the turf matures. It becomes more severe if left unmanaged.

The spring dead spot fungus attacks the roots, rhizomes, and stolons of bermudagrass during the fall and winter. This activity does not directly kill the plant, but instead makes the bermudagrass more susceptible to freezing injury. As a result, spring dead spot is most severe in the northern range of bermudagrass adaptation and is usually more severe after extremely cold winters.

Any factor that restricts bermudagrass root growth or increases its susceptibility to winter injury will also enhance the disease. Excessive nitrogen, potassium deficiencies, poor soil drainage, over-irrigation, excessive thatch accumulation, and soil compaction have been shown to encourage disease development. The impact of soil pH on spring dead spot development in bermudagrass is not well understood.

spring dead spot root and stolon rot

Characteristic	Description
Host Grass Species	bermudagrass, zoysiagrass
Month(s) with symptoms	April to September
Stand Symptoms	spots, circles, patches (6 inches to greater than 3 feet), rings
Foliar Symptoms - Location/Shape	blighting of entire leaves
Foliar Symptoms - Color	tan, yellow, orange
Root/Crown Symptoms	roots, stolons, rhizomes, and/or crowns dark brown or black
Fungal Signs	none

CULTURAL CONTROL

Fertilize to meet the nutritional needs of the turf, but do not apply excessive rates of nitrogen. Do not apply nitrogen within 6 weeks of winter dormancy, and do not exceed more than 1 pound of nitrogen per 1,000 square feet per application at any time during the growing season. Reduce thatch buildup and relieve soil compaction through aggressive aerification and vertical mowing. Areas that are severely affected by spring dead spot should be hollow-tine aerified at least three times per year, during the summer when bermudagrass is most actively growing. Golf greens should also be topdressed along with aerification to control thatch accumulation.

The impact of soil pH on spring dead spot development is unclear at this time. Past recommendations focused on the use of acidifying nitrogen sources like ammonium sulfate to manage this disease. However, recent research at NC State University has shown that different spring dead spot pathogens respond differently to nitrogen sources. *Ophiosphaerella korrae*, the most common pathogen in the eastern US was controlled effectively by application of calcium nitrate as the sole nitrogen source. On the other hand, *O. herpotricha*, the most common pathogen in midwestern states, was suppressed by ammonium sulfate. Fall applications of potassium, which have been frequently recommended for spring dead spot management, had no effect on the disease in our research.

Once the symptoms of spring dead spot appear, the only means of control is to encourage the spread of bermudagrass into the affected patches. Frequent spiking or aerification is recommended to break up the mat of dead turf in affected patches. Applying extra nitrogen to encourage recovery is not recommended, as this can enhance the disease in the following year. Dinitroaniline (DNA) herbicides, which are commonly used for preemergent control of annual grasses, can slow the recovery of bermudagrass from spring dead spot injury and should not be used in sites with a history of the disease.

CHEMICAL CONTROL

Fungicides are available for spring dead spot control, but they must be applied preventatively in the fall. Fenarimol and tebuconazole have been the most effective and consistent fungicides for spring dead spot control. Applications are most effective when soil temperatures are between 60 and 80°F. To move the fungicide into the root zone, apply in a high volume of water (5 gallons per 1,000 square feet) or water in with ¼" of irrigation immediately after application. Repeat applications at high label rates may be necessary in severely affected areas. Affected areas should be mapped in the spring for treatment in the fall to reduce fungicide expenditures.

5. **Bermuda Grass Decline**[5]
   [Gaeumannomyces graminis var. graminis]

SYMPTOMS
Circular patches .5 to 3 ft. diameter; initially yellowish; gradually turning brown and thinning; roots darkened; chlorotic leaf blades may develop next to green shoots at margins of diseased area; roots brown and without feeder roots and root hairs; root surface appears as dark brown hypal runners; runner hyphae may be visible during microscopic examination.

HOST GRASSES: Major hosts: Bermudagrass, St. Augustinegrass. Other hosts: Zoysiagrass, Centipedegrass

DISEASE CYCLE:
Symptoms most evident in late summer (hot, wet periods) and early fall-fungus organism most active during fall, winter and spring in moderate temperatures and abundant moisture; root attacking fungus; spread by mechanical means and plant-to-plant contact; fungus grows on the surface of roots, stolons, rhizomes, crown and leaf sheaths-and then penetrates and infects the tissues; pathogen survives on infected debris and infected perennial parts of living grass plants

FACTORS THAT MAY PROMOTE DISEASE DEVELOPMENT:
Cool, moist weather are conditions which favor growth of the fungus; symptoms increase in summer months; stressed turfgrasses-low mowing heights, water stress, excessive thatch, excessive fertilization, compaction, alkaline soils, etc… promote the disease.

CULTURAL CONTROL:
Raise cutting height; maintain moderate nitrogen; control excessive thatch; positive plant water balance, soil acidifiers in alkaline soils; use of ammonium sulfate to decrease pH; aerification program; some research has been done using higher rates of ammonium sulfate and moderate aerification on bermudagrass greens-Dr. Richard White.

CHEMICAL CONTROL:
Fungicide applications are not very effective; proper cultural practices, especially in the infected areas, are a must.

[5] Disease profile provided by http://aggieturf.tamu.edu/answers4you/disease/bermdecline.html

B. Insects

Central Texas offers a variety of pests and potential pest infestation problems that vary from golfer safety to turfgrass damage. The highest pressure for potential pest problems comes from cutworm and fall armyworm damage where little damage can be tolerated on greens surfaces. Fire ants can pose a potential safety issue to patrons and guests at the facility and also have the potential of negatively influencing customer satisfaction in multiple aspects. Monitoring for insects will consist of routine visual inspection of susceptible areas on a weekly basis. General turfgrass cultural practices leading to optimal turf vigor are the primary means of minimizing the potential for insect infestation. If cultural practices are ineffective at preventing damage thresholds for a specific pest form being exceeded, the selective use of insecticides will be employed. Rotational strategies will be employed as necessary to reduce insect resistance to specific products.

A description of specific insect pests, symptoms of infestation, and corresponding control measures follows:

1. Fire Ants[6]

***[Solenopsis invicta* Buren]**

Red imported fire ants infest approximately 300 million acres in the United States. Every year these ants cause hundreds of millions of dollars in damage. These costs affect everyone from small property homeowners to large landowners and ranchers to managers of golf courses and commercial properties. Fire ants are the single most prolific pest in turfgrass. Although they do not damage the turf directly, the mounds are unsightly and can cause damage to mowing equipment. Fire ants hinder outdoor recreation, which thus affects tourism. Although less than one percent of the human population has extreme reactions to fire ants stings, they can pose a serious medical threat to visitors of public lands. Serious incidents can be costly to managers of these areas, which can be held liable for such an event. Golf courses are especially attractive to fire ants due to the ideal conditions that exist there. Their mounds can ruin a good shot. In the south, the 'unofficial ruling' is that you may remove your ball from the mound the distance of one club length. Golf courses are man-made ecosystems that include natural habitats; wildlife population's (permanent and migratory) ground and surface water, managed turf, and provide recreation for millions of people each year. Additionally, grasses release oxygen and reduce glare and noise. Irrigation water applied to golf courses provides an ideal habitat for fire ants. Fire ants are attracted to areas of high moisture content, fertile soil, and open sunny areas.

Chemical Control

Many golf course superintendents indicate their budget does not allow for fire ant treatments exclusively. However, for the ideal situation, a combination of two approaches should be able to provide acceptable levels of fire ant control at a reasonable cost.

The Two-Step Method: This method is suitable for larger turfgrass areas and provides relatively long-term control, but rarely provides 100 percent control:

Step 1) Make an annual or semi-annual (once or twice per year) broadcast application* of a baitformulated insecticide. Conventional baits (i.e., Amdro® or Seige®, Award®, Ascend® or Varsity®, or Extinguish™) are applied at 1 to ½ pounds of product per acre. Other products (i.e., FireStar®) require different rates. Periodic broadcast applications of fire ant baits provide roughly 90% suppression of ants when properly

[6] Disease profile information provided by Texas A&M University at **http://fireant.tamu.edu/materials/fact-sheets/**

applied (using fresh bait, applied in late evening/mid morning). The speed and duration of ant suppression differ with the product used. A late summer or early fall application can produce fewer ants by the following spring.

Step 2) Wait several days after the bait is applied, and then treat nuisance ant colonies (in high traffic areas) using an individual mound treatment such as products formulated as dusts, granules, granules drenched with water after application, liquid drenches, baits, or aerosol injections.

The Ant Elimination Method: This program controls nearly all ants in treated areas. Its effects are more rapid than those of other programs, and re-invasion of treated areas by migrating colonies and mated queen ants is minimized as long as the contact insecticide remains active on the treated surface. However, it is relatively more expensive and uses more insecticide, requiring more frequent treatments. For high use areas in golf courses such as putting greens and tee boxes where maximum fire ant control is required, this program would be preferable.

Step 1) (Optional) Broadcast a bait-formulated insecticide in areas where there are more than 20 per acre. Wait at least 2 to 3 days before conducting the next step.

Step 2) Apply a contact insecticide (i.e., pyrethroid products like those containing bifenthrin, permethrin, lambda-cyhalothrin or others, or products containing fipronil granules like Chipco® Choice™ or Chipco® TopChoice™) to turf periodically as directed (i.e., generally every 4 to 8 weeks, or when ant activity is detected). Liquid or granular products that can be evenly applied to an area are appropriate for this treatment. Areas treated must be watered soon after application to wash the insecticide below the surface. Although surface treatment may not initially kill ants located deep in mounds, routine re-application will eventually eliminate colonies.

