

THE PERFECT LIE

Studying the lie of a golf ball on fairway turf with a Lie-N-Eye.

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ALTHOUGH the Rules of Golf never mention the word *fairway*, everyone associated with golf knows that fairways are an integral part of most courses. The history of the golf course fairway is somewhat like most evolutions where humans are involved. There was a gap between the teeing and putting grounds and, over time, fairways filled that void.

Originally, golf course fairways were known as *fairgreens*. These were areas that golfers would try to reach from the teeing area to set up the next shot. These areas contained some managed turf and gave a clear shot to the green. No one is quite certain if the managed turf was more important than the clear shot to the green on these early fairways. It could be imagined that both attributes were important to the early golfer, especially when finding the ball could have been quite a challenge. In these early days, the function of the

fairway was not completely clear, and the fairway's form followed the natural contour of the course.

Today, fairways make up the largest part of finely managed turf on most golf courses. A typical 18-hole golf course can have between 30 and 60 acres of intensively managed fairway turf. Newly constructed golf course fairways are shaped and graded with specialized equipment to form smooth, contoured surfaces. At one time, having irrigated fairways was unique enough to use as an advertising advantage; now, irrigated fairways are commonplace and expected in most areas. Advancements in mowing equipment and maintenance practices have led to closer and closer mowing of golf course fairways. The driving force behind the state of the golf course fairway today is that most golfers have come to expect a ball cleanly perched on a well-drained, uniform, verdant fairway.

Fairways have become very important on each golf course primarily because golfers know that they should always play the ball as it lies. This dictate comes into effect after one has hit the ball from the teeing ground and is playing from the area deemed through the green. *Through the green* is defined as the "whole area of the golf course except the teeing ground and the putting green of the hole being played and all hazards on the course." Golf course roughs, surrounds, aprons, native vegetation, forests, decorative plantings, and fairways fall under this definition. Since most of the game is played from these areas, the lie of the golf ball on the fairway is important because it provides a better lie than any other through-the-green area. The lie of the ball is produced by all of the turf species and/or cultivars and the management practices employed to maintain them.



Lie-N-Eye is a device developed by University of Illinois researchers to measure the ability of a turfgrass species to support a golf ball under a typical fairway setting.

The importance of the golf ball lie (what we are referring to as the amount of a golf ball exposed above the canopy) can be expressed using simple physics. A golf ball in contact with a lofted club has two main types of force acting upon it, one normal (at a 90° angle) to the face of the club and one parallel (tangential) to it. The force normal to the club generally affects the velocity, while the tangential force rotates the ball. The rotation or spin (when a ball is hit correctly, backspin or under spin) placed upon the ball is necessary for proper lift and flight. The backspin imparted on the ball creates an upward force or lift, similar to an airplane wing.

There is another force acting between the ball and clubface known as friction. Increasing the roughness of the clubface increases the friction, allowing a rough clubface to grab the ball more than a smooth clubface would. This can increase the tangential force needed to spin the ball effectively. Ball spin greatly affects the flight path of the golf ball: sidespin results in a hooked or sliced ball, while topspin results in a ball with negative lift, creating a quickly diving path of flight. When there is an inadequate amount of the ball exposed above the turf canopy, there may not be enough friction to give the ball the desired spin. Most golfers have heard of a *flier lie* that often occurs when a ball is nestled down in the turf canopy, usually in the rough. Here, the grass blades that are between the clubface and ball are crushed, lubricating the two surfaces. In this situation, the clubface imparts less backspin on the ball, and ball flight and landing are less controlled.

Though the lie of the golf ball is relative to each particular golfer, the lie can still be quantified. This can be accomplished by accurately measuring the amount of golf ball exposed above

the surface canopy of the fairway. A golf ball in accordance with the Rules of Golf must not be less than 1.680 inches in diameter. The greater the amount of ball above the canopy, the better the lie of the ball. A good lie allows the golfer to strike the ball cleanly with the club and impart the desired amount of backspin needed for proper shot control. With this in mind, we intended to create an instrument that would accurately measure golf ball lie on fairway turf, especially on higher-cut turf (0.75" to 1").

