Sunbelt Seed's Joe O'Donnell is flanked by Great Western's Will Sheperd (left) and Jim Parsons (right) in a field of Palmer II ryegrass. Recent rains have the grass plants lying down.

Photo by Joel Jackson

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Hoping for dry weather, Joe O'Donnell inspects a field of Crenshaw bentgrass that is surrounded by acres of blueberries and mint on the Helms Brothers farm.

Touring the Lofts/Great Western Seed Company operation in Albany, Oregon

largest bookstore in the world. It covered a whole city block! Brother-in-law, Alan, wanted to sample some microbrew fare as well as visit the friends and relatives.

As for me, I wanted to see first hand the fabled Willamette Valley and its seed fields. Joe O'Donnell, General Manager of Sunbelt Seeds, was kind enough to arrange a tour of the Lofts/Great Western Seed Company operation in Albany, Oregon.

I must admit I wasn't sure that the rest of our merry band would enjoy the side trip to the seed fields. We were trying to think of alternative activities for the group, but we decided that the road to the spectacular Oregon coast ran through seed country and so they tagged along. My wife loves learning about how things are made and soon the whole group was into learning about the whole process.

The process begins when Lofts/Great Western contracts with independent local growers to produce seed. For 1995 they have contracts with 139 different growers to plant around 29,000 acres. The contracts are risky for the seed company because they are "by the acre" and not "by the yield."

Interesting to note that it only takes a quarter-pound of bentgrass to sow an acre field that should yield a ton, and about five pounds of ryegrass seed for the same result. Think about the rates we use! The results can vary from crop to crop creating shortfalls and overages, which ripples on down to the consumer.

Bob Richardson, vice president and general manager, took us on a walking tour of the blending, bagging, and shipping operations in Albany. While golf courses focus on those 50 pound bags coming off the back of a truck, we were shown machine after machine dedicated to filling 2-, 5-, and 10-pound boxes and bags for homeowner use.

The bagging plant was quiet on this day. After all, it was only June 19 and all this year's crop was still in the fields maturing on the grass plants. Questions about when they would be harvesting were met with anxious glances and concerned looks.

"This is not typical June weather," Bob said. "Normally the rains have quit by now for the summer and we can start thinking about when to cut the fields. The cuttings need seven to ten days to dry out before we harvest and clean. If it doesn't let up, we are going to get jammed up trying to cut, harvest, clean, blend, bag and ship to meet end user schedules.

"We are at Mother Nature's mercy! You fellows in Florida have a little bigger window and can seed a little later than folks north of you. The physical output capacity of our machinery is our limiting factor. We can blend, bag and ship only so much product in a 24 hour day. The sooner we can get started the better for you and for us."

Another new wrinkle in shipping was shown to us as we toured the plant. It seems that the bulky wooden pallet we all know and hate is disappearing at least in some applications. Home and garden stores like Kmart and Home Depot don't have the time or space to deal with wooden pallets. They are being replaced with thin semirigid sheets of plastic. When the whole load is shrink wrapped it's easy to handle with a lift that has knife-thin forks attached.

We left the main plant and made our way to north to a cleaning plant operation. This is an independent operation that serves all the seed companies. The raw harvested seed is stored in deep bins and is moved around by suction lines and ducts.

Cleaning machines are like large vibrating sieves that glean out the chaff from the seed. Sometimes blowers are added to use air to separate out the seed. This is a time consuming step in the process and re-screenings can be costly. Once again, physical capacity of the equipment limits how much seed can be processed in a day.

I was flabbergasted to learn that the

Photo By Joel Jackson

Recovery of 60% of harvested bentgrass seed is considered normal at a seed cleaning plant such as this one near Albany, Oregon. The tiny seeds are almost impossible to separate from the fine chaff.

'...They use the cannons on the grass fields also when the geese are migrating. A flock can wipe out a field in a day.'

best they can do with bentgrass is to recover about 60% of the seed that goes through the cleaner. It is just so small that it is difficult and cost prohibitive to try to get more out of the process. Quite frankly, the current process and equipment just isn't sophisticated enough to get any better results.

Now we were ready to go see some of the grass fields. Our first stop was a Crenshaw bentgrass field on the Helms Brothers farm. The bentgrass should have been at least knee deep, but the rainy weather had it laying down to about mid-calf high. Seed heads were evident and it wouldn't be long, weather permitting, before cutting.