Individual Mound Treatments: In areas with just a few fire ant mounds, use of an individual mound treatment product may be all that is needed. This approach may help preserve native ant colonies that are left untreated.

Program combinations: The three programs described above can be used on specific sites within a managed area where different levels of fire ant control are desired. On golf courses, for instance, The Ant Elimination Method may be suitable for high use areas such as putting greens and tee boxes. In fairways and rough areas, The Two-Step Method may be sufficient. Careful monitoring may document the absence of imported fire ants in some areas, or the presence of competitor ants that are not pestiferous. These areas can remain untreated. Furthermore, imported fire ants migrating from nearby untreated areas can be detected and treatments applied only as barrier zones to prevent movement of colonies into the managed areas from these reservoirs.

Cultural Control

Practices used by golf course managers for managing the imported fire ant management involves mowing frequency and height. The more times areas are mowed, the less time fire ants can establish colonies. Constant disturbance of ant colonies nesting in frequently mowed areas usually causes them to move to less disturbed areas. As an example of a management program, greens can be mowed seven times a week, tee boxes and fairways moved three times a week, and roughs can be mowed once each week. Spot treatments for fire ants may only be needed on roughs. Watering turfgrass and bodies of water will attract ant colonies. Conversely, minimizing watering may result in reduced ant nesting activity.

2. Cutworms[7]

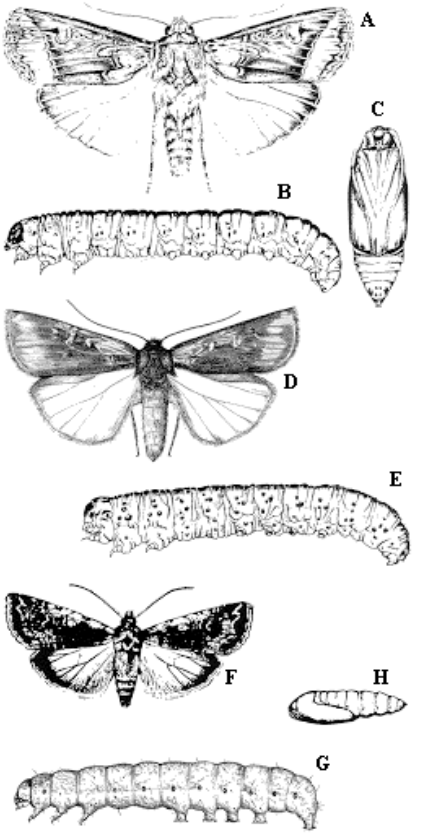
General Information

Cutworms are caterpillars that feed on the stems and leaves of young plants and often cut them off near the soil line, hence their common name. Although there are many important species of cutworms, the black, granulate, and variegated cutworms are the ones most commonly encountered on turfgrass.
Distribution -- Cutworms are found throughout the United States.
Host Plants -- Besides turf, cutworms attack many field and vegetable crops.
Damage -- Many cutworms prefer wilted plant material and sever the plants sometime prior to feeding. Cutworms in turf often burrow in the thatch or ground. At night they emerge and chew stems and blades near the soil. The damage may appear as circular spots of dead grass, finger-sized brown crescents or ball marks on a golf green. Bronzed cutworms are active in spring and fall and may strip large areas of turf at ground level.

Life Cycle

Adult -- When resting, cutworm moths hold their wings back in a triangular position. The moths are generally stocky and have a wingspan of about 1.5 inches (40 mm). The forewings are dark brown and mottled or streaked; the hindwings are lightly colored and unmarked.
Egg -- The eggs are usually white (becoming darker prior to hatching), round, and smaller than a pin head (0.5 to 0.75 mm) in diameter.
Larva -- If disturbed, the larvae usually curl into a C-shaped ball. Cutworms are plump, smooth, dull-colored caterpillars that measure about 1.75 inches (45 mm) when fully grown.
Pupa -- Pupae are brown and 15 to 22 mm long.

Each cutworm species differs slightly from the others in details of habits and appearance, but their life histories are generally similar. Adults and larvae are nocturnal and hide during the day but may also become active on cloudy days. Larvae are very active and may crawl 60 feet or more during the night. Cutworms overwinter in the soil either as pupae or mature larvae. In the spring, the hibernating larvae pupate. Adults begin to appear in the middle of March. Female moths deposit eggs singly or in clusters, and each female can lay as many as 500 eggs. Under optimum conditions, the eggs hatch in 3 to 5 days, and larvae develop in 3 to 4 weeks passing through 6 instars. Pupae mature in 2 weeks during the summer and as many as 9 weeks in the fall. Some of the cutworms can produce as many as four generations each year.



