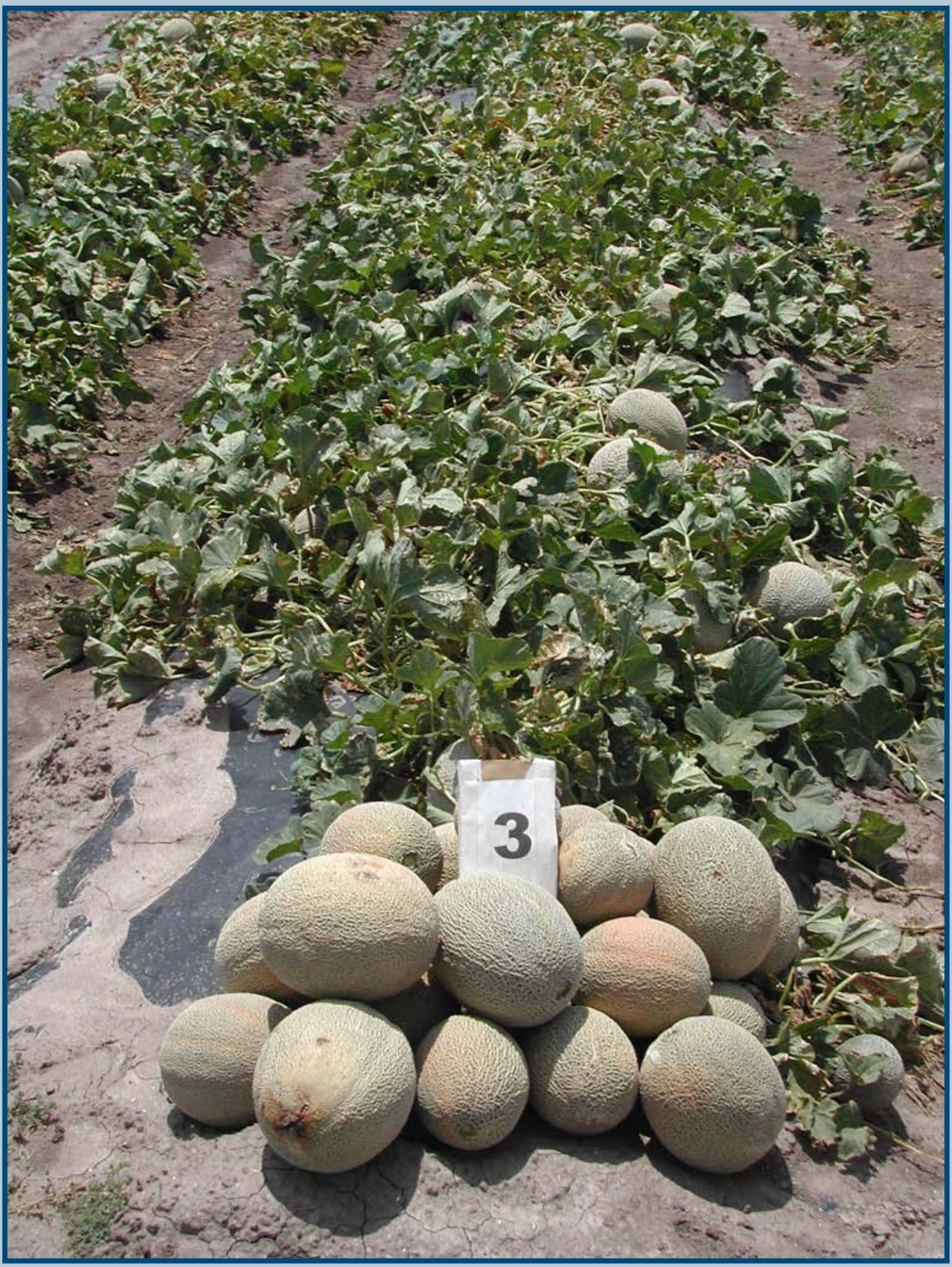
OUTCOMES

from the Rio Grande Basin Initiative

November 2009, Vol. 8, No. 2



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Investigating water management techniques

Plant grafting practices lead to efficient irrigation

By Leslie Jordan

Watermelon crops annually contribute more than $160 million to the Texas economy. However, not only is the popular summer treat a major source of agricultural revenue for Texas and the Lower Rio Grande Valley, it is also an excellent source of nutrition, providing vitamins A, C, and B6, phytochemicals such as lycopene, and thiamine. In order to help melon growers sustain profitable, nutritious crops in the face of drought and root diseases, Dr. John Jifon, an associate professor of plant stress physiology at the Texas AgriLife Research and Extension Center in Weslaco, is investigating how on-farm water management strategies can improve the efficiency of applied irrigation water used by melon crops.

"The recurrent drought affecting many parts of the state has hit the vegetable industry particularly hard, in part because many vegetables are harvested, marketed, and consumed fresh and therefore require precise water management," Jifon said. "Drought vulnerability of vegetable crops has also been aggravated by root-damaging soil-borne diseases that limit water uptake. The goal of this research is to develop cost-effective and science-based sustainable technologies that growers can use to conserve water and manage economically important soil-borne root diseases of the target crops."

Jifon collaborates on these projects with Dr. Juan Anciso, assistant professor and Extension vegetable specialist in Weslaco; Dr. Bob Wiedenfeld, retired professor of soil sciences; Dr. Daniel Leskovar, professor of horticulture and vegetable physiology in Uvalde; and Dr. Kevin Crosby, associate professor of horticultural sciences. Jifon's research on water issues is focused on two physiologically based management techniques: regulated deficit irrigation (RDI) and grafting.

According to Jifon, while irrigated agriculture nationwide accounts for over 80 percent of freshwater consumption, only a fraction of the water applied is actually used by plants to produce biomass and yields; most of the water ends up cooling plant leaves or preventing wilting, or it simply evaporates from the soil surface and goes unused.

"The basic idea behind RDI is to reduce the amount of irrigation water applied during periods of the growing season when vegetative growth is high, and only maintain normal irrigation levels during periods of rapid fruit growth," said Jifon, who is also affiliated with the Department of Horticultural Sciences. "The overall effect is to reduce excessive vegetative growth, which is often associated with excessive water use, while having little or no effect on fruit development, yield, and quality."

Funded by the Rio Grande Basin Initiative, Jifon's research on muskmelons and watermelons has demonstrated that, when applied correctly, the RDI strategy can conserve water and improve fruit quality and overall crop water use efficiency.

Jifon and his fellow researchers observed that reducing irrigation amounts by 15 percent (based on crop evapotranspiration) saved on average 0.75" of irrigation water per growing season. The productivity of water applied, that is yield per acre per inch of water applied, was increased by about 10 percent with no significant negative impacts on fruit yield or quality, Jifon said.

"By exposing the crop to mild water stress during non-critical parts of the growing season, yield reduction is minimized and the water saved can be diverted to irrigate other crops," Jifon said.

However, Jifon realizes that under-irrigating crops is a major risk to ask growers to take. He said that irrigating more than is needed to obtain optimum yields not only wastes resources, but can lead to poor fruit quality, specifically the sugar contents. If growers continue to frequently over-irrigate, strategies such as high density planting and grafting, which maximize crop water uptake and utilization, could also increase the amount of water available for plant use.

Representative fruit yields from drip-irrigated field plots using the regulated deficit irrigation (RDI) scheduling technique at 100 percent (top), 75 percent (center) and 50 percent (bottom) of crop evapotranspiration rate.

"One strategy that we are now investigating is combining deficit irrigation and high density plantings to make the most of every drop of irrigation," Jifon said.

Grafting, another technique that Jifon researches, is becoming popular not only as a tool for managing soil-borne diseases, but also for mitigating abiotic stresses such as drought. Grafting is a propagation technique that involves fusing the tissues of two plants; the bottom, root part of the fusion is called the rootstock and the top, which develops into stems, leaves, flowers and fruits, is called the scion.

Vigorous rootstocks are preferred because many of them can tolerