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ing less adaptive breeds. Natives tend to require less water after establishment and grow well in local soils. "Natives are emphasized in xeriscaping," notes Cyrus McKell, Ph.D., of Native Plants, Inc., a plant biotechnology firm. He recommends also selecting plants with greater stress tolerance.

According to LANDSCAPE MANAGEMENT research, nearly 52 percent of the magazine's readers are engaged in some form of irrigation. In 1986, readers spent over $101 million on irrigation equipment, $59 million on sprinklers alone.

Expenditures on electronic irrigation controls increased more than $5 million from 1984 figures, to $20.8 million.

"Irrigation will become more computerized and automatic," comments Steve Bock, an assistant golf course superintendent in Papillion, Neb.

"One (advancement) would probably be a control box that could be placed in the office," adds Gregg Wilson, co-owner of Southern Turf, a landscaping/lawn maintenance firm in Goldsboro, N.C. "With it, all systems could be programmed or controlled. This would discontinue any hustling to a site in case of rain during the time set for irrigating."

CHANGING TIMES

"The computer is really the thing that's going to change the irrigation industry," says Vince Nolletti of Buckner, Inc. Adds Tom Fermanian, Ph.D. of the University of Illinois, "Over the next 20 years they will be widely accepted in the industry."

Much of the technology needed for efficient systems exists already, and some of it is not new at all. Computers already run irrigation systems.

Computers can make use of the latest technology that reads the environment. Golf courses can now have weather stations installed as part of irrigation systems. Weather stations monitor atmospheric and ground moisture conditions to determine the evapotranspiration (ET) rate and adjust irrigation rates and timing accordingly (see sidebar below).

Included in weather stations are tensiometers, instruments measuring soil moisture content. Palm Springs, Calif., recently experimented with tensiometers. According to Ronald L. Baetz of the Desert Water Agency, the city took a 6½-acre park served from two irrigation meters, divided it in half and installed tensiometers in one half. For the two-year life of the project, water use was cut by 54 percent on the fitted half, translating into a savings of $11,000, just for that one small area. Not surprisingly, "the city is following a program to retro-fit most of its landscaping with tensiometers," Baetz says.

Edward Hunter of Hunter Industries sees low-cost plastic rotors replacing the fixed heads used today. To use tensiometers effectively, sprinklers must "apply evenly and at an acceptable rate. Most apply too fast for absorption," Hunter says, about 1½ to 2 inches per hour.

These new heads are likely to oper-

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More 'eyes' for turf managers

New irrigation equipment can help turf managers save water, a resource that is becoming increasingly valuable. However, further technical evolution is needed; landscape managers can never have enough "eyes" to help them monitor water usage.

Irrigation manufacturers are taking a hint from these signs of the times by trying to develop sophisticated yet easy-to-use equipment. Not often in irrigation industry have manufacturers generally agreed on marketing plans, but in this instance they do.

Rain Bird Sales of Glendora, Calif., has devised a complete irrigation system which can include weather stations that can calculate probable daily evapotranspiration loss and automatically set the controller so that the correct amount of water can be put back into the turf. The system is called the Maxi ET.

But just because it's almost fully automated, the Maxi ET does not waste the landscape manager's expertise.

"He is the expert," notes Rene Evelyn-Veere of Rain Bird. "The Maxi first draws on his experience because the superintendent or landscape manager can modify the weather station data for specific weather conditions. Then, once the turf manager gets 'tuned into' the system, he can slowly, more precisely replace the water."

The weather station, placed centrally on a golf course for instance, senses temperature, solar radiation, relative humidity and wind speed to calculate the water lost to evapotranspiration over 24 hours. It then subtracts rainfall during the period and, through an IBM PC computer, adjusts irrigation to replace the lost water.

"The user defines ET upload time," notes Evelyn-Veere, "and the system then automatically adjusts the irrigation."

Adds Ed Shoemaker of Rain Bird Golf Sales: "We're finding very few superintendents who have any problem with this concept." If there is a problem, it is trying to get golf course superintendents to think in terms of *inches* of water rather than amount of *time* the system is switched on.

A handy secondary function of the system is that it can switch lights, open gates, operate fountains—virtually anything that has an on-off switch.