I heard what sounded like shotgun blasts in the distance. Then from behind a windbreak right behind us, BLAM! We must have looked white as ghosts as we flinched. Our guides, Joe O'Donnell, Will Shepherd and Jim Parson were stifling laughs and grins.

"Propane cannons," Will offered. "The blueberries are almost ready to pick and they're scaring off the birds! They use the cannons on the grass fields also when the geese are migrating. A flock can wipe out a field in a day."

Gee, those geese are a problem even before we plant the grass on a golf course! We

painstaking work that requires patience, perseverance and humor

zig-zagged out of the farm down dirt roads lined with all sorts of vegetable crops side by side with the seed fields.

Our next stop was a Palmer II ryegrass field. A crew of six people were roaming about in the field with burlap bags.

"They're rouging the field," Jim explained. "Notice how the grass is laying down from the rain? Also notice how some plants are standing more upright? That's a telltale sign of an 'off type.' They're looking for those upright plants and are manually removing them. A simple but effective method of quality control."

In fact, both Will and Jim are field representatives for Lofts/Great Western and they serve as liaison between the company and the growers making sure concerns are communicated and resolved.

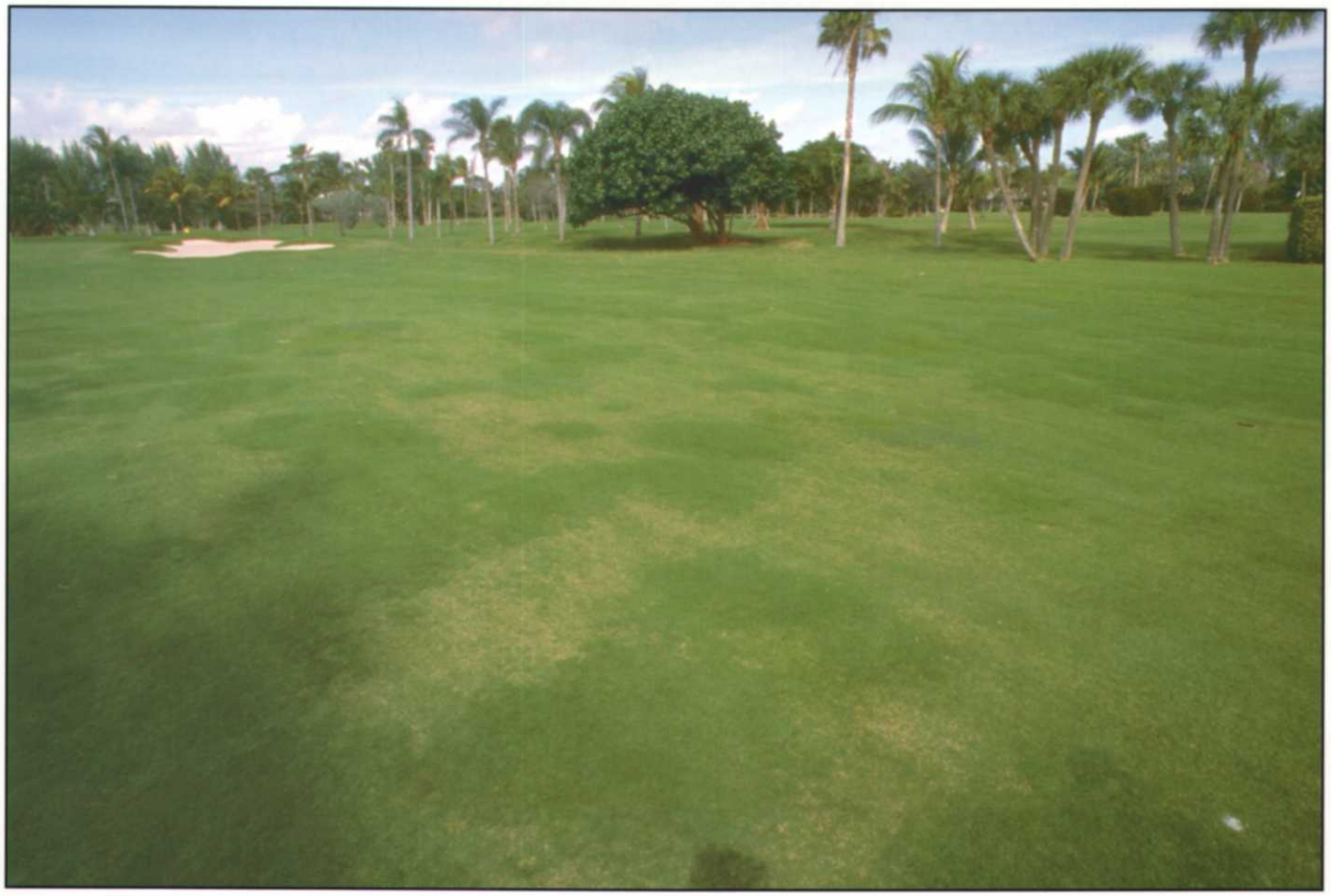
They regularly inspect the fields for good management practices and purity. They both have Ag Science degrees and come from farming families. We had Jim identify some of the crops we had seen so far as we headed toward the Lofts Research Farm. After all, we had never seen hops, alfalfa, and canola in the raw before!