The Development of the Device

A device called a Lie-N-Eye is designed and constructed to measure the ability of a turfgrass species to support a golf ball under a typical fairway setting. The main component of the Lie-N-eye is a Mitutoyo Digimatic® Caliper. The caliper accurately measures an object by means of positioning the object between two jaws. In this project, the two jaws were adapted by adding necessary surfaces to measure ball position on golf course fairway turf. The first surface or plate was made from stainless steel and was added to the upper movable jaw. The lower measuring surface was added to the lower stationary jaw of the caliper and was constructed from sheet acrylic. The transparent property of the acrylic sheet was necessary to align the lower surface with the upper plane of the turfgrass canopy. A handle was also added through this lower measuring surface for two purposes. The first and obvious reason was to give the operator a place to hold the instrument. The second was to provide a means by which to place the instrument in the ground in a stable manner. This was achieved by grinding the opposing end of the handle to points and using them to position the instrument in the turf.

The operation of the Lie-N-Eye is very simple. After a golf ball has been uniformly rolled or dropped onto fairway turf, the user opens the jaw of the device past the target zone of measurement. The Lie-N-Eye is then placed alongside the ball and the lower surface of the acrylic sheet is lined up with the upper edge of the turfgrass canopy. The upper measuring surface of the Lie-N-Eye is then lowered onto the top of the ball and the measurement is shown on the liquid crystal display of the caliper and recorded.

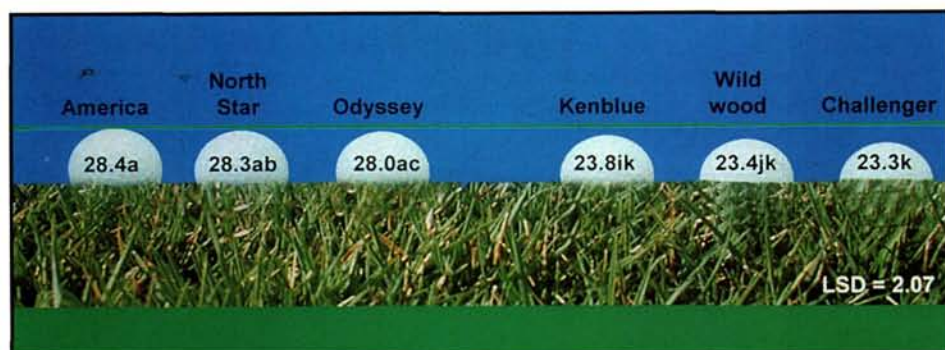
A second, improved device, Lie-N-Eye II was developed to detect differences on shorter-cut fairway turf (0.375" to 0.625") and improve data collection. The basic operating principle of the Lie-N-Eye was used in the development of the Lie-N-Eye II, but the new device differed in several characteristics. Those characteristics were as follows:

- The lower measuring surface was machined to surround the golf ball on three sides.
- The upper measuring surface was resized and positioned to measure the ball perpendicular to the caliper.
- The handle was moved to the rear of the device.
- The Lie-N-Eye II used a Mitutoyo Digimatic® Absolute Caliper with SPC (Statistical Process Control) output.
- The SPC output enabled a direct link to a Palm™ IIIx organizer running DataGet™ software.

Testing and Results of the Devices

The Lie-N-Eye was tested in 1999 on 25 Kentucky bluegrass (*Poa pratensis* L.) cultivars grown to simulate golf course fairway conditions in Urbana, Illinois, at the University of Illinois Turfgrass Research Center. They were planted in a randomized complete block with three replications, maintained at 0.875", fertilized with 4 lbs. N/1,000 sq. ft. per year, and irrigated to prevent stress. The Lie-N-Eye was tested by uniformly rolling six balls onto each plot and measuring each ball for a total of 18 ball lie measurements per cultivar.