Black cutworm. A, Adult. B, Larva. C, Pupa. Granulate cutworm. D, Adult. E, Larva. Variegated cutworm. F, Adult. L, Larva. H, Pupa.

Scouting

Since cutworms may be difficult to detect, soap flushing solutions can be helpful for detection. Use 1 oz of lemon-scented liquid dishwashing detergent in 2 gal of water. Dispense with a watering can within a 3ft x 3ft grid. Larvae should appear in five to ten minutes. Treatment threshold is five to ten larvae per square yard. Threshold may be lower on finer turf such as golf greens. Irrigate the grid with plain water afterwards. Commercial pheromone traps that attract male moths can be used to determine treatment timing but are not indicators of larval densities in the turf. Damage can be expected 2 weeks after peak flight so time pesticide applications accordingly.

[7] Insect Profile provided by http://www.turffiles.ncsu.edu/insects/Cutworms.aspx

Nonchemical Control Strategies
Kentucky bluegrass is a non-preferred host, for black cutworm, compared to creeping bentgrass and perennial rye and may reduce infestation. This may be used in mixed turf or in border areas. The nematode, *Steinernema carpocapsae* is moderately effective against black cutworm. Follow label instructions exactly. *Bacillus thuringiensis* products work best while larvae are young. Collection and removal of clippings from the area may be helpful.

Chemical Control- For chemical control, liquid formulations should be used, applied as late in the day as possible, and not watered in for at least 24 h. Treating a 20-30 ft buffer zone around greens and tees will reduce migration from outlying areas. Precede chemical treatments with mowing 24 hours prior to treatment. Apply chemicals in the evening for optimal night time contact.

Please note the formulation, application, and site restrictions for some products. Follow all label directions. Spinosad, deltamethrin, halofenazide, bifenthrin, lambda-cyhalothrin, carbaryl, trichlorfon and azadirachtin are examples.

C. Weeds

Two weeds stand out as the hardest to control in bermudagrass stands depending on season. During the cool season, poa annua continues to be a nuisance in bermuda grass stands and is easily controlled in non-overseeded environments, however, when other desirable cool season grass are incorporated, its management can be a challenge. During the growing season, dallisgrass as well as goosegrass, can provide a challenge in control and overall quality of bermudagrass stands. Many of these pests can be controlled with proper preventative action, leaving only an isolated need for post emergent control.

1. Annual Bluegrass
[Poa Annua]

Poa annua, also known as annual bluegrass, is a cosmopolitan weed in all turfgrass situations. The vast majority of the annual bluegrass is the true winter annual (*Poa annua* var.*annua*) that germinates in the fall, grows throughout the winter season, flowers profusely in the spring during March and April, and then dies as the summer temperatures rise. The seed will remain in the soil all summer long and will germinate again early during the next fall. The annual form of *Poa annua* produces stemmy seedheads that often grow in a circular pattern around the leaves, especially when the turf is mowed regularly. In the summer, when bermudagrass grows well and is manicured regularly, the bermudagrass greens will squeeze out most of the *Poa,* both annual and perennial forms. The hot weather stress is not conducive for *Poa* growth.
The perennial form of "annual" bluegrass, *Poa annua* var. *reptans,* occurs much less frequently. The perennial types of *Poa annua* essentially survive only in very close-cut turfs like golf course greens. In higher cut turfs on tees, fairways, and roughs, the annual type will be the more common weed. Weed control programs in turfgrasses generally are targeted against the annual form of *Poa* and consideration should be given to strategies based on the type of herbicides to apply at different growth stages of *Poa* in different turfgrasses.

Preemergence Control of *Poa annua*

There are many options available if a winter turfgrass is not overseeded into the bermudagrass. Several preemergence grass herbicides will easily control *Poa* by preventing seedling emergence. Treat bermudagrass turf before late September. If these herbicides were applied in the previous spring for summer annual grass weed control, these chemicals will not last long enough in the soil to be effective against *Poa* in the fall season.

When bermudagrass **will** be overseeded with a winter turf (ryegrass), the selection of an herbicide is limited and timing of application of a preemergence herbicide is very critical. In this case, ryegrass must be able to emerge safely after overseeding and at the same time try to prevent *Poa* establishment. Most preemergence herbicides will also prevent the ryegrass from emerging. However, a properly timed and a very early application of a preemergence herbicide is one option. Another option is to use selective chemicals that control the *Poa* while being safe on the emerging winter turf.

Postemergence Control of *Poa annua*

The *Poa* is emerged and exists as a seedling or established plant. The size and age of the weed and the "background" turfgrass are important considerations when applying postemergence herbicides for a *Poa* control program. When ryegrass is overseeded and established as a winter turfgrass, the safety to ryegrass and the underlying dormant bermudagrass is critical.