We twisted and turned down some back roads and ended up at the research facility in Lebanon, Oregon. I had met Dr. Virginia Lehman before at either the Lofts hospitality tent at The Nestle Invitational at Bay Hill or at a GCSAA conference. She gave us a chance to stretch our legs as we walked about the facility looking at the myriad varieties of grasses undergoing observation and selection.

Dr. Lehman described the lengthy process required to breed and select a grass suitable for marketing. The repetitive process of replication of a desired trait and selecting only the best plants of each generation for testing and field trials takes anywhere from five to ten years minimum. It is painstaking work that requires patience, perseverance and humor. Dr. Lehman has all three.

We all broke bread together for lunch. Got to know each other a little better and then the Jackson clan headed for Newport on the coast for some views of that beautiful, rugged and rocky coastline.

We had spent a great morning learning about a part of the turf business we probably take for granted. It sure has given me a new outlook on that wonderful wacky world of overseeding we look forward to every year.



Dark green genetic off-type (T-3) appeared in patches on a Florida fairway in 1993, 2 years after Tifway bermudagrass was supposedly planted. The surrounding matrix grass (T-1) is yellowish green.

Golf course professionals have long been confronted with the problem of off-types in greens and fairways

DNA

BY PHIL BUSEY, CHARLIE GUY, AL DUDECK AND NIGEL HARRISON

There is a world with perfect lawns in H.G. Wells' *Time Machine.* Time Traveler found the future "air was free of gnats, the earth from weeds or fungi; everywhere were fruits and sweet and delightful flowers..." Predicting advances from technology, Wells pointed out that in the early 1900s nature was "...shy and slow in our clumsy hands. Some day all this will be better organized."

Wells' imaginary future was not altogether desirable. But for better or worse, unprecedented biological change is already here. This article answers basic questions about DNA technology, focusing on DNA in bermudagrass fingerprinting. We'll show that DNA fingerprinting can provide quality assurance, by supporting the certification of Florida bermudagrass planting stock. First let's look at the problem of off-type bermudagrasses.

Dark green off-type (T-3) grown in a container differed morphologically from Georgia foundation Tifway' (T-28), which was yellowish green. T-3 also had abundant inflorescences and pollen, while 'Tifway' did not. Matrix grass (T-1) could not be distinguished morphologically from 'Tifway'.)

Bermudagrass Fingerprinting

Rising expectations are as much behind the problem as the fact that we are growing grasses developed 35 years ago

The problem: off-type bermudagrasses

Golf course professionals have long been confronted with the problem of off-types in greens and fairways. Off-types are genetic variants, generally of unknown origin. In a 1975 article, "What is happening to our bermudagrass?" Monty Moncrief recognized the occurrence of off-types. The complaint 20 years ago was that hybrid bermudagrass greens (i.e., Tifdwarf and Tifgreen) were showing patches with different characteristics. Ever since, a growing demand for faster greens, higher number of rounds and better year-round color have made these irregularities more conspicuous. Excessively close mowing may have further exposed genetic variants that would not be obvious at a higher cut. Rising expectations are as much behind the problem as the fact that we are growing grasses developed 35 years ago (i.e., Tifdwarf, Tifgreen and Tifway) that were never meant to be stressed in the way they are today.

