Conclusions

As is very often the case, carefully controlled laboratory research has reinforced the observations of turfgrass managers that environmental factors such as temperature and rainfall, and soil factors such as pH, percent organic matter, and water holding capacity influence the performance of soil insecticides in controlling scarab grubs. Specific properties of insecticides, such as characteristic lag time, affinity to thatch, and solubility then reduce or compound the effects of these environmental conditions.

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How to Minimize Unintended Movement of Pesticides

by Christopher Sann

A cursory examination of all the factors involved in pesticides applied to turfgrass moving off-site can leave even experienced turfgrass managers shaking their heads and muttering "Where do you start?" The task of deciding which pesticide to use, in what formulation, and how and when to apply it, is already challenging. It pales in comparison to having to consider product solubility, affinity for adsorption, persistence, vapor pressure, and runoff and leaching potential — not to mention site environment, host condition, topography, and soil characteristics.

The only way turfgrass managers can deal with all the data and processes in keeping pesticides from moving to undesired locations, is to develop and use a conscious decision-making process. The following discussion "walks" the reader through much of what must be considered. This framework can be used "as is," or modified to correspond to your needs.

No matter how this framework is configured, there are some universals that need to be addressed. These universals apply to decide on control action, regardless of whether or not movement off-site is a serious consideration.

Action 1 - Decide if control action is required

Step 1 - Locate the pest: The full extent and location of a pest infestation needs to be accurately identified and mapped, so that the control action selected can be applied to the proper location in the appropriate manner.

Step 2 - Identify the pest: Make sure that the pest targeted for your action is in fact the pest that is causing the problem. At sites where multiple pest identifications are likely, have your diagnosis confirmed by a "second opinion," by off-site microscopic examination, or a diagnostic lab.

Step 3 - Determine the development stage of the pest, then determine the growth stage of the insect or weed pest, or how far a disease has progressed.

Step 4 - Determine the magnitude of the infestation: Try to gauge the size and density of the infestation. Locating, identifying, and determining development stages are important, but it is also important to have some idea how "bad" — how intensive and extensive — a problem is. Small problems may require little or no corrective actions.

Step 5 - Determine the need for a control action: Determine if the problem exceeds your treatment threshold for that site. What is a big problem to some managers is not a big problem to others.

Once you have decided that a control action is required, determine how best to contain that action and its consequences to the site. Serious action may be called for. However, you must adhere to local, state, and federal regulations.

Action 2 - Analyze the site to determine whether the movement of pesticides to non-target locations is possible and/or probable.

Step 1 - Determine the following:

A) Host species
B) Level of growth or development (seedling, juvenile, mature)
C) Level of activity (growing or dormant)
D) Use patterns and cultural practices (cutting height, etc.)
E) Recent activities on the site
F) Current or predictable level of environmental stress for the site.

Step 2 - Analyze this information. These considerations are important because some species have dense foliage and root masses that can restrict pesticide movement while others do not. Seedling (up to one year old) turf stands are prone to runoff and leaching; juvenile (1 to 3 years old) turf stands are also prone to leaching; mature (older than 3 years) turf stands will often limit movement. Soil compaction and length of leaf cut can affect movement off-site. Have you already treated the site? Is the plant host in the proper condition to accept a systemic control material? Do environmental conditions prohibit the use of any pesticides or herbicides?

Step 3 - Analyze site structure. Do slopes or other features of the site topography increase the possibility of runoff or leaching? Are there obvious drainage patterns within the site? Are any of these near, or does one of them lead to a body of water, above or below ground?

Soil: Is the soil at the site open and porous, layered, or compacted? Is there thatch on it? Does the soil have a low (0-1%) or high (4-5%) organic content? What is the current soil pH? And, what is the current soil water content: bone dry (8-10%) or saturated (greater than 40%)?

Porous soils or those with high sand content can be prone to leaching. Soils with little or no thatch, and soils low in organic content, are prone to both runoff and leaching. The pH of soil, irrigation water, and tank mix water all have a dramatic effect on pesticide half-life. Low or high water content in soil can bind up, displace, or leach pesticides.

Step 4 - Analyze site environment. Do air flow, shade level, site orientation with respect to the sun, prevailing wind direction, and natural or supplemental water availability affect the permanent site conditions? What have been recent weather conditions (temperature, humidity, wind speed and direction, cloud cover, and precipitation) that could affect movement? What are the current site weather conditions? What is the weather forecast? What are site historical trends that can be extrapolated for the future?

