One of the most critical challenges facing the Green Industry is an adequate supply of water. The lifeblood of this industry is slipping away through waste and pollution.

Last month WEEDS TREES & TURF began a two-part series on water use, conservation and quality in the Green Industry.

In "Thirsting for Answers, Part I," we examined water problems and issues in three key states; California, Texas and Florida.

In this second and final part, some solutions to these problems are offered through research, irrigation industry and Green Industry association involvement.

Development of low water use turfgrass is the kingpin in research currently being conducted.

University-level researchers across the country are currently trying to develop types of drought-resistant turf.

Backed up by concern for producing more efficient irrigation equipment from irrigation companies and financial and moral support from associations such as the USGA Green Section and Golf Course Superintendents Association of America, progress, slowly, is being made.

Tall cylinders *provide growing chambers for Dr. David Casnoff's root enhancement work study at the Texas A&M greenhouse in College Station. He is studying 11 warm season grasses.*

Research is kingpin in ebbing water woes

Dr. Jim Beard of Texas A&M, College Station, TX, oversees one of the largest turf water usage programs at the college level in the country.

With a staff of six, Beard's current research emphasis is water use rates, root enhancement, drought resistance and salt tolerance. His staff is doing interspecies work with 30 species. When that's complete, intraspecies work will be done.

"The future of the turfgrass industry rests on this type of research," Beard says. "It is a sobering responsibility and tremendous challenge."

Also, according to Beard, the number of man-year-equivalents (number of Ph.D-level researchers) doing work has doubled in the water area, largely due to the support of the USGA Green Section, this year to the tune of $332,000 with an estimated $3 to $4 million being spent in this area in the next eight to 10 years.

"When I first started my work back in the '60s, I had a budget of $2,000," says Beard. "Our USGA grant this year is $85,000."

Add to that the $90,000 in capital Texas A&M University has supplied and a half-a-million dollar physical plant, and Beard's operation is impressive.

Work is done on the 14-acre turfgrass research farm on the A&M campus. Field and plot manager Doug Dahms is responsible for its overall operation, mowing and fertilizing.

Root enhancement

Dr. David Casnoff is a post-doctoral student working with Beard in the area of root enhancement and stomata, the parts of a plant that allow water to enter and exit the leaf.

He believes the key to turf water usage is in the root system.

Casnoff is looking at the maximum root growth of 11 warm season grasses including Tifway; Tifgreen; FB119; Tex Turf 10; Texas Common St. Augustine; common centipedegrass; Argentine bahia; Adalayd sandknot grass; Emerald and Meyer zoysia; and Texoka buffalograss.

"We're not only trying to describe the difference between growth rate, but also how different species respond during spring when in their maximum growth period," explained Casnoff. "The ones that have more new root tips at a lower depth will probably have more active surface area for uptake of water."

Casnoff is also doing research with stomates.

"Stomates could possibly tell us why some grasses use more water than others," Casnoff said. "We know the size and number of stomates on the plant leaf are inversely related to each other, but we don't know whether or not it's better to have more or less."

Casnoff's work dovetails with turfgrass stress work research associate Steve Griggs is doing.

"Steve will have the low water use data and I will have stomate data. We can combine the two, and hopefully, come up with some important discoveries. At this point, the negatives are as important as the positives."

Griggs is a research associate in charge of testing humidity, dewpoint and light in the university's turfgrass stress chamber. Known environmental conditions can be created in the chamber which holds individually planted pots or lysimeters, of different species of grass.

Griggs said denseness in grass is becoming more important than stomata.

"Drought tolerance and water use are two different things," Griggs explained. "Buffalograss doesn't need a lot of water, but it will use water if it's available."

Griggs' daily routine includes weighing the lysimeters to calculate grams of water used. Cutting height is also important. Three replications per week are done of several cultivars of different turfs—mainly warm season grasses.

Sam Sifers, a retired colonel with a degree in history, is another research associate involved with minimal maintenance turfgrass—water, labor, energy and equipment.

