Applying Weather Basics to Your Golf Course

In this section, you'll take a look at how wind can impact the golf course and what superintendents can do with windbreaks to control that element. An overview of macro- and micro-climates is also included.

Objectives - Students will

- Understand some impacts of wind on chemical applications.
- Learn key characteristics of windbreaks and how they can be used.
- Recognize the effects of macro- and micro-climates on the growth of plants and maintenance practices.

Wind Velocity and Air Stability

Understanding wind patterns is extremely important in the application of plant protectants. Wind speed is widely recognized as an important factor affecting spray drift. However, vertical movement of air also has a large influence on damage to non-target plants from spray drift.

When the air next to the ground is warm and temperatures decrease, wind will move vertically to meet cooler air at higher elevations causing instability. In other words, the warm air will rise and the cool air will sink providing vertical mixing of air.

Stable air or inversions, occur when air temperature increases or changes little as elevation increases. With these temperature relationships, very little vertical movement of air occurs since cool air will not rise into warmer air above.

With stable air (inversion), small spray droplets may be suspended just above the ground in the air mass, and when the wind increases it moves the mass long distances laterally. The droplet mass may be deposited on susceptible plants in higher concentrations.

Low wind velocity in combination with unstable air generally will result in very little damaging spray drift since the mass is pulled to a higher elevation. Low wind velocity with inversion has the potential to result in severe damage over a long distance.

Stable air usually can be identified with smoke or dust moving horizontally and staying close to the ground. Fog would also indicate stable air. Herbicide application should be avoided during stable air conditions unless spray drift is not a concern.

In high wind conditions, long-distance drift can occur with particle drift as well as vapor drift. Volatile and highly active herbicides can damage sensitive plants up to several miles away. Planned applications should be postponed when these conditions exist.

Windbreaks

Windbreaks are barriers used to change wind patterns or protect from the wind. The reduction of wind speed behind a windbreak modifies the environment and/or microclimate in the sheltered zone. This can be very useful on a golf course to create a more favorable teeing area, protect sensitive areas from drifting debris (sand, snow, etc.), and to create favorable rest areas, to name a few.

Windbreak Characteristics

Height

Windbreak height (H) is the most important factor determining the downwind area protected by a windbreak. This value varies from windbreak to windbreak, and increases as the windbreak matures. In multiple row windbreaks, the height of the tallest tree-row determines the value of H.

On the windward side of a windbreak, wind speed reductions are measurable upwind for a distance of 2 to 5 times the height of the windbreak (2H to 5H). On the leeward side (the side away from the wind), wind speed reductions occur up to 30H downwind of the barrier. For example, in a windbreak where the tallest trees are 30 feet, lower wind speeds are measurable for 60 feet to 150 feet on the windward side, and up to 900 feet on the leeward side. Within this protected zone, the structural characteristics of a windbreak, especially density, determine the extent of wind speed reductions (UNL, EC 91-1763-B).

Density

Windbreak density is the ratio of the solid portion of the barrier to the total area of the barrier. Wind flows through the open portions of a windbreak, so the more solid a windbreak the less wind passes through. Low pressure develops on the leeward side of very dense windbreaks. This low-pressure area behind the windbreak pulls air coming over the windbreak downward, creating turbulence and reducing protection downwind. As density decreases, the amount of air passing through the windbreak increases, moderating the low pressure and turbulence, and increasing the length of the downwind protected area. While this protected area is larger, the wind speed reductions are not as great. By adjusting windbreak density different wind flow patterns and areas of protection are established.

In designing a windbreak, density should be adjusted to meet the golf course superintendent's objectives. A windbreak density of 40 to 60 percent provides the greatest downwind area of protection. To get even distribution of snow across a fairway, densities of 25 to 35 percent are most effective.

The number of rows, the distance between trees, and species composition are factors controlling windbreak density. Increasing the number of windbreak rows or decreasing the distance between trees increases density and provides a more solid barrier to the wind.

Effect of orientation

Windbreaks are most effective when oriented at right angles to prevailing winds. The purpose and design of each windbreak is unique, thus the orientation of individual windbreaks depends on the design objectives.
Sensitive greens, fairways and tee boxes usually need protection from cold winds and blowing snow or dust. Orienting these windbreaks perpendicular to the troublesome winter wind direction provides the most useful protection.