In situations when the bermudagrass is not overseeded with a winter turf, there are many options available. Many of the herbicides are non-selective and so it is critical to be sure that the underlying bermudagrass is dormant before making applications. The *Poa* will begin to flower from late January to mid-April with profuse flowering in March. It is better to eliminate the *Poa* before flowering.

2. Common Grassy Weeds – (Dallisgrass/Crabgrass/Goosegrass)

Cultural Control

The presence of these weeds can be eased by the optimization of turf health through standard cultural practices. Proper fertilization, irrigation, and insect/disease control produces a dense vigorous turf that optimizes resistance to many weeds. Normally the weed pressure from common grassy weeds is so great, that a preventative herbicide application is necessary to reduce and/or eliminate the need for multiple post-emergent applications.

Chemical Control

Pre-emergent herbicides will be applied in early spring, prior to germination period for Crabgrass/Dallisgrass. It is recommended that the application rate of this application be split into two separate applications, February and May to ensure prolong control of both early germination varieties that tend to become active in early spring, as well as, boost control for those weeds that prolong germination into early summer. This "booster" application should help provide quality goosegrass control.

Post-emergent control will be done based on weekly scouting performed during weed pressure timeframes and decisions made based off of threshold requirements. If proper pre-emergent applications are made, only small broadcast, and spot applications will be necessary to keep turf relatively weed free throughout the growing season.

3. Nutsedge

The nutsedges are grass-like, colony-forming, perennial weeds that grow actively during the frost-free season, spread by rhizomes, and propagate from year to year by small, starchy tubers (sometimes called "nutlets," which give the weeds their common name). Nutsedges, also called nutgrasses, are difficult to manage because of their tolerance to heat, drought, and flooding; their prolific underground vegetative reproduction; and their ability to regrow after cultivation.

Control

An effective pre-emergent control has not been found for nutsedge in a bermudagrass turf environment. It is recommended that a post-emergent application be made that focuses on sites that are medium to heavily infested with nutsedge to keep turfgrass quality at a reasonable level.

Pesticides

1. Pesticide Definition

A pesticide is any substance that is used to control pests including insects (insecticide), weeds (herbicide), fungi (fungicide), nematodes (nematicide), and algae (algaecide). The mechanism of action of most pesticides is to eliminate the pest by suppressing, weakening, or eradicating the target pest.

2. Pesticide Use Determination

The ideal pesticide is highly potent (requires minimal application), is target-specific (is safe for non-target species), and is compatible with the environment. While pesticide manufacturers pursue these properties, the degree of cross-toxicity and environmental compatibility in pesticides approved for use by the Environmental Protection Agency can vary considerably. As a result, if avoidable, pesticides will not be used. In the event that pesticide application is necessary, pesticides will be applied according to label.

The primary strategy for pest management as defined in this Integrated Pest Management plan is to optimize turf vigor through cultural practices to optimize turf resistance to, or tolerance of pests. In the event that cultural practices do not contain pest populations below damage thresholds, chemical control measures will be employed as necessary. Pesticides applied to control pests will be selected by the Superintendent based on their safety, efficacy, economic impact, toxicology, and environmental compatibility. In addition, the Superintendent will monitor developments in pesticide research and development; and he/she will incorporate the use of newly developed, tested, and improved pesticides approved by the EPA where appropriate.

3. Projected Pesticide Use

The location of pesticide use and the projected frequencies are shown in Table 5.

Table 5> Landa Park Golf Course:
Pesticide Application Areas and Typical Application Frequencies

Area	% Total Area	Pesticide Applications per Year	Pesticide Category
Greens	2.5%	20-30	Fungicide, Herbicide, Insecticide
Tee Surface	3%	10-15	Herbicide, Insecticide
Fairway	21%	10-15	Herbicide, Insecticide
Immediate Rough	25%	4-8	Herbicide, Insecticide
Secondary Rough	35%	3-6	Herbicide, Insecticide
Native	13.5%	0-2	Insecticide

The pesticides that have potential for use at Landa Park Golf Course include five fungicides, five herbicides, three insecticides, and one wetting agent (Table 6). To minimize the development of resistance, pesticides in different families with different mechanisms of action will be rotate as frequently as practical and necessary. In addition, if pest resistance to one or more of these pesticides does develop, or if unanticipated circumstances arise, the Superintendent may use alternative pesticides that are EPA approved for treatment of the specific indication.