Is this really a problem? Yes, it is a serious problem. Tifway and Tifdwarf

DNA fingerprinting is any method for identification or comparison based directly on an organism's DNA

are still the most serviceable grasses for Florida golf courses. When planted successfully in pure stands, these grasses are responsive to maintenance and play. If the thousands of dollars spent on golf course operations are applied to pure Tifway and Tifdwarf, then consistently high density and wear tolerance, uniform color and predictable ball roll result. In contrast, the presence of genetic mixtures results in excess maintenance costs, disappointed expectations of golfers and serious challenges to the credibility of golf course superintendents. If you are growing the wrong grass, there's no telling how much money you might throw at it and still not have a golf course on par with the one down the street.

Where do off-types come from?

Amazingly, we don't know where off-types come from. It is reasonable to presume that some off-types originate from contaminated sprig stock used to plant golf courses. Other off-types may by spontaneous mutations. They and seedling of *common bermudagrass* might also be redistributed on golfers' shoes, golf cart tires and mower parts. Nevertheless, and despite much speculation (Table 1), we still do not know where the off-types come from, how they may be prevented or if they can be prevented. DNA fingerprinting offers us the potential to understand the problem and solve it.

What is DNA fingerprinting?

DNA fingerprinting is any method for identification or comparison based directly on an organism's DNA (*See related story,* "What is DNA?," *Page 64*) Later we will discuss different DNA fingerprinting approaches, such as RFLPs and PCR profiling. The purpose of any technique is to tell whether a grass source is what it is claimed.

How can DNA fingerprinting help?

Golf course facing reconstruction, replanting and new construction have quandaries such as, "How do we know we are getting clean planting stock?" and "How do we know we're going to remain clean over the next five years?" DNA fingerprinting is offered as a key to understanding the problem, and it may provide a solution. This is because DNA fingerprinting can be used as a quality control step in the production and distri-

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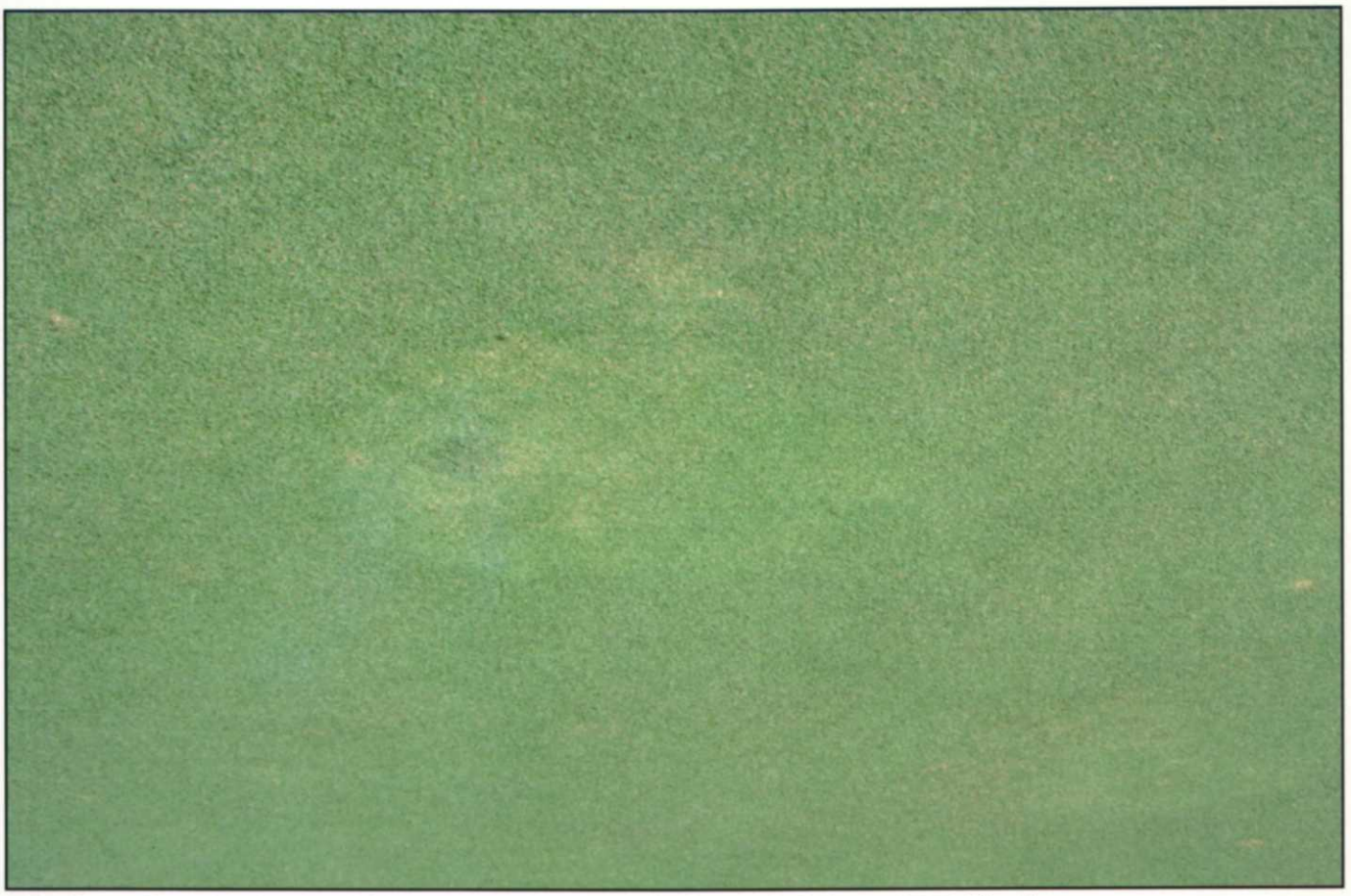
bution of planting stock. It makes sense that this be done on a statewide basis before the grass ever hits the market as a part of certification. Otherwise, each superintendent and greens committee is left to do it piecemeal.