Sifers set out to prove grasses with low nitrogen grow and perform as well as grasses with a high nitrogen content to give breeders parameters to judge turf.

"I eventually want to deny nitrogen totally and see what happens," Sifers explained.

His work entailed studying four bermudagrasses that required high medium and low doses of nitrogen—Midway (high); Tifgreen (medium), and TexTurf 10 and FB119 (low).

"We analyzed many different aspects of the grasses; shoot density, spring green-up, shoot growth, things like that."

Spring root decline is another area that Sifers is involved with.

Beard discovered the phenomenon of spring root decline—the grass turns brown above ground, but the roots don't stop growing—in the university's rhizotron, an underground

Dr. Jim Beard *heads one of the largest turfgrass water use research programs at the college level in the country.*

Sam Sifers, Texas A&M, *College Station in the greenhouse with growing boxes that chart root growth, simulating conditions of the university's rhizotron.*

growing chamber that allows the roots of live, growing grass to be seen from behind glass-like walls placed in the ground. (Texas A&M's rhizotron was the first in the world and is only one of seven that currently exists). Beard describes the phenomenon as the most significant discovery of his career.

Sifers has duplicated the rhizotron conditions in boxes in the greenhouse to duplicate warm/hot springs.

"We've not really found any decline," he reports. "With a gradual warming trend, there seems to be no effect. That could be one reason why superintendents have such a hard time from year to year. One season the grass seems to die, the next it doesn't," said Sifers.

"Stomates could possibly tell us why some grasses use more water than others."

—Casnoff

The next phase of Sifers' experiment will be Carbon-14 testing to pinpoint at exactly what temperature spring root decline is halted. He'll also study the effect phosphate has on the vegetative establishment of grasses. Sifers has already found with stolons that phosphate at three pounds per thousand square feet gave the fastest establishment of grass. He will next test phosphate with sprigging and sodding.

Kisun Kim, a graduate student studying under Beard, completed a comparative evapotranspiration (ET) rate study of 11 warm season grasses under non-limiting (watered everyday) soil moisture and progressive water stress conditions.

He found that, in general, tall fescues used more water and zoysia, bermuda, and buffalograss used less. There was a higher ET rate when the leaves were erect, shoot density was low and there was a high leaf area. St. Augustine and Adalayd had the highest evapotranspiration rate among warm season grasses. Emerald zoysia, buffalograss, centipedegrass and Tifgreen showed a low evapotranspiration rate. The conclusions of Kim's study were that zoysia species, centipedegrass and buffalograss can be recommended as prospective species when water saving is a high priority.

Those grasses which had a low vertical leaf extension rate, high shoot density, low leaf area and prostrate growth habit, had a low evapotranspiration rate. All grass species showed higher ET rates when maintained at their respective optimum nitrogen level and cutting heights, primarily due to the resultant, more rapid shoot growth.

Wallace Menn, an instructor in the A&M turf program, as part of Beard's overall turf water use research, did a four-year study of St. Augustine using Cutless and Embark growth regulators.

He sprayed the lysimeters with dif-

ferent rates of the regulators and weighed them every 24 hours. He found growth regulators can save 20 to 30 percent in water use. Results from studies with bermudagrass were not as significant.

Salt tolerance

At the A&M research center in El Paso, TX, Dr. Garald Horst is evaluating zoysias, St. Augustine and bermudas for salt tolerance and water use rates. He expects the research to go on for another two years. Bluegrass, tall fescues and ryegrasses have been completed.

Horst conducts his salinity tests with grasses bred by Dr. Milt Engelke at the Texas Agricultural Experiment Station, Dallas.

"We have come up with some good germ plasms for salt tolerance, but the tests need some refinement and then we will test again. Horst analyzes 20 cultivars of each variety.

Ninety percent of Horst's work is oriented toward urban use.

"I think education and public awareness is the way to go," Horst maintains. "Lots can be changed by just altering people's water habits."

Horst also sits on the El Paso Park Board which oversees 630 acres of park land, and made a presentation to the board on water conserving grass.

