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Developing an Integrated Pest Management Plan

Article written by Alec Kowalewski, Ph.D. - Turfgrass Specialist, Oregon State University
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Integrated pest management (IPM) is an environmentally and economically effective approach to pest management. IPM programs identify weed, insect, and disease pests, and then use current, comprehensive information on pest life cycles and their interaction with the environment. This information, in combination with available pest control methods, is used to make a decision about managing pests by the most economical means and with the least possible hazard to people, property, and the environment. The goal of IPM in turfgrass is to keep pest populations or damage at a tolerable level so there is no reduction in quality or safety of the turfgrass.

In turfgrass management, the essential tools for a successful IPM program include the pest triangle, prevention using proper cultural practices and scouting methods, and finally, the use of pesticides. This bulletin will discuss these three components in detail using various examples.

Pest Triangle

The three corners of the Pest Triangle are the Host, Pest, and Environment. Only when these three components are present will a pest problem occur. For instance, a common pathogen of perennial ryegrass is red thread. This pathogen is a facultative saprophyte, meaning that when the host plant is healthy, the pathogen is capable of feeding on organic matter. The pathogen can also survive as dormant mycelium. The red thread pathogen is likely present wherever perennial ryegrass is grown, even when symptoms are not being expressed. Red thread will often remain dormant until environmental conditions favor development. Periods of cool (temperatures below 75°F), wet weather, and deficient nitrogen levels all favor the development and expression of red thread. Altering environmental conditions, such as applying nitrogen fertilizer during periods favorable for disease development, can minimize disease incidence. Other examples that illustrate how environmental conditions can be altered to minimize pest pressure include crane fly mitigation through improved drainage, increasing fertility to decrease dollar spot, and moss control by decreasing irrigation rates (Table 1 and Image 1). The point of this discussion is that if the environment (moisture, fertility, organic matter, etc.) is not changed, the pest will persist regardless of the amount and frequency of pesticide applications.

Table 1: Examples of the pest triangle, factors include the pest, host and environment necessary for this pest to become a problem, as well as the cultural practices which will mitigate these pests.

Pest	Host	Environment	Cultural Changes
dollar spot	all turf species	low fertility	increase nitrogen levels
necrotic ring spot	Kentucky bluegrass	excessive organic matter	remove organic matter with cultivation
red thread	perennial ryegrass	low fertility	increase nitrogen levels

Pest	Host	Environment	Cultural Changes
pink snow mold	Kentucky bluegrass	high fertility	avoid late fall nitrogen applications
false dandelion	cool-season turf	drought conditions	increase irrigation
white clover	all turf species	low fertility	increase nitrogen levels
ground ivy	all turf species	shade conditions	improve sunlight by reducing shade
annual bluegrass	all turf species	low mowing height	increase the mowing height
moss	all turf species	shady, wet soil conditions	reduce shade and irrigation
knotweed	all turf species	compacted soil	improve soil aeration
European crane fly	cool-season turf	wet soil conditions	improve drainage, reduce irrigation

Image 1: Red thread of perennial ryegrass (left) is easily controlled with increased fertility, necrotic ring spot of Kentucky bluegrass (middle) can be mitigated with core cultivation, and finally moss can be reduced by reducing shade and irrigation rates (right). Photos provided by Neil Bell, Tom Cook and Brian McDonald.

Prevention

Pest prevention is a critical component to proper IPM. Prevention methods include cultural practices and regular scouting and utilizing action thresholds. Proper implementation of the primary and secondary cultural practices will not only reduce the susceptibility of the host turfgrass, but also prevent conditions conducive to pest development. The primary cultural practices within sports turf management are mowing, fertilization, and irrigation, while the secondary cultural practices include cultivation, inter-seeding, and over-seeding. As budget and labor hour constraints come into play, reduce secondary cultural practices while trying to maintain consistent primary cultural practices.

Mowing

Mowing is the most demanding of all the cultural practices within turfgrass management. Increasing your mowing height and increasing your mowing frequency can help reduce pest occurrence. Increasing your mowing height provides a number of benefits, such as deeper rooting, which will translate to increased drought tolerance and resistance to pathogens that damage root systems, such as summer patch and necrotic ring spot, and root feeding insects, like white grubs and crane fly. Increasing the mowing height will also prevent weed seed germination. Weed seeds are constantly entering fields, but establishment will be substantially reduced by increasing mowing height. The increased mowing height reduces the amount of sunlight that reaches weed seeds at the soil surface. Research has shown that simply increasing your mowing height on a mixed stand of cool-season turf from 1.5 inches to 3.0 inches will

reduce crabgrass cover by up to 52%, dandelion by up to 45% and white clover by up to 58% (Calhoun et al., 2005; Kowalewski et al., 2010). Other work has shown that annual bluegrass encroachment can be substantially mitigated by increasing the mowing height from 0.625" to 1.25" (Image 2).