Table 6> Pesticide Selection for Potential Application at Landa Park GC

Pesticide Trade Name	Pesticide Chemical Name	Pesticide Category
Fore	Mancozeb	Fungicide
Daconil Action	Chlorothanlonil	Fungicide
Heritage	Azoxystrobin	Fungicide
Cleary 3336	Thiophanate-methyl	Fungicide
Cleary 26/36	Iprodione/Thiophananate-M	Fungicide
Andersons 8% Carbaryl	Carbaryl	Insecticide
Award	Fenoxycarb	Insecticide
Advion	Indoxacarb	Insecticide
Monument	Trifloxysulfuron	Herbicide
Revolver	Foramsulfuron	Herbicide
Illoxan	diclofop-methyl	Herbicide
Barricade	Prodiamine	Herbicide
Ronstar	Oxadiazon	Herbicide
Revolution	Modified Alkylated Polyol	Wetting Agent

4. Pesticide Storage

All pesticides will be maintained in a dedicated, dry, well-ventilated, approved storage area that has restricted access and meets the requirements of the Texas Department of Agriculture.

5. Pesticide Mixing

The entire pesticide product label will be read and understood prior to the use of any pesticide prior to pesticide mixing; the Superintendent will determine that local weather conditions are suitable for pesticide application. All pesticides will be mixed according to manufacturer's labeling instructions by a licensed pesticide applicator. Personnel will wear proper personal protective equipment during the entire mixing process, as instructed on the label of the pesticide being mixed.

6. Application

All pesticides will be applied by a licensed pesticide applicator or personnel properly trained in the safe application of these agents by a licensed pesticide applicator. Applicators will wear appropriate personal protective equipment appropriate for the pesticide being applied. All pesticide application equipment will be properly calibrated prior to the addition of the pesticide formulation to the equipment and application to the golf course.

The areas of the golf course requiring pesticide application will be specifically defined by the superintendent. Whenever possible, applications will be selective and limited to localized, targeted areas to minimize the amount of pesticide being applied. No pesticide spray application will occur if wind speeds exceed 10 mph or if wind direction or activity will carry pesticides toward, or deposit them upon open water. Pesticides will not be applied if heavy rain is forecast following the potential application event.

No pesticide applications will be made in defined buffer zones.

7. Clean Up and Disposal

Pesticide containers, mixing tanks, and equipment will be rinsed n accordance with recommended procedures and rinse water will be disposed of in accordance with state and local ordinances.

8. Pesticide Documentation

All pesticide applications and usage will be documented to the specification required by the Texas Department of Agriculture. Information recorded will include date of application, location of application, the type of pesticide applied, rate of application, weather conditions including wind and temperature, target pest, the equipment used for application, and indentifying the person making the application. In addition, current pesticide labels and MSDS sheets will be compiled and maintained in a location accessible to all employees. All pesticide documentation will be in accordance with state and federal regulations.

Facilities Description

1. Maintenance Building

Current maintenance functions are performed in a modified stone building adjacent to the golf course property. The building is segregated into three main areas. The first area is an open space for crew lockers, postings, and picnic style seating. The second area consists of a semi-enclosed storage area for small tool and janitorial storage as well as a small climate controlled office space that has been converted to staff

quarters and irrigation control office. The third area consists of mower and fertilizer storage and occupies the back half of the golf section of the building. This building is also shared with park operations as a joint use facility to accommodate centralized park operations.

2. Petroleum and Fuel Storage and Disposal

Hydraulic and engine oil will be stored in a dedicated area to keep a level of confinement around stored petroleum. Used fluids will be stored in separate dedicated containers labeled with the type of fluid and in appropriate containers for that type of fluid. Fluids will be disposed of according to state and local regulations.

3. Fuel Storage

With no current on site fueling depot, fuel is maintained on site in two to five gallon cans for both diesel and unleaded fuel. These containers are to be kept in a flammable safety cabinet and secured when not in use. Fueling and transport is minimized by using the closest fueling station to the maintenance shop facility.

4. Equipment Washing

All equipment is to be washed on two centralized wash stations centrally located within the two nine hole sections of the course. This eliminates any contamination to adjacent waterways from grass clippings and petroleum rinsate. Equipment will be washed with water only, in the exception of the occasional pressure wash that may include the use of a mild degreaser.

5. Pesticide Storage

Current pesticide storage is located behind the maintenance building in a dedicated, locked chemical storage shed. This building has limited access to ensure adequate safety and security.