"People are amazed that you can use less water and less fertilizer and still have the same quality grass."

University of Florida

Quantity of water isn't the problem in Florida, which averages 50 to 60 inches of rain a year. Quality is a problem. Because the soil is sand, there is a constant threat of chemicals leaching into the groundwater supply.

Still, Dr. Bruce Augustin of the University of Florida Institute of Food and Agricultural Sciences, Ft. Lauderdale, is trying to find ways of drought conditioning turf. He is studying nitrogen and potassium by taking recommended rates and going lower under different irrigation levels which include: daily (the type the typical homeowner would use) evapotranspiration replacement (twice a week or best "guestimate" of when to water); and wilt only (irrigates only when 30 to 50 percent of the turf plot is wilting.)

"The thrust of my work is on visual tests and common sense," says Augustin.

His testing has found that irrigation can be limited to an as-needed basis instead of sticking to a set schedule (which could cause over-irrigation) and produce better results. Also, water soluble nitrogen can be used as effectively as slow-release nitrogen with the added benefit of being less expensive.

Another problem in South Florida is the chemical content of the soil.

"We have some phosphorous but it doesn't move in the soil," said Augustin. "Nitrogen and potassium have to be added on a regular basis."

Augustin uses a Troxler density gauge for measuring moisture in the soil.

"I've found that homeowners and superintendents can tell how many minutes they've watered but not how many inches," explained Augustin. "In water conservation, the latter is more important."

University of Nebraska

Dr. Robert Shearman at the University of Nebraska is trying to determine evapotranspiration rates for cool season turfgrass species and cultivars and is looking at drought avoidance mechanisms in the same grasses which include tall fescue, Kentucky bluegrass, fine-leaved fescues, perennial ryegrasses, creeping bentgrasses and annual bluegrass.

He has overseen the work being done at Nebraska, another large uni-

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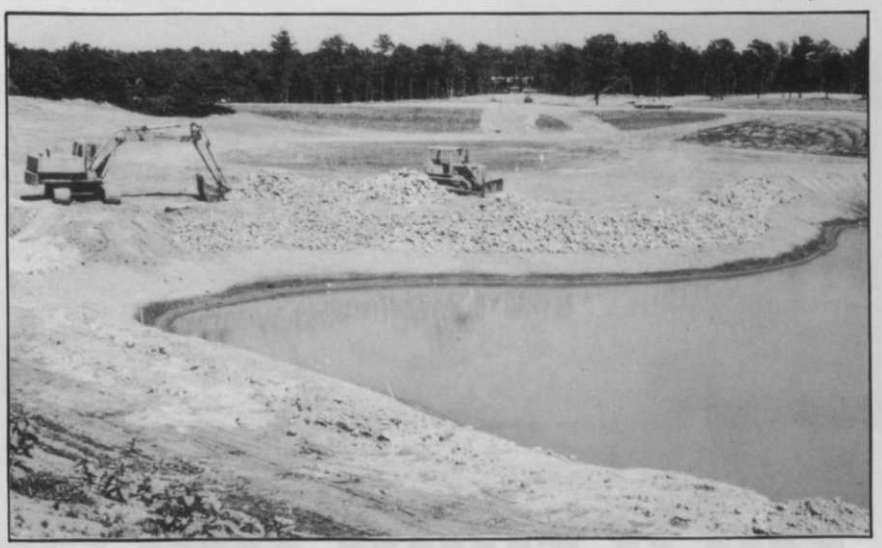
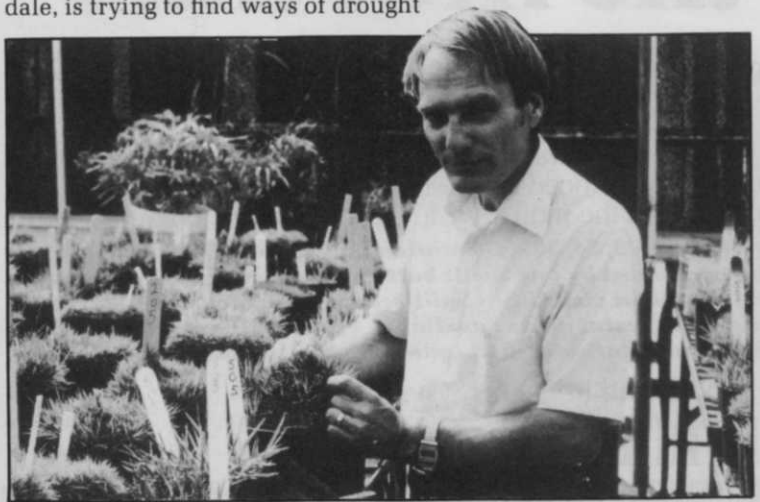
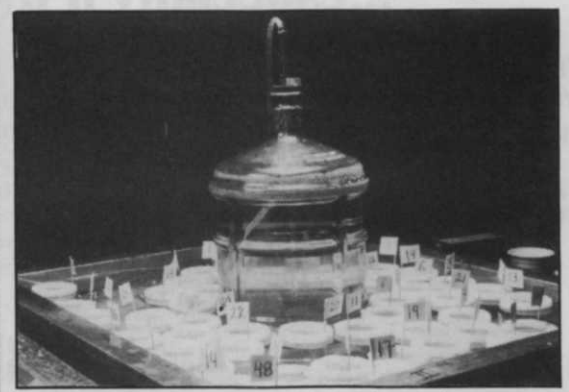