Image 2: Annual bluegrass encroachment within a stand of perennial ryegrass maintained at a 0.625" height of cut (left), in comparison to a perennial ryegrass stand maintained at a 1.25" height of cut (right), Corvallis, OR, 2013. Photos provided by Alec Kowalewski.

Increasing mowing frequency will also mitigate weed encroachment by increasing turfgrass density. More frequent mowing triggers a physiological response within the turfgrass directing more energy and resources into lateral growth rather than vertical growth. Sports turf research conducted at Michigan State University determined that increasing the mowing frequency on cool season turfgrass from once to twice per week increased the number of soccer games a field can host by 45% while maintaining acceptable turfgrass (Calhoun et al., 2002). Additionally, having denser turfgrass during the spring athletic season minimizes the establishment of summer annuals, like crabgrass, and a dense stand in the fall will mitigate winter annuals, like annual bluegrass.

Fertilization

The second primary cultural practice is fertilization. Maintaining adequate levels of nitrogen and monitoring soil pH are important for a successful IPM program. Nitrogen is the primary nutrient, and turfgrass will require substantially more nitrogen annually than any other nutrient. The annual nitrogen recommendation for warm season grasses is 2 to 5 lb N per 1,000 square feet. Cool season grasses are recommended to receive 2 to 4 lb N per 1,000 square feet. A maximum rate of 1 lb N per 1,000 square feet can be applied in a single application. For cool-season sports fields, applications should be made in the spring and fall months. Warm-season sports fields should receive nitrogen applications throughout the summer, beginning in the spring and ending in the fall.

To adequately monitor soil pH, soil tests should be conducted every 1 to 3 years. A basic soil test will quantify your current pH, lime requirement, and a handful of essential nutrients, typically phosphorus, potassium, magnesium, calcium and sulfur. Research has shown that turfgrass can tolerate a wide range of pH values. When soil pH levels reach 5.5 or less, an application of lime is recommended. Liming rates vary depending on the soil test, but 25 lbs product per 1,000 square feet (around 1,250 lbs per field) is a good starting point. Maintaining a pH within a 6 to 8 range will help turfgrass maximize the available soil nutrients. When the soil pH begins to drop below 6, the available macro nutrients (nitrogen, phosphorous and potassium) will begin to be limited. Weeds that thrive in low pH and nutrient deficient conditions include clover, dandelion, knotweed, and plantain.

Irrigation

The final primary cultural practice is irrigation. When developing an irrigation program for an IPM plan, it is important to know irrigation rates and how to increase irrigation frequency, not depth. Every field manager should have a good understanding of the irrigation depth applied in a single run. This is important because the time required to apply a given depth, for example 0.25 inches, will vary drastically depending on the type of irrigation heads, spacing, nozzles, etc (Image 4). For instance, pop-up sprayers set on 12 foot spacing can provide 0.25 inches of water in as little as 7 minutes. On the other hand, sports turf rotors set on 90 foot spacing will likely require 30 minutes or more to provide 0.25 inches of water.

Image 4: Use a rain gauge (left) or collection cup (right) to determine your irrigation depth. Adjust run time to apply 0.25" per application 4 times per week to provide a cumulative weekly depth of 1". Photos provided by Alec Kowalewski.

The second point is increasing the number of weekly irrigation events, but not the irrigation depth. Weekly irrigation depths typically range from 0.75 to 1.5 inches depending on the environmental conditions. Applying irrigation at a 0.25 inch depth 4 times per week will put your irrigation program at 1 inch cumulative depth. If more water is required, increase the number of events per week, not the irrigation depth. In reference to proper IPM, this is essential because periods of drought stress between irrigation events will increase turf susceptibility to disease like necrotic ring spot, summer patch, and anthracnose. Weeds that are an indication of too little irrigation include false dandelion and summer annuals like crabgrass. Weeds that are an indication of excess water include moss, sedges, annual bluegrass, and rough bluegrass.

Secondary Cultural Practices

The two secondary cultural practices essential to proper IPM within a sports turf system include cultivation and inter-seeding or over-seeding. Cultivation or aerification will provide 5 major benefits on a sports field: 1) relieve compaction, 2) reduce organic matter, 3) improve gas exchange, 4) improve drainage, and 5) promote turfgrass root growth. Knotweed is an indicator that soil is heavily compacted. Necrotic ring spot is a sign of excessive organic matter accumulation. Moss is an indicator of poor drainage. If the field has knotweed, necrotic ring spot, or moss, cultivation is likely required. Cool-season turfgrass should be aerified in the spring and fall, while warm-season turfgrass should receive cultivation in the summer months.