The results of this test show that the Lie-N-Eye was able to measure small differences in ball lie among the various Kentucky bluegrass cultivars. Obviously, if planting Kentucky bluegrass fairways, cultivars that not only have good pest resistance and appearance but also possess the ability to provide a good ball lie should be con-



The numbers represent the mean amount of golf ball exposed above the Kentucky bluegrass canopy (measured in mm). The means followed by the same letter are not significantly different, according to Fisher's Protected LSD.

Table 1

Cultivar	Lie Mean (mm)	Cultivar	Lie Mean (mm)
America	28.4a†	Conni	25.9dh
NorthStar	28.3ab	Serene	25.8di
Odyssey	28.0ac	Rambo	25.7di
Baron	27.8ad	Princeton105	25.7di
Limousine	27.5ae	Allure	25.6ei
Eclipse	27.6af	Raven	25.6ei
Absolute	27.4af	Midnight	25.4fj
Award	27.2ag	Explorer	25.2gk
SR2000	27.0ah	Glade	25.1hk
SR2109	26.6ah	Kenblue	23.8lk
NuGlade	26.5ah	Wildwood	23.4jk
TotalEclipse	26.2bh	Challenger	23.3K
RugbyII	26.1ch		
LSD			2.07

†Means followed by the same letter are not significantly different, according to Fisher's Protected LSD (0.05).

sidered. Conversely, cultivars that may offer a less desirable ball lie should be avoided.

The Lie-N-Eye II was tested in a similar fashion in 2000, but on six bentgrass (*Agrostis* spp.) fairway turfs. Three colonial bentgrass (*A. tenuis* Sibth.) and three creeping bentgrass (*A. palustris* Huds.) cultivars were tested at the University of Illinois Landscape Horticulture Research Center. The bentgrass cultivars were planted in a randomized complete block with three replications, maintained at 0.5", fertilized with 4 lbs. N/1,000 sq. ft. per year, and irrigated to prevent stress. The Lie-N-Eye II was tested by uniformly rolling six balls onto each plot and measuring each ball for a total of 18 ball lie measurements per cultivar. Results of these measurements indicate that the Lie-N-Eye II was able to identify small differences on the lower-cut bentgrass turf.

Future Use of the New Device

The results of these tests indicate that golf ball lie is determined, at least in part, by turfgrass species and/or cultivar. The reasons behind these differences have not been adequately studied; however, we can speculate that morphological characteristics (e.g., density or leaf width or angle) and/or physiology (e.g., cell wall constituents) play a role. What we do know now, due to the ability to measure ball lie, is that differences between turfs do exist.

The Lie-N-Eye and Lie-N-Eye II were designed to aid in the turfgrass selection process, as well as to judge the suitability of a turfgrass to support a golf ball in a fairway setting in an objective manner. The ability to measure and accurately quantify golf ball lie has interested others in this characteristic of golf course fairway turf. Studies are now being conducted on warm-season turfgrasses (bermudagrass) used for fairway turf to identify differences in the ball-lie ability of these turfs.

Other proposed work with the Lie-N-Eye II includes measuring the additional effects of turf species or cultivar selection and also management practices on golf ball lie. These may include the following:

- Management practices (fertilization, irrigation, cultivation, and mowing).

- Growth regulation.
- Turfgrass morphology.
- Traffic.
- Golfer/ball lie interaction.

Good golf ball lie is an important characteristic of a quality fairway. Anything that furthers the understanding and development of improving fairway ball lie will potentially make golf that much more enjoyable for golfers and turf managers alike.

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Table 2

Cultivar	Type	Lie Mean (mm)
L-93	Creeping	40.7a†
Providence	Creeping	40.3ab
SR7100	Colonial	39.5bc
Pencross	Creeping	39.3bc
SRX7MOBB	Colonial	39.1c
Tiger	Colonial	38.7c
LSD		1.10

†Means followed by the same letter are not significantly different, according to Fisher's Protected LSD (0.05).