Air movement over a site relates directly to the potential for volatilization (more air flow, more potential for movement). Areas with moderate to deep shade often have evaluation problems causing granular formulations to adhere to leaf surfaces. Wetness increases the movement of liquid applied materials by water flow or traffic. Materials applied to south- or west-facing sites with sloping grades may be more subject to photo degradation or rapid volatilization, necessitating reapplication. Sites without supplemental watering facilities or areas that are blocked from rainfall may not be good locations for products that require supplemental watering or rainfall soon after application. Temperature, humidity, wind direction and wind speed all affect volatilization/evaporation. Sunlight and current or predicted rainfall can affect all three of the possible means of pesticide movement.

Action 3 - The next step in the process is to use all of the pest and site information you have gathered to decide whether a pesticide-based or a non pesticide-based solution will solve the problem.

It is easy to just opt for the pesticide-based solution. The better answer, however, is to opt for the solution that is most cost-effective. For instance, non pesticide-based control solutions such as keeping fertilizer applications to a minimum are less costly than their pesticide-based counterparts.

If you decide to use non pesticide-based controls, the process monitoring the effectiveness of the control action(s) selected cycle back to the beginning. If, however, you choose to use a pesticide, you must then choose which one.

Action 4 - If you decide to use pesticides, develop a list of the pesticides and their different formulations that are appropriate for your situation and that are available. Try to list the products by efficacy. Check available reference materials –including those presented in this issue of *TurfGrass TRENDS* – for information on solubility, adsorption, and persistence, as well as displacement and leaching potential.

Action 5 - Compare the site specific information gathered in Action 2 with the list of products and their potential movement characteristics (see Dr. Hull's Table 1). In comparing these data the best pesticide choices should emerge.

Here's an example to illustrate. The problem is a moderate to heavy "Dollar Spot" infestation that is damaging a juvenile bluegrass stand on a sloped area at the back of a green. The area immediately below the slope drains into a small stream. Supplemental watering is available and rainfall is not forecast for the next five

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Table 1. Six Contamination-Relevant Characteristics of Five Fungicides (based on Hull *supra*)

Fungicide	Number of Applications	Solubility	Adsorption	Persistence	Runoff	Leaching Potential
"A"	two	low	moderate/ high	moderate	medium	nonleacher
"B"	one	low	moderate	long	small/ medium	inter- mediate
"C"	one	low	moderate	moderate	medium	nonleacher
"D"	one	low	moderate	long	large	inter- mediate
"E"	one	low	moderate	moderate	medium	inter- mediate

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days. Which fungicide would offer the lowest probability of movement off-site, while still providing excellent control of this "Dollar Spot" problem?

Five products – let's refer to them here as "A" through "E" – offer excellent control of "Dollar Spot." Three of the five are systemics; two are contact fungicides. Table 1 compares these five products on a number of relevant dimensions.

Combining the movement-related information from the table, the products' use specifications, and the location data collected earlier yields the following comparison. This comparison should be made in terms of the "pluses" and "minuses" of each product.

Product "A's" pluses are low solubility, moderate/high adsorption, and nonleaching; its minuses are moderate persistence, medium runoff, and the possible need to make a second application. Product "B's" pluses are one application, low solubility, moderate adsorption, small/medium runoff; its minuses are long persistence, and intermediate leaching. Product "C's" pluses are one application, low solubility, moderate adsorption, nonleaching; its minuses are moderate persistence, and medium runoff. Product "D's" pluses are one application, low solubility, moderate adsorption; its minuses are long persistence, large runoff, and intermediate leaching. Product "E's" pluses are one application, low solubility; its minuses are low adsorption, moderate persistence, medium runoff, and intermediate leaching.

Of the five products, the systemics "B," "D," and "E" do not appear to be the best choices in this situation. The two contact fungicides, "A" and "C," are marginally better choices, with "C" being a better choice than "A" because of the strong possibility of one application controlling the "Dollar Spot." Add to this the fact that, according to the labels, "C" can control the disease with one half to one fourth the needed active ingredient.

Action 6 - Select a product, choose the formulation of that product that is most appropriate. In the case of the example, both "A" and "C" are available in both liquid and granular formulations. Granulars are difficult to apply uniformly to sloped areas, they offer the possibility of dislodging from juvenile turf, and contact fungicides are more effective when applied as sprays.

Action 7 - Decide when the application should be done. In the example outlined above, there is no rainfall forecast for the next five days and the supplemental watering is controllable, so the application should be made as soon as possible.

Conclusion

Even if limiting the likelihood of off-site movement of applied pesticides has not been a regular consideration in your pest control plans, you should take the potential for such movement into your calculations. The process described above should help you accomplish this. In the long run, your gain – measured both in dollar savings and environmental protection – will be more than worth it.

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