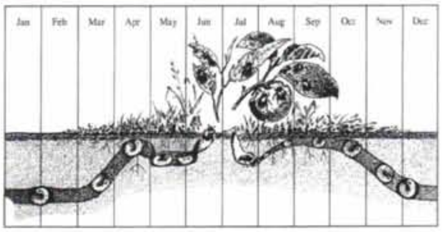
John Finnell *Nels J. Johnson Tree Experts*

Creature Feature! The Japanese Beetle

The Japanese beetle, Popillia japonica, *is an exotic pest in the United States. Introduced from Japan into New Jersey in 1916, the Japanese beetle is now found as far west as Wisconsin and Illinois and south to Alabama. The adults are a metallic-green color with copper-brown elytra, oval in shape, and can reach up to 10 millimeters in length. The larvae are white grubs with a c-shaped body, white head and three pairs of legs. The grubs can be identified from other soil-dwelling white grubs by the raster pattern of a v-shaped row of spines on the ventral side of the last abdominal section. Larvae can range from 1.5 millimeters in length in their first instar, to 32 millimeters in the third and last instar.*



(Top) Japanese beetles are considered "skeletonizers" of leaves. (Middle, left) Japanese beetle traps are marketed as a control tactic for adult insects. (Middle, right) The grub. (Bottom) The Japanese beetle's life cycle.

In the Chicagoland area, Japanese beetle adults emerge in late June to early July and begin to feed immediately. The male and female adults are able to release a congregation pheromone to attract other adults to the host plants. Additionally, the females release a sex pheromone to attract males. Females may mate with several males on the host plant or ground. The females prefer to burrow into moist soil to lay one to five eggs, two to four inches into the soil. Adult females may return to feed and mate several times from July to mid-August, and may lay 40 to 60 eggs during a lifetime of four to six weeks. The eggs are white, oval and 1.5 millimeters in length. Depending on soil temperature and moisture, development may last nine to 30 days. The first instar moves to the thatch layer and feeds on roots of turf, ornamental plants and vegetables, as well as dead organic material. The larvae molt twice, with instar duration dependent on soil temperature. Generally, the larvae are in the third instar by early fall and begin to migrate down in the soil when soil temperatures fall below 50° Fahrenheit. The grubs can be found from four to eight inches deep, but may move to 11 inches deep in response to dropping soil temperature. The grubs return to the soil surface in spring as conditions warrant, generally in mid-April when soil temperatures reach 60° Fahrenheit. The grubs continue to feed and develop, and by mid-June form pupa.

The larvae are serious pests of landscape turf environments. The female adults prefer irrigated turf and warm soils when laying eggs. Root feeding causes sod damage, which is identified by irregular patches of turf wilting and browning. Root damage allows the sod to easily be pulled off of the soil. Sod damage usually occurs at a concentration of 10 to 12 grubs per square foot. Additional turf damage can occur from predator feeding on the grubs by raccoons, skunks and birds, notably starlings, cowbirds, blackbirds and robins. The adult Japanese beetle is an important pest of woody landscape plants due to its vast host range for feeding as well as its preference to feed in groups, resulting in defoliation in severe infestations.

Depending on the source, the adult beetles feed on 200 to 400 different species of plants. Although almost any broad-leaved plant can be a host to the adult, Japanese beetles' preferred hosts are Norway maple, Japanese maple, gray birch, sycamore, elm, grape, linden (silver linden is considered resistant), and species in the rose family. Adult Japanese beetles may feed on flower buds and fruit as well as entire leaves of delicate-veined species (e.g., rose). However they are considered skelotonizers, feeding on the upper surface of the leaf tissue between the leaf veins. The damage results in a "lace-like" pattern to the damaged leaves, which in turn wither, turn brown and die. In severely injured

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hosts, the plant from a distance may seem scorched. Leaf feeding rarely kills the host plant, as most can withstand low-to-moderate defoliation; however, severe infestations can lead to a decline in plant health and susceptibility to secondary insect pests and pathogens.