Toro's entry is the Network 8000. Its user chooses one of the four ET measurement methods, and that method is used to drive the system, determining each day what amount of water must be dispersed to replace the water lost to ET. The four choices are based on:

(1) Temperature: every Network 8000 satellite has a built-in ability to measure temperature, and ET can be calculated from an equation based on the high and low daily temperature and the area's latitude and longitude;

(2) Solar radiation and other data available from an attached weather station (temperature, wind speed, relative humidity);

(3) Historical ET data: ET data for the last 30 years is available, and if monthly values are assigned, a projection can be made automatically of how much water to apply at a specific time of the year;

(4) CIMIS, California Irrigation Management Information System: a network of 60-plus weather stations around California that daily collect data and feed it to the University of California at Davis, where phone modem access is provided to anyone who wants to use the data for a specific locale.

The Network 8000 is fully automatic, but a key requirement is that all nozzle data be entered into the system's IBM personal computer. With

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ate under lower pressure. Low-pressure irrigation is a new concept for which technology and equipment have only recently been developed and implemented (see story page 20).

Low-pressure systems work at lower P.S.I. than present systems, delivering a more accurate amount of water at lower pump energy, saving money on both water and energy. Pumps will be designed more efficiently, as will other equipment used in irrigation systems, such as piping.

According to Rain Bird's Ed Shoemaker, pump technology has advanced significantly over the last 10 years. Improvements have been made in controls, pressure regulating valves and surge tanks.

A key to the future, he says, will be to match irrigation systems to pumping plants for the most efficient system.

Pumping systems are designed now as a series of smaller pumps installed with demand sensors which control pump flow. If someone is just using a hose to water flowers around the clubhouse, only the first, smallest pump will be activated to provide water to save energy and wear and tear.

Computerization of the pumps and low-pressure systems will make them even more accurate.

Advanced technology for irrigation efficiency will be simplified further through portable infrared thermometry instruments. "Infrared thermometry reads the canopy temperature to schedule irrigation times," says Bob Carrow, Ph.D., University of Georgia.

"The canopy temperature rises when moisture stress begins and before wilt shows," Carrow says. The technology is designed to prevent both over- and under-watering. Irri-

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More 'eyes' for turf managers *from page 20*

tem's IBM personal computer. With nozzle radius, spacing, and flow data entered, the precipitation rate can be accurately determined for each Network 8000 station, and the desired water flow more closely matches actual ET.

A further enhancement of matching water dispersion to ET demand is accomplished through entering data from each station into the system. "We knew that turf managers would want to customize their watering based on the characteristics of each course," says Toro Irrigation's Terry Mylne, "and that's really the only way you're going to be sure you're not over- or under-watering.

"Our solution was to create a system that assigned values for type of soil and turf, soil compaction levels, and slope of soil for each station. Special groupings such as north or south facing slopes, and rocks, trees and beaches may also be entered. All of these 'attachments and attributes,' as we call them, become associated with every station, and can all be scaled up or down for relative importance."

Motorola has been using weather station technology in agriculture for about 15 years, according to Motorola's Eric Scott. But it has only been within the last year that the company has entered the golf course market with a weather station-equipped irrigation system. The reason: "The education of superintendents is increasing, and these people are becoming more aware of these things," Scott says. "The industry is more receptive to high-tech."

Motorola's systems, the 3500 and 5000, gather data which is transferred by radio, technology which the company is noted for, to a central computer which adjusts the system accordingly. Software for the system was written along Motorola specifications by International Hydrological Services, a consulting firm of former irrigation industry members.

Rene Evelyn-Veere of Rain Bird says the golf course superintendent remains the expert, despite new technology.

The system only operates under optimum flow and pressure conditions, Scott says. If conditions necessitate it, the computer will prioritize areas to be irrigated: greens first, then tees and so on.

A hand-held monitor that measures plant stress much like a weather station is being marketed by Standard Oil. The ST-27 Turf Monitor, a "gun" attached to a computer worn at the waist on a shoulder strap, monitors the physiological state of the turf. After measuring the plant's leaf temperature, ambient temperature, relative humidity and solar radiation load, the data is processed by the computer. The resulting "stress index" gives the turf manager information needed to analyze irrigation effectiveness and project irrigation requirements.

"Its ultimate purpose is to serve as an additional set of 'eyes' for the superintendent," notes Steve DeSutter of Standard Oil.

New water-saving technology is not just limited to hardware. Indeed, most turfseed marketers are currently studying varieties with better drought-tolerance characteristics. It is generally known that Bermudagrass, zoysiagrass, tall fescue and creeping bentgrass have excellent to good heat hardiness. As improved varieties are released over the next few years, water use promises to decrease—as it must.

—Jerry Roche