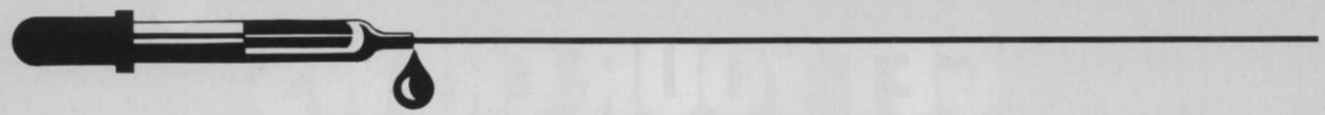
Surface water at Dennis Highlands *is piped into a retention pond in a low area of the course for future irrigation purposes. The pond also reduces wind evaporation of the water and adds to the surrounding scenery.*



Dr. Garald Horst, *Texas A&M, El Paso*



Turfgrass plants *are tested for their tolerance of salinity levels at Texas A&M, El Paso.*



versity-level study comparable to Beard's of A&M, for the past nine years.

"With the ET studies, we're looking at those grasses under optimum conditions, such as the best mowing height and best nutrition regime for each species and under uniform conditions. The key is trying to characterize the ET under cool season growing conditions."

Shearman's preliminary findings relating to Kentucky bluegrasses are: there is a wide range of water use rates in Kentucky bluegrasses with the cultivars or varieties differing greatly.

Shearman is also using modeling to predict ET rates.

In the Modified Penman method, various mathmatical equations or models can be used to predict ET rates.

"What happens is that we use climate data to predict what the ET should be for the plant. In determining the ET on a particular day, we can also calculate what we predict it to be and then compare the two and come up with an equation or model that a turf grower could use to schedule irrigation. Growers can then plug this information into their own computers and adapt it to their own crops."

The department also found growth regulators can significantly reduce ET rates compared to plants that hadn't been treated.

"We found a 25 to 40 percent reduction in water use after 14 to 28 days of treatment.

"Overall, we're looking for ways on a short-term basis to reduce water uptake through cultural practices," concludes Shearman. "On a long range, we're trying to identify grasses with low ET rates and deeper, more extensive root systems under turf conditions and the ability to redistribute the root system with changing soil moisture. This will tie in with our long range goals of breeding low water use, drought avoidance grasses."