Several tactics are currently in use to manage the spread of Japanese beetles into uninfested areas. The United States Department of Agriculture's Animal Plant Health Inspection Service *(USDA-APHIS)* and local/state government agencies manage quarantine zones. Airport and railway areas are under quarantine, and containers can be inspected and treated before shipment. Traps are maintained in quarantine areas to prevent high build-up of beetle populations in shipping areas. Plant materials and sod must have certification before shipment from an infested site to an uninfested area. Through these methods, the spread of Japanese beetles has not been stopped, but the population spread has been slowed.

Japanese beetle traps are marketed as a control tactic for the adult beetle. The traps are for adult beetles, and use a synthetic equivalent of two pheromones: a combination of a sex attractant and a floral lure attract both male and female beetles. The design of the trap finds them caught in the bag or funnel portion of the trap. Japanese beetle traps are useful in assessing the beetle population in a given area in a general manner—present or not present, low population or high population. However adult beetles can fly long distances, so those caught in the trap may have come from up to a mile away and the traps may attract more beetles than they control. Placing traps near preferred host plants will result in increased damage to the plant.

Several types of natural control agents exist for Japanese beetles; they can be organized into biotic and abiotic classifications. Biotic or biological control consists of insect parasites, pathenogenic diseases and entomophagous nematodes. Parasitic wasps *(Hymenoptera)* and flies *(Diptera)* have been introduced to provide control, with little success. The wasps have been more successful in warmer areas where the beetle has spread. The bacterial milky spore disease, *Bacillus popilliae*, has proven effective but provides inconsistent results in reducing grub populations. It can take up to three years to establish in soils and is density-dependent, showing enhanced results in higher Japanese beetle grub populations. Additionally, milky spore disease is not a control of other white grub beetles that create similar turf damage. The active ingredient in another bacteria, *Bacillus thuringiensis (tenebrionis)* (Bt), has been produced synthetically and shows control of leaf-feeding beetles. The use of nematodes, *Steinernema Heterorhabditis spp.,* commercially available as "Cruiser," has increased as problems with production and establishment are enhanced. Nematodes are effective only against first and second instar grubs, and sufficient soil moisture is critical.

Abiotic control consists of three management strategies: modifying the landscape environment, mechanical control and slowing the spread of Japanese beetles through quarantines, as described above. Adult females prefer to leg eggs, and grubs develop more rapidly in moist, warm soils. Eliminating irrigation during egg-laying and the early instar stage may reduce damage. Japanese beetles also seem to avoid egg-laying in turf shaded by trees. Avoiding planting trees and ornamental species preferred by the adult beetles will also reduce damage; for example, using silver linden instead of little leaf or American linden. Mechanical control can be attempted using one of several chemical controls for grubs: Merit, Mach 2 and Dylox are commonly used. Foliar insecticides—Sevin, Merit and malathion are some examples—target the adults. Some references also claim traps may be useful in controlling very small populations of the adult beetle, and hand-picking of the beetles can provide control, albeit labor-intensive, in very small populations as well.

Several tactics are currently in use to manage the spread of Japanese beetles into uninfested areas.

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Superintendent's Perspective: The NTEP Putting Green at North Shore Country Club

Editor's Note: This is the second part of a two-part article describing the results of the National Turfgrass Evaluation Project (NTEP) putting green research at North Shore Country Club in Glenview, IL. Part one, which reported trial results, appeared in the February 2004 issue of On Course.

As the superintendent of North Shore Country Club, I feel very fortunate to have been part of the onsite bentgrass evaluation project sponsored by NTEP, USGA and GCSAA.

As Dr. Tom Voigt previously described, the goal of the study was to evaluate bentgrass cultivars' performance under "real world" putting green conditions. The trial green at North Shore serves our members and guests as a putting and short-game practice facility, complete with two greenside bunkers and a 70-yard bentgrass fairway. Over the five-year data-collection period, Dr. Voigt from the University of Illinois accumulated much useful information. Cultivar differences in seedling vigor, green speed and general quality ratings were formally assessed. Overall, the study proved very beneficial to our industry and was especially fruitful for us in the Chicagoland area. Selecting a cultivar or blend of cultivars for putting green use is very important and not a simple task. Many considerations must be studied for long-term success. Soliciting information from several resources is often the best approach to understanding a cultivar's personality. Data from NTEP, researchers at universities, turfgrass breeders, turf pathologists, sod farm growers, turfgrass seed producers and fellow superintendents all contribute to understanding cultivars' needs, strengths and weaknesses.

