available to certified growers in 1997, continues to show the almost no mole cricket activity, as originally reported in 1993. In addition to mole cricket non-preference, Tift 94 has excellent color, quality, and cold resistance and should be an excellent grass for golf course fairways, sports fields, parks, lawns and landscaping. TW72, a potential new dwarf bermudagrass for golf greens in the future, also continued to show significantly less mole cricket damage than Tifdwarf.

The turf breeding research at Tifton, GA, shows that mole crickets prefer to avoid certain cultivars where a choice of cultivars exists. What would happen if the cultivars showing non-preference were the only ones available? Experiments will be conducted in 1997 in cooperation with Kristine Braman, entomologist at the UGA Georgia Station in Griffin, GA, to determine the level of genetic resistance associated with the non-preference.

Dr. Wayne Hanna is a research geneticist with the U.S. Department of Agriculture at the Coastal Plain Experiment Station in Tiston, Georgia. He has been breeding turf and forage grass for twenty five years.

Dr. Will Hudson is an Associate Professor of Entomology at the University of Georgia. He has been invloved in mole cricket research and extension for fifteen years.

Planning Ahead to Minimize Insecticide Impacts on Golf Courses

by Rick L. Brandenburg
North Carolina State University

The use of insecticides on golf courses has been documented to have the potential for adverse, off-target effects on the environment. The key word is "potential." Insecticide use can and should be directed in such a fashion so as to keep the potential risk to a minimal level. This, of course, involves the use of properly selected pesticides chosen specifically for the pest and site to be treated. It also requires that insecticides are properly applied in an appropriate manner and timed in accordance with the insect's life stage. However, minimizing the potential for adverse risk from insecticide use starts long before the actual pest outbreak.

In theory, environmentally sound pest management should start during golf course design and construction. The installation of catch basins to capture insecticide contaminated runoff has proven effective for several years on many courses. More common considerations for avoiding runoff from areas that may require insecticide use include utilizing the slope of the land to direct runoff into buffer areas and appropriate landscaping. It is important to select proper landscape plants. Some plant materials can contribute significantly to turfgrass insect pest problems. Certain ornamentals that are attractive host plants for Japanese beetle adults can greatly increase the likelihood of a white grub problem. Since Japanese beetles prefer to lay their eggs in moist soil under healthy turf, any plants that attract the adults into the vicinity of the turf are likely to increase the chances of having such a problem.

Other more subtle problems can occur with insects like the two-lined spittlebug. The adults prefer to feed on hollies while the nymphs favor certain grasses. If hollies are used in plantings around buildings, they will attract adults and soon increase the number of nymphs feeding on the turfgrass. The same is true for grubs of the green June beetle and several other common turfgrass pests. Adjustments in landscaping can help avoid insect problems and thus reduce the need for insecticide use.

Areas of special concern over insecticide use (i.e. those immediately adjacent to water) can still provide the aesthetics and challenging ball play desired without the use of highly maintained turf-

grass immediately adjacent to the water's edge. In many such sensitive areas where serious insect pests such as mole crickets often are present, control is virtually impossible. Even if this area is not the focal point of a fairway and the insect's presence can be tolerated, they provide a source of infestation for the remainder of the course each year they are not controlled. Reevaluating the need for turf extending directly to the water's edge in light of such concerns may prompt the use of an attractive, low maintenance, playable ground cover that does not feed insects. The use of alternate plant material maintained in an organic mulch may form an excellent buffer to protect surface water bodies. Some mulches such as oyster shells, gravel, or other similar materials may actually enhance the likelihood of runoff into an area of concern. Such landscape modifications can greatly ease the pressure on a superintendent over pesticide use in environmentally sensitive areas.

Of course, we now have some alternative biological strategies for insect control (i.e. nematodes, bacteria, fungi) that offer opportunities to limit pests in such areas. However, the best approach is still to survey each site and determine if design or structural modifications can be made that will reduce the likelihood of pest problems in the area or make the insect's presence more tolerable.

By monitoring insect infestations and spot-treating areas where damage is occurring rather than wholesale broadcast applications, the quantity of insecticide used can be reduced markedly. Perhaps the most logical means of minimizing insecticide impact on the environment is to treat areas only when threatened by insect attack and to select an insecticide based on the site considerations, including choosing less toxic, less mobile, and less persistent materials. However, a persistent insecticide may result in a reduction in the total number of treatments required. Timing of insecticide use may even consider the presence of migratory bird species or modifying application methods through the use of newer technology such as subsurface application equipment. Chemical formulation can also play a factor since some are more susceptible to runoff and surface loss. Indirectly, pesticide formulations can play a role in reducing the quantity applied because you may be better equipped to apply some formulations more accurately and in a more timely fashion than others. Granular formulations are often considered to present greater risk for runoff or ingestion by birds, however, proper irrigation following treatment minimizes this risk and granuals offer less likelihood of drift injury or off site transport.

Remember, each insecticide use decision needs to be site specific. Environmental concerns can vary across a golf course as much as the soil types. Your insecticide use patterns may need to change as well with different locations. Many superintendents like the new synthetic pyrethroids such as lambda-cyhalothrin or fluvalinate because of their low use rates and their relative safety for people, mammals, and birds. However, these products can be very toxic to fish. Proper site selection for the use of such products is critical and these concerns can provide positive off-target benefits when considered prior to choosing an insecticide.

Fortunately, the science of insecticide selection has made great strides in recent years. Various indexes of pesticide leaching potential, toxicity rankings, and other rating systems help one customize insecticide selection and use to the needs of each specific site. This information is available from a number of sources including your state extension service, private consultants and technical publications. A listing of state extension services is attached, and one of the best sources of private consultants is your state or regional turfgrass association. In addition, assistance and information on pest identification is available through a number of turfgrass diagnostic laboratories listed in past issues of *TurfGrass Trends* (October 1996).