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by hand-raking the trash left in the bunker. However, this method leaves the raw edge exposed unless the sand is brought to turf level, eliminating the desired lip. Require the operator to wear goggles.

(2) **String trimmer**—It does a fair job in the hands of a good operator, but it's difficult to maintain a clean and straight edge. It also leaves the turf with ragged edges. Hand rakes are needed to remove the trash in the bunker after this operation. Require your string trimmer operator to wear goggles.

(3) **Hand edging**—The preferred method, by far, because pulling the runners that protrude leaves the turf with a groomed look and lets it drape over the edge. Also, it's easier to draw the sand under this drape and leave a good margin. This procedure is also labor-intensive and adapted to higher-budgeted courses. Normally, this is done at each raking to maintain the groomed look.

Regardless of the method, rhizomes

growing into the sand must be removed periodically. This takes the time-honored method of reaching into the sand four to six inches and pulling out the rhizomes. Left unattended, the bunker will close in and be unsightly. How often this needs attention depends on the species and season.

**Drainage**—The most vexing problem facing the superintendent in bunker maintenance is drainage. The three types of drainage designed into a bunker are: (1) internal; (2) surface; and (3) no drainage. The first, installed properly, gives the most lasting results. The second method starts out as a problem and gets progressively worse. The third requires your attention, today.

Drains must be kept open at all times; you never know when the next rain will hit. Following a heavy rain, water will percolate through the sand slowly, leaving a film of silt on the surface. The most important part of restoring your bunker is removing this layer. Skim it into piles and get it out before

any raking, as you will contaminate the entire bunker.

Surface-drained bunkers will wash the sand onto the turf at the lower end (usually in front of the green) following a rain. This means shoveling the material off the surface and brushing the residual into the turf. The only permanent solution is to install drains in the bunker and carry the water away from the playing ground.

Not having any drainage may or may not present an immediate problem, particularly if you have no sand in the bunker. That is not uncommon on many restricted budget courses. However, if you wish to provide a better playing surface in your bunkers, they will need some form of drainage. We shall discuss this next month.

—The author of this article, Al Frenette, CGCS, passed away in September, 1992. It originally appeared in "Through the Green," the publication of the Georgia Golf Course Superintendents Association, and is used with their permission.

## On the cutting edge of bio-tech

**New biological concepts and technologies will help golf course superintendents meet the future demand for quality trees, shrubs and herbaceous plants.**

by Douglas J. Chapman,  
Dow Gardens

■ Trees, shrubs and bedding plants provide interest and color, often the difference between an average and an exciting golf course. To better develop the course while not increasing maintenance, a superintendent should be aware of biological concepts that affect the type of tree, shrub and herbaceous perennial to be planted.

Some of these concepts are:

- native plant adaption to high and/or low temperature,
- photo-period's impact on vegetative and reproductive growth,
- disease-resistant cultivars, and
- unique pheno types (growth habits).

Provenance is adaptation of plants to regional environmental conditions. As many golf course superintendents know, *Acer rubrum* is native from northern Michigan to



*Spirea blumalda*

northern Florida. But northern Michigan red maples will not survive high temperatures south of Kentucky. Conversely, southern ecotypes will not survive low northern temperatures.

Further, as one moves north, native trees within the same species (plants in general) exhibit provenance by being more photo-periodic responsive (responsive to day length). Two results of this photo-periodic response are the beginning of abscission (dormancy) and hardening off (low temperature tolerance).

Photo-periodism was first discovered by Garnard and Allard in the late 1920s. Their basic research showed that some plants initiate a reproduction cycle by virtue of day length—like chrysanthemum, short days. As photo period was more extensively researched, it was shown that juvenile



*Acer rubrum* 'Northwoods.'

plants native to northern latitudes are more day-length responsive. When grown under continuous light, the plants remain vegetative. Some plants, like Japanese maple, Blumalda spirea, and paper birch can grow to at least three times their normal annual height in 12 months. The plant remains continually vegetative until it is allowed to go dormant by shutting off the supplemental light.

Using this technique, one can accelerate growth of many northern plants propagated by tissue culture, cuttage and/or seedage which dramatically reduces the time needed to produce landscape-effective conifers, birch and northern woody ornamentals.

Northern genotypes can be selected for unique habits of growth, fall color, etc. while being extremely low temperature hardy. Ecologists have shown that native





**Forsythia tetragold**

maples in continental climates like Minnesota, North Dakota and South Dakota are taxonomically the same species as found in the Great Lakes region, but more xerophytic (can survive in droughty conditions).

These regional cultivars will be selected for local environmental tolerances, disease resistance, or adaption to extreme temperature variation found in the Dakotas and downtown sites. These regional cultivars should result in better plants with decreased maintenance requirements.

The University of Minnesota has embarked on a selection and hybridization program to introduce northern continental hardy trees, shrubs and herbaceous perennials.



**Malus sugartyme**

Some products of this program are 'Northern Lights' azaleas, 'Northwoods' red maple, and early-flowering hardy chrysanthemums.

Golf course superintendents will have the opportunity to landscape their courses with plants that are resistant to disease (such as apple scab), cold temperature hardy trees like *Acer rubrum* 'Northwoods,' salt tolerant sugar maples like 'Green Mountain,' and adapted shrubs like 'Dakota Sunrise' potentilla. Further, these tailored plants will assist management of the course and improve the overall ambience.

—Douglas J. Chapman is horticulturist-director of Dow Gardens, Midland, Mich.

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