University of California, Riverside

Editor's note: Much of the low water use turf research in California has been done by Drs. Victor Youngner and Victor Gibeault. Two weeks after WEEDS TREES & TURF interviewed Dr. Youngner for this story, he died of a heart attack. Because of the timeliness of his comments and the commitment Dr. Youngner showed to this industry over the past 30 years, his comments have remained in the story.

In 1966, Dr. Victor Youngner of the University of California, Riverside, released a bermudagrass cultivar he developed called Santa Ana. At the time it was hailed for its tolerance to smog and ability to continue growth right into the cool winter season. The fact that it was a water efficient grass was noted, but at the time, smog was a bigger danger than water consumption.

That has changed.

It was in the '60s, that Youngner began his research with the now retired Dr. Al Marsh, to determine the water requirements of turfgrasses. They chose two warm season grasses—St. Augustine and common bermuda and two cool season—Alta tall fescue and Merion Kentucky bluegrass. The two consecutive studies were done over several years. The study found warm season grasses to use much less water with virtually no effect on turf quality. Fescues also did well. Bluegrasses were stressed. The Youngner/Marsh test was the first time this data was produced.

This year, another Youngner zoysia cultivar will be released called El Toro. This is another turf with low water requirements.

Ongoing research, supported by the Metropolitan Water District, is looking at the survival ability of several grass species under severely reduced water levels. They include three warm season grasses (Santa Ana bermudagrass, *paspalum vaginatum* (Adalayd and Excalibur) and Jade zoysia) and three cool season (a blend of several bluegrasses, a blend of several ryegrasses and Alta tall fescue.)

Wetting agents

Studies done by Dr. John Letty, also of the Riverside campus, on wetting agents, concluded that when soils repel water for whatever reason, (organics, thatch build-up, etc.) surfactants have been found to allow better water penetration.

Youngner agreed.

"Wetting agents are of use in water conservation to avoid runoff in areas with hydrophobic soils or thatch," he said.

Alternatives

Youngner's colleague, Dr. Vic Gibeault, an environmental horticulturist with the University of California Agricultural Extension, Riverside, is focusing his current work on studying alternative plant materials that would use less water than turf.

The facts tend to support this research.

In Southern California, where 60 percent of the state's population lives, 3.1 million acre feet of water is used by 12.1 million people. That figure can rise to as much as 3.6 acre feet. With the loss, however, of part of its Colorado River supply in a few years because of a water rights dispute, Gibeault explained that that would put the Southern California water supply right on line—no surplus.

"Because we would not be dealing with a surplus situation, restrictions could be placed on the water supply at any time."

There is also an estimated influx of 3 million people coming into the state in the next 16 years; a whopping 25 percent population increase.

"We started looking at turf usage and came up with 1.4 million acres of turf in California," Gibeault said. "Of those acres, 65 to 70 percent are residential and 35 percent are professionally maintained such as golf courses, parks, cemeteries and military bases. Lots of water is being used to irrigate turf."

"About five years ago, we started water awareness programs with those in the professional turf community. Our goal is to paint a long-term scenario. The professional industry is recognizing the problem very clearly. Some facilities have changed from cool to warm season grasses because of their water-saving qualities. Homeowner awareness is a great problem."

Gibeault also explained there's some hesitancy among golf course superintendents because of the dormancy of warm season grasses. Much of the zoysia work at the U of C, Riverside, is aimed at finding cultures with less dormancy to make the grass more appealing and acceptable aesthetically.

In the 1.4 million acres of turf in Southern California, within each area, such as golf courses and parks, if water use areas were identified, you'd come up with about 50 percent of the area in existing grasses. Gibeault maintains these areas don't "need" to be planted in grass.

"We plan on studying alternatives that use less water and are just as pleasing to look at," he said.

Gibeault feels there's an issue that even overrides the type of turf selected in areas where water is precious—and that's irrigation equipment design.

"We always have to deal with the driest spot. If a system isn't designed well it wastes a great deal of water. Up until now, water has been too cheap to go with a more expensive system. In most cases, we're using twice as much water as we really need."

Major irrigation companies in the U.S. couldn't agree more.