Some golf courses need protection from hot, dry summer winds, abrasive, wind-blown soil particles, or both. The orientation of these windbreaks should be perpendicular to prevailing winds during critical growing periods.

Successful golf course windbreaks should be designed to fit within the golf course facility and be assessed for their future impact on maintenance and play. Consideration should be given to reducing wind damage, providing protection, increasing irrigation efficiency and improving wildlife habitat. To recharge soil moisture with drifting snow, windbreaks should be placed perpendicular to the prevailing winter winds.

Although wind may blow predominantly from one direction for a season, it rarely blows exclusively from that direction. As a result, protection is not equal for all areas on the leeward side of a windbreak. As the wind changes direction, and is no longer blowing directly against the windbreak, the protected area decreases. The use of multiple-leg windbreaks provides a larger protected area than a single windbreak. Again, individual placement depends on the site, the wind direction(s), and the design objectives.

Effect of length

Although the height of a windbreak determines the extent of the protected area downwind, the length of a windbreak determines the amount of total area receiving protection. For maximum efficiency, the uninterrupted length of a windbreak should exceed the height by at least 10:1. This ratio reduces the influence of end-turbulence on the total protected area.

The continuity of a windbreak also influences its efficiency. Gaps in a windbreak become funnels that concentrate wind flow, creating areas on the downwind side of the gap in which wind speeds often exceed open field wind velocities. Lanes or course accesses through windbreaks should be located to minimize this effect or if possible avoided altogether.

Microclimate modifications

The reduction in wind velocity behind a windbreak leads to a change in the *microclimate* within the protected zone. Temperature and humidity levels usually increase, decreasing evaporation and plant water loss. Actual temperature modifications for a given windbreak depend on windbreak height, density, orientation, and time of day. Daily air temperatures within 10H leeward of a windbreak are generally several degrees higher than temperatures in the open. Beyond 10H, air temperatures near the ground tend to be cooler during the day. On most nights, temperatures near the ground in sheltered areas (0H to 30H) are slightly warmer than in the open. However, on very calm nights, sheltered areas may be several degrees cooler than open areas.

Soil temperatures in sheltered areas are usually slightly warmer than in unsheltered areas. Taking advantage of these warmer temperatures may allow earlier planting and germination in areas with short growing seasons. In the area next to an east-west windbreak soil temperatures are significantly higher on the south side due to heat reflected by the windbreak. On the north side of an east-west windbreak, soil temperatures, especially in the early spring, are lower due to shading by the windbreak. These cooler temperatures may reduce the rate of snowmelt, and cause problems with course access in early spring.

Relative humidity in sheltered areas is 2 to 4 percent higher than in open areas, depending on windbreak density. Higher humidity decreases the rate of plant water use, so production is more efficient than in unsheltered areas. However, if the windbreak is too dense, and humidity levels get too high, diseases may become a problem with some turfgrass varieties.

Heat loss due to wind-chill is reduced on the leeward side of a windbreak. Moderation of the chill factor is most important in farmstead and livestock windbreaks where humans and other animals readily notice increased energy efficiency.

Most windbreak benefits come about indirectly because of changes in the microclimate of the sheltered zone.

Macro- and Microclimates on the Golf Course
The Earth's climate consists of a series of interlinked physical systems. On the golf course, superintendents are usually concerned with local climate systems.

Macroclimate refers to the climate of a larger area such as a state or region. *Microclimates* are the variations in climate in small, distinct areas, such as those found on and around a golf course.

The macro- and microclimates have important effects on the growth of plants and maintenance practices found on the golf course.

An understanding of how microclimates are formed on a golf course and the impacts of man-made and natural structures on the climate can help the superintendent solve problems and/or enhance the golf course. Knowing how to impact the macroclimate to create a favorable microclimate or change a microclimate can be valuable in deciding turf types used, modifications to improve playing conditions, maintenance activities and timing of maintenance.

Macroclimate
The macroclimate around a golf course cannot be affected by design changes, however the golf course is normally developed with knowledge of the macroclimate in which the golf course is located. Considerations normally include:

Seasonal accumulated temperature differences (degree days)
- Typical wind speeds and direction.
- Annual totals of solar radiation.
- Historical rainfall totals.