Pest Worksheet

Pests	Timing	Pest Stage	JAN				FEB				MAR				APR				MAY				JUN				JUL				AUG				SEP				OCT				NOV				DEC			
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
I-1: Nuisance Ants	C	A																							(X)				(X)				(X)																
I-2: Fall Armyworm	C	L																							(X)				(X)				(X)																
I-3: Cutworm	C	L																							(X)				(X)				(X)																
I-4: Southern Mole Cricket	C	A																							(X)				(X)				(X)																
D-1: Algae	C						X				X				X				X																														
D-2: Dollar Spot	P														X				X				X				X				X				X														
D-3: Rhizoctonia complex	P							X							X				X				X				X				X				X														
D-4: Spring Dead Spot	P							X																											X				X										
D-5: Bermuda Decline	P											X							X				X				X				X				X														
W-1: Poa Annua	P	Pre																																							X										
W-2: Goosegrass	C	Post																			X			(X)																	X										
W-3: Killinga	C	Post																							X																										
W-4: Nutsedges	C	Post																							X																										
O-1: Localized Dry Spot	P					X								X								X				X				X				X														
All Applications are Broadcast																																																	
(X) = Only expecting one																																																	
application based on activity																																																	

Management zone: **Greens**

Course: Landa Park Golf Course Completed by: Jason Wiedeman Date: 1/15/2013 Year Covered: 2013

C = Curative
P = Preventive
Post = Post emergence

Pre = Pre emergence
L = Larval stage
A = Adult stage

X - Anticipated Applications based on pest pressure
(X) - Tenative Application based on scouting and pest threasholds
- Anticipated Pest Presents based on historical and cultural data
- Color coded to anticipated product on IPM planner worksheet

Pest Worksheet

Pests	Timing	Pest Stage	JAN				FEB				MAR				APR				MAY				JUN				JUL				AUG				SEP				OCT				NOV				DEC			
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
I-1: Fire Ants	C	A												X			(X)				(X)				(X)				(X)				(X)				X												
I-2: Fall Armyworm	C	L																																															
I-3: Cutworm	C	L																																															
I-4: Southern Mole Cricket	C	A																																														
W-1: Poa Annua	P	Pre			(X)																															X												X
W-2: Goosegrass	P	Pre			(X)						X														(X)				(X)																			
W-3: Dallisgrass	P	Pre			(X)						X												(X)				(X)				(X)				(X)												
W-4: Nutsedges	C	Post																							X											X												
W-5: Broadleaves	P	Pre			(X)						X														X											X												

Management zone: **Tees, Fairways, Roughs**

Course: Landa Park Golf Course Completed by: Jason Wiedeman Date: 1/15/2013 Year Covered: 2013

C = Curative
P = Preventive
Post = Post emergence

Pre = Pre emergence
L = Larval stage
A = Adult stage

X - Anticipated Applications based on pest pressure
(X) - Tenative Application based on scouting and pest threasholds
- Anticipated Pest Presents based on historical and cultural data
- Color coded to anticipated product on IPM planner worksheet

IPM Planner

Product or Practice	Rate	Rate Units	Area Units	JAN 1	JAN 2	JAN 3	JAN 4	FEB 1	FEB 2	FEB 3	FEB 4	MAR 1	MAR 2	MAR 3	MAR 4	APR 1	APR 2	APR 3	APR 4	MAY 1	MAY 2	MAY 3	MAY 4	JUN 1	JUN 2	JUN 3	JUN 4	JUL 1	JUL 2	JUL 3	JUL 4	AUG 1	AUG 2	AUG 3	AUG 4	SEP 1	SEP 2	SEP 3	SEP 4	OCT 1	OCT 2	OCT 3	OCT 4	NOV 1	NOV 2	NOV 3	NOV 4	DEC 1	DEC 2	DEC 3	DEC 4
Cool Season Stress																																																		
Warm Season Stress																																																		
Tree Maintenance				X																																											X			
Renovation																																																		
Overseeding																																																X			
Aeration																X															X																		
Heavy Topdressing																X							X								X																		
Venting																																																		
Grooming														X					X			X				X				X							X				X							X			
Verticalmowing																	X				X				X				X				X				X				X									
Light topdressing							X				X				X				X				X				X				X				X				X				X						
Traffic Control				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Soil Testing								X																X												X													
Irrigation Water Testing								X																X												X													
Andersons 19-0-15	0.57	lbs/N	M			X											X									X								X														
Andersons 13-0-26	0.52	lbs/N	M									X									X									X									X										
Foliar Sprayed Nutrition	0.11	lbs/N	M		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X
Irrigation Maintenance				X								X								X								X								X				X									
Drainage Improvement								X																			X																				X			
Hand Watering																								X	X	X	X	X	X	X	X	X	X	X	X														
Andersons 8% Carbaryl (I 1-4)	1.70	lbs	M																							(X)				(X)						(X)													
Fore (D-1)	6.00	oz	M					X				X																																					
Daconil Action (D-1,2,5)	2.00	oz	M													X				X								X				X				X											
Heritage (D-3,4,5)	0.40	oz	M							X						X				X								X								X											
Cleary 26/36 (D-2,3,5)																								X																								
Cleary 3336 (D-2,3,4,5)	4.00	oz	M											X																						X						X							
Visually Monitoring				X				X				X		X		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X				X			
Monument (W-1,3,4)	0.53	oz	A																								X																						
Revolver (W-1,2)	0.40	oz	M																				X																						X				
Illoxan (W-2)	0.90	oz	M																						(X)																								
Primo Maxx	3.00	oz	A										X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X	
Mikropak (Fe,Mg,Mn,Zn,S)	2.50	lbs	A										X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X	
Revolution Wetting Agent (O-1)	6.00	oz	M				X							X								X				X				X				X														
All Applications are Broadcast																																																