If DNA testing can show a prospective planting stock to be authentic, then this is extra assurance that it will perform predictably. (In practice, one would use DNA fingerprinting to reject rather than accept planting stock.) DNA fingerprinting is appropriate because it has great power to distinguish genetic off-types. DNA fingerprinting is so powerful that it gives scientists a way to quantify degrees of relationship. This is helpful in determining whether off-types are mutations or seedling variants. The advantage of DNA testing over other methods is its capability of being faster and more accurate than other methods. As we will explain later, however, a sound program needs to be three-pronged, considering chromosomes, morphology and DNA.

Despite the capabilities of new technology, nobody should promote DNA fingerprinting as a cure-all. Even in this new age, Monty's excellent practical recommendation, "constant surveillance is necessary," is good advice.

Is DNA fingerprinting a specific method?

No. There are two general approaches, RFLPs and PCR profiling. RFLPs (restriction fragment length polymorphisms) analysis is more precise, but usually more expensive. They work directly with specific regions of an organism's DNA. In contrast, PCR approaches usually amplify random regions of the DNA, using the Polymerase Chain Reaction (PCR). This lab procedure copies minute traces of DNA to produce 2, 4, 8, 16, 32, 64, 128 and eventually millions of copies. So much DNA is made that it is readily visible in the presence of fluorescent stain.



Stoloniferous off-type (T-75) surrounded by matrix grass (T-74) on a Florida green. Both T-74 and T-75 differed in DNA profile from Georgia foundation 'Tifdwarf' and from one another.

Often, to detect the small amount of DNA, the visualization process uses radioactive isotopes

Both RFLPs and PCR profiling methods produce banding patterns, much like the bar codes used at the supermarket checkout. Characteristic differences in banding patterns tell two grasses apart.

How does DNA fingerprinting work?

Both RFLPs and PCR approaches are founded on recognition sequences contained in the organism's DNA. (*See related story,* "What is DNA?" *Page 64*) A recognition sequence is a region of DNA with a particular sequence of nucleotides, much like a signature or a pass code. Whereas RFLPs use both enzymes and complementary DNA sequences to do the recognizing, PCR methods use only the complementary property of DNA itself to do the recognizing.

For RFLPs, each enzyme used recognizes only a particular DNA sequence, and then cuts the DNA fragment at that point. For PCR, recognition occurs during the amplification, or copying, of DNA, in which specific primers are used to start the process of copying DNA. Primers bind specifically with "complementary" sequences. Each method produces characteristic fragments of consistent length, using recognition sequences at each end of the fragment. The recognition sequences are sometimes portrayed as "bookends."

Is one method of DNA fingerprinting best?

No. The usefulness of a particular DNA fingerprinting method is based on its cost, reproducibility and power to discriminate. RFLPs involve a hybridization process that is laborious and requires a high level of technical skill. Often, to detect the small amount of DNA, the visualization process uses radioactive isotopes that require safety containment. In contrast, PCR is rapid, requires a lower level of technical skill and does not require the use of radioisotopes.

Recipe improvements in PCR profiling are constantly being made, and their use depends on the situation. The first two documented methods were RAPD (random amplified polymorphic DNA)