This data provides an impression of the climate at the golf course site so planning and design can adequately be performed. However, the ultimate design and features of the golf course will affect the local climate.

Microclimate
The site of a golf course can have numerous microclimates caused by the presence of ridges, hills, trees, surface water features and even tinted glass in office buildings.

Slopes, valleys and hills
Slopes have effects on air movement, especially at the bottom of valleys or hollows. In low lying areas, air warmed by the sun rises upward (anabatic flow) to be replaced by cooler air flowing down the slope (katabatic flow) to replace the warmed air. Therefore, low lying areas and valleys are significantly colder than locations up the slope. Katabatic flows often result in frosts persisting for longer periods in low-lying locations. The most favorable locations in valleys are known as thermal belts that are just above the level where cold air builds up but below the elevation where wind increases.

Crests of hills and ridges compress wind flow similar to an airfoil leading to higher wind velocities.

Fan-tastic
Trees can create microclimates similar to buildings by shading the turfgrass, soil, and blocking wind. When the tree-cutting solution isn't viable, it's typically up to superintendents to come up with "artificial" solutions. Fans are among the most popular strategies for coping with microenvironments, and superintendents have devised innumerable ways to use a variety of permanent and temporary fans.

Selecting solutions
The obvious goal of using fans is to increase wind movement across greens (to about 3 or 4 miles per hour), which speeds evaporation and lowers humidity. When air movement across a green is less than about 2 miles per hour, little air stirs within the turf canopy. That causes humidity within the canopy to rise. Contrary to popular opinion, the fans offer little cooling benefit to the turfgrass, but they do dry out the soil and increase ET.

Covers, irrigation heads and more
Placing covers on greens with varying microclimates is an obvious strategy to protect turf, stimulate growth and manipulate weather conditions. In open areas where winter winds constantly sweep across greens, covers can prevent winter desiccation and frost damage. Covers can sometimes help prevent snow mold disease, too. Under certain conditions, however, covers may actually open the door to turf disease.

Wherever a protective cover is used, the area beneath it becomes a microclimate as well. Closely monitor conditions beneath the covers to determine the best time for removal. It's equally important to know when to put on covers, because early implementation can retard the hardening of the soil. Taking covers off too late may weaken plants' ability to repair themselves.

Once covers have been removed, it's necessary to wean turfgrass from the microclimate to which it has become accustomed. Permeable covers are often used to shield greens from lingering winter effects after tougher, impermeable winter cover has been removed.

Superintendents increasingly are learning to consider unique conditions resulting from microclimates when scheduling irrigation, remembering to account for higher air

temperatures and increased evapotranspiration (ET) estimates in non-irrigated areas where on-site weather stations are set up.

Strategically placing two sets of irrigation heads near greens is another method used to cope with microclimates. Adjustable part-circle heads are placed specifically to water greens; another set of irrigation heads waters green surrounds. This method allows for precision irrigation and helps prevent overwatering in areas that microclimates make difficult to manage.

Buildings

Buildings create microclimates by shading the ground and blocking wind flow patterns. Clusters of buildings, pavement and heat holding materials such as stone walls and walkways, can cause a heat island effect by warming air. Housing developments -- often built months and even years after the golf course has been built as the centerpiece -- can create significant microclimates for golf courses. Where there was no early morning shade before, houses or offices alter the climate, drainage and air movement.

Superintendents are using "botany bottles" or handmade "biospheres" to predict and anticipate microclimates. These are often fashioned out of plastic 2-liter soft drink bottles to evaluate the extent of winter injury or incubate diseases. They're crude compared with the complex growth chambers that turfgrass scientists use, but they can set the stage for better coping with microclimates.

By placing a turf sample in a botany bottle, a microclimate is created that forces the acceleration of a disease and makes damage symptoms much easier to identify. It can give insight into what organisms are present. It can help determine if turf is still viable after extreme low temperatures. A plug removed from an overseeded green can be placed in a bottle and subjected to "instant summer" or another microclimate, for example.

Understanding the relationship between microclimates and cultural practices helps superintendents create their own microclimates and manipulate the environment. Modifying weather conditions can be tricky, but ignoring microclimates is often an even greater mistake.

Resource: ‘Micro’ management by Mike Perrault, Golf Course Management March 1999