Inter-seeding, applying cool-season turfgrass seed to cool-season turf stands, or over-seeding, applying cool-season turfgrass seed to warm-season turf stands, is another essential secondary cultural practice. While several seed options are available, perennial ryegrass will likely provide the best results because of its quick germination rate (7 to 10 days).

Inter-seeding or over-seeding should be performed whenever turfgrass density is reduced, for instance, after every game. If seed is not applied during these times, summer and winter annual weed infestations can be expected.

Scouting and Action Thresholds

Scouting requires turfgrass managers to be out on the field inspecting the turfgrass surface and turfgrass environment. The action threshold is the pest population at which control measures are justified to maintain aesthetic or economic value. The tolerance level is the pest populations preceding the action threshold or the populations at which aesthetics or value are not compromised. Scouting and action thresholds are most easily understood using insects as an example.

Turfgrass insects feed on either the roots or the foliage. For root feeding insects, such as white grubs and crane fly larvae, soil sampling should be done with a shovel (Image 3 and Table 2). For foliage feeding insects, such as billbugs, chinch bugs, armyworm and cutworm, do irritant sampling with dish detergent - lemon scented is typically the most effective (Image 5). Scouting periods vary significantly from insect to insect (Table 2). For instance, the optimum time to scout for fall armyworm is July and August, while crane fly larvae is December and January, and white grubs (Japanese beetle, European chafer and May/June beetle) can be found from September to October. Action thresholds can be set for insects according to their reproductive cycles. Once the insect population reaches the action threshold, control measures may be needed. Insect action thresholds range significantly from insect to insect - 1 fall armyworm per square foot to 80 billbugs per square foot (Table 2).

Image 3: A leather jacket, the larval stage of a European crane fly (left), feed on the turf roots for 11.5 months, before it emerges as an adult for a 2 week period in the fall (middle), during which it reproduces, lays eggs, and then dies. Scouting at a three inch depth using a flat end shovel should be done in the winter months before the larvae reach the third instar (right). Photos provided by Alec Kowalewski and Tom Cook.

Image 5: For irritant sampling of foliage feeding insects apply 3 fl oz of lemon scented dish detergent to every 5 gallons of water using a watering can (left), or bucket (right). Photos provided by Alec Kowalewski.

Table 2: Economic action thresholds for destructive turfgrass insects in irrigated and unirrigated turfgrass. Note: These thresholds will vary considerably depending on turf selection, environmental conditions, and cultural practices (i.e. mowing height, fertility and cultivation).

	Unirrigated turf	Irrigated turf	When to scout	Scouting method
Japanese beetle grub	5 to 10	10 to 20	Sept. and Oct.	Shovel*
European chafer	6 to 10	10 to 20	Sept. and Oct.	Shovel
May/June beetle grub	3 to 5	5 to 10	Sept. and Oct.	Shovel
Crane fly	15 to 25	25 to 50	Dec. and Jan.	Shovel
Billbugs**	5 to 10	10 to 20	April and May	Irritant soak***
Chinch bugs	20 to 30	30 to 50	June and July	Irritant soak
Cutworm	1 to 2		June and July	Irritant soak
Fall armyworm	1 to 2		June and July	Irritant soak
Mole cricket	2 to 4		April and May	Irritant soak

* Using a flat end shovel remove a 1" wide x 1" long x 3" deep sample.
**Adult bluegrass, Hunting and Phoenician billbugs.
***Using a bucket or watering can apply lemon scented detergent, 3 fl oz of detergent to 5 gallons of water.

Pesticides

Only after you have changed the environment and/or cultural practices that have resulted in your current pest problem should you consider the use of pesticides. Otherwise, the pest will return despite regular pesticide applications. Within IPM we often refer to preventative and curative applications. The best example to illustrate the use of preventative and curative applications is weed management. Some weeds are easily controlled with post-emergence applications of selective herbicides or curative applications. For instance, common and false dandelion, buckhorn and broadleaf plantain, and the thistles are easily controlled with fall applications of post-emergence selective herbicides containing a high concentration of 2,4-D (Image 6). White clover, ground ivy, and English daisy require post-emergence applications of products containing high concentrations of triclopyr. Conversely, annuals like crabgrass and annual bluegrass are best controlled with preventative applications of pre-emergence herbicides, such as products containing the active ingredients pendimethalin and dithiopyr.

Image 6: Weeds like common dandelion (left) are easily controlled with curative applications of post-emergence herbicides containing 2,4-D, while annuals like crabgrass (right) are best controlled with preventative applications of pre-emergence herbicides.

Conclusion

Regardless of the pest you are managing, whether it is diseases, insects, or weeds, determine how the environmental conditions and cultural practices (mowing, fertilization, irrigation, cultivation and inter/over-seeding) within your niche environment affect the pest. If improper environmental conditions or cultural practices are not remedied, pests will inevitably persist despite regular pesticide applications.

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