"Which cultivar is the best?" is a question often asked . . . Like any relationship, the best fit is one where both parties can fulfill each other's needs.

Valuable Lessons Learned the Hard Way

I recall when C-15 decline *(Xanthomonas campestris)*—our first known bacterial blight on turf in the Chicago area—hit in the early 1980s. Many Toronto C-15 putting greens were affected and succumbed to this disease, a lesson learned on the potential problems of planting cloned monocultures. At North Shore Country Club, we had 11 putting greens, collars, nursery turf and tees growing Toronto C-15. However, only turf grown under the stress of putting green conditions succumbed to the disease.

Most superintendents growing C-15 greens looked to regrassing. Basically, Seaside, Emerald, Penncross and Penneagle were the seeded cultivars from which to choose. After consulting with experts, North Shore received the recommendation to grass greens with Penneagle creeping bentgrass. NSCC was shortly to host the 83rd U.S. Amateur Championship. The theory was that Penneagle's fine texture, upright shoot growth and reduced thatch potential would produce the highest-quality putting surface. As Penneagle was fairly new to the market, experts' understanding of this variety's nature was gained from nursery trials. Clubs in the area started to plant Penneagle on their greens. In a few years, Penneagle's lack of vigor demonstrated poor putting surfaces when grown under the stress of putting green conditions. Another tough lesson learned! Ball-mark recovery, wear from play (golfers wore metal spikes then) and *Poa annua* infestation all became highly problematic for Penneagle. Penneagle is no longer considered a turf for putting green use, but one of the better performers for fairway use. Many of these lessons could have been learned under the rigors of putting green trials.

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Challenges with Onsite Testing