Management zone: **Greens**

Date: 1/15/2013

Course: Landa Park Golf Course

Completed by: Jason Wiedeman

Year Covered: 2013

M = 1000 sq ft
A = acre

oz = ounce
fl oz = fluid ounce
gal = gallon

lb = pound
qt = quart

X - Anticipated Applications based on pest pressure
(X) - Tenative Application based on scouting and pest threasholds
- Color coded to match timing schedule on Planner Worksheet

IPM Planner

Product or Practice	Rate	Rate Units	Area Units	JAN				FEB				MAR				APR				MAY				JUN				JUL				AUG				SEP				OCT				NOV				DEC			
				1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Cool Season Stress																																																	
Warm Season Stress																																																	
Tree Maintenance				X		X		X																																						X			
Renovation																																																	
Overseeding																																																	
Aeration																																																	
Heavy Topdressing																																																	
Traffic Control				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Soil Testing								X																												X													
Irrigation Water Testing								X																X												X												
Helena 20-0-10 Mesa w/ Kmag	0.70	lbs/N	M						X																																								
14-0-14 Ronstar** (200lbs/A)	0.64	lbs/N	M											X																																			
10-0-10 AMS/Kmag Blend	0.50	lbs/N	M																					X																		X							
Irrigation Maintenance				X								X								X								X						X						X							
Drainage Improvement								X																																						X			
Advion (I-1) Spot Treatments	1.5	lbs	A														(X)				(X)				(X)				(X)				(X)																
Award (I-1)	1.5	lbs	A											X																							X													
Monitor for Insect Damage												X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X														
Visually Monitoring for Disease												X				X				X				X				X				X				X				X								
Barricade (W-1,2,5)	16	oz	A																																		X												X
Ronstar (W-2,3,5) **	2	lbs/a.i.	A									X																																				
Monument (W-1,4,5)	0.53	oz	A																							X											X												
Illoxan (W-2)	0.90	oz	M																							(X)				(X)																		
Revolver (W-3)	17.4	oz	A																					(X)				(X)				(X)				(X)												
Growth Regulators																																																	
Trimmit 2sc (Overseeded Fwys)	10.00	oz	A				X				X																																					X
Primo Maxx (Tees and Par 3's)	11.00	oz	A																	X		X		X		X		X		X		X		X		X		X		X		X					

Management zone: **Tees and Fairways** Date: 1/15/2013

Course: Landa Park Golf Course Completed by: Jason Wiedeman Year Covered: 2013

M = 1000 sq ft
A = acre

oz = ounce
fl oz = fluid ounce
gal = gallon

lb = pound
qt = quart

X - Anticipated Applications based on pest pressure
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IPM Planner

Product or Practice	Rate	Rate Units	Area Units	JAN				FEB				MAR				APR				MAY				JUN				JUL				AUG				SEP				OCT				NOV				DEC			
				1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Warm Season Stress																																																	
Tree Maintenance				X		X		X																																						X			
Renovation																																																	
Traffic Control				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Irrigation Water Testing								X																X												X												
Helena 20-0-10 Mesa w/ Kmag	0.70	lbs/N	M						X																																							
14-0-14 Ronstar** (200lbs/A)	0.64	lbs/N	M												X																																	
10-0-10 AMS/Kmag Blend	0.50	lbs/N	M																					X																								
Award (I-1)	1.5	lbs/	A												X																								X										
Monitor for Insect Damage																				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X													
Barricade (W-1,2,5)	16	oz	A																																				X										X
Ronstar (W-2,3,5) **	2	lbs/a.i.	A									X																										X										
Monument (W-1,4,5)	0.53	oz	A			(X)																					X											X										
Illoxan (W-2)	0.90	oz	M																							(X)																						
Revolver (W-3)	17.4	oz	A																					(X)				(X)				(X)				(X)										

Management zone: **Rough** Date: 1/15/2013

Course: Landa Park Golf Course Completed by: Jason Wiedeman Year Covered: 2013

M = 1000 sq ft
A = acre

oz = ounce
fl oz = fluid ounce
gal = gallon

lb = pound
qt = quart

X - Anticipated Applications based on pest pressure
(X) - Tenative Application based on scouting and pest threasholds
- Color coded to match timing schedule on Planner Worksheet