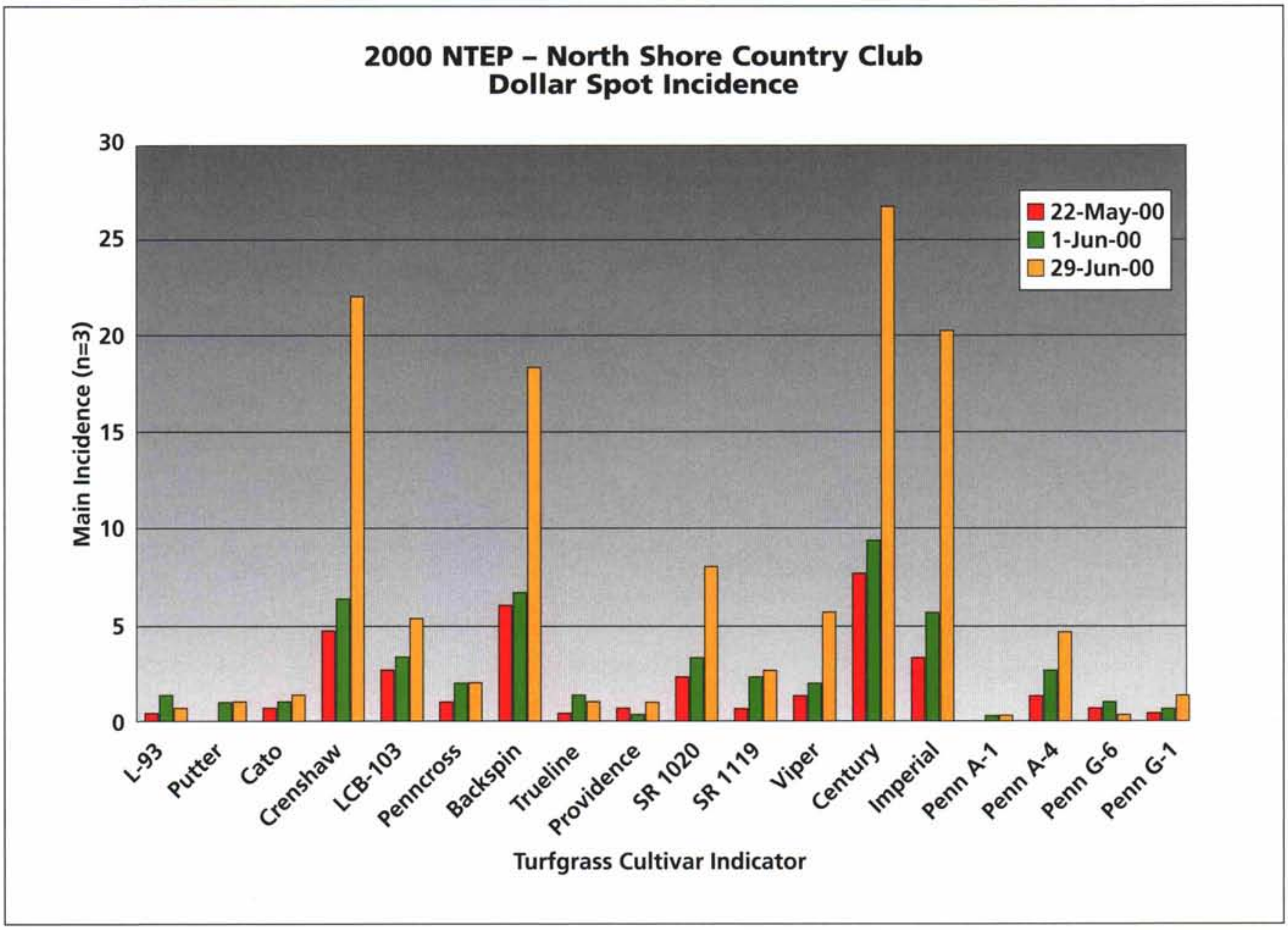
How to fairly maintain various cultivars grown for onsite testing has its challenges. I was instructed to maintain the green as one of the 18 greens used in regulation. This in and of itself was challenging, for the other 18 greens are mostly *Poa annua* growing on a "pushup" root zone. However, I understood the goal and viewed the putting surface as a product needing to be comparable to those greens played in regulation.

Officially, 18 cultivars are growing in the trial at NSCC. Living in the world of researchers, one learns of the forced compromises in field evaluations. To be consistent, and to generate scientific data, a management program needed to be applied equally across all cultivars. Yet mowing heights, topdressing frequency, grooming, nitrogen application rates, disease management and other cultural practices can differ greatly from one cultivar's needs to another. For example, large differentials in dollar spot *(Sclerotinia homoeocarpa)* susceptibility occurred with several cultivars. If a plan were implemented based on suppressing symptoms of a disease-prone cultivar, over-application of plant protectants would occur with other, less disease-prone cultivars. This high application rate may mask disease symptoms that could otherwise be learned and skew depiction of a cultivar's susceptibility.

At first, it was a struggle to develop a management plan that would not impact quality ratings on certain cultivars. Common sense dictated not to tailor to individual cultivar needs but to manage the general stand of turf. I subscribed to "less is better" most of the time. In general, daily mowing heights were maintained at 120-125/1,000ths of an inch, with topdressing every three weeks, daily grooming, water as needed and fertilizing based on soil and tissue tests and according to general color and clipping yield. We applied disease controls only as needed based on symptoms observed on least disease-prone cultivars. Under this disease-management program, cultivars prone to dollar spot got pretty ugly at times. The trial demonstrated clearly that great differentials occur with plant genetics in terms of susceptibility to various diseases.

Beyond Cultivar Evaluations

Data generated from this study would prove very useful to anyone selecting a new turf for putting green construction or overseeding. Perhaps less obvious is the useful information gained from the study on how to best manage these new cultivars. The test green attracted a lot of attention from many, stimulating interesting discussion on various management issues. Dr. Randy Kane, Dr. Hank Wilkinson, Dr. Tom Voigt, Dr. Bruce Branham, Dr. Tom Fermanian, Dr. Andy Hamblin, the USGA's Paul Vermeulen and others, in conjunction with experiences from the study, contributed to a database



on how to best manage various cultivars. What makes onsite testing fairly unique are the tools and resources available. Better understanding the impacts of such inputs proves helpful and adds direct correlation to the practioner. We all learned from each other in a growing environment common to most courses.

The Frustrating Question

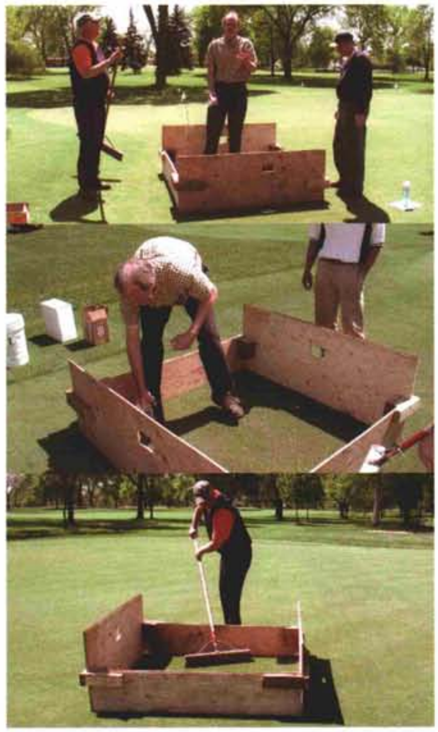
"Which cultivar is the best?" is a question often asked. One might think that question has an easy answer. The best way I can respond is by first sharing which cultivars performed poorly. Often this relates to a cultivar's susceptibility to diseases. Color, texture and general quality did differ, but among some, differences could be challenged if they had not grown side by side. I feel many cultivars can produce high-quality putting surfaces. In part, selecting the best cultivar relates to the level of commitment and resources available at each site. The higher-density cultivars require management practices that differ from those with half the shoot density. Like any relationship, the best fit is one where both parties can fulfill each other's needs.

Learning Continues from the Onsite Test Green

Now that the formal five-year commitment has been completed, we are free to look into other questions on potential cultivar differences, including competitiveness against *Poa annua*, ball-mark recovery, long-term genetic disease resistance, genotype segregation, cultivars' response to various *Poa annua*-control chemistries, tolerance to ultra-low mowing heights, drought tolerance and attraction to plant-parasitic nematodes, to name a few. With help from turfgrass researchers Dr. Bruce Branham, Dr. Tom Voigt and Dr. Randy Kane, several of these questions are already being addressed.

A *Poa annua* study is underway to evaluate the bentgrass cultivars' competitiveness against *Poa annua*. In June of 2003, *Poa annua* seed was used to overseed each variety cell. After double-core aerification with 3/8≤ tines, the replicated 5′ by 10′ plots were divided in half, overseeding only half of the cell. A 5′ by 5′ isolation box was used to ensure no seed escaped outside the overseeded area. Before removing the isolation box, we worked the seed in with a broom. Upon completion of the overseeding process, we topdressed the entire green with straight sand and watered it in. Over a several-year period, we hope to see differentials of *Poa annua* establishment in cultivars. The second part of the *Poa annua* study will include two objectives: one, to evaluate each variety's tolerance to *Poa annua*-control products and each variety's ability to out-compete *Poa annua* when control products are implemented.

We will continue to observe and utilize the onsite test green as a research site. Visitors are always welcome to observe for themselves the evaluation plots. I also have data that is easily shared via e-mail or hard copy. Also, look for a follow-up article on the root-zone trials later this season. Many organic and inorganic root-zone amendments are being evaluated on the other half of the green with some interesting results.



A study to evaluate the bentgrass cultivars' competitiveness against Poa annua *began last summer. Half of each 5′ by 10′ plot was overseeded with* Poa*; use of a 5′ by 5′ isolation box should ensure that no seed escaped outside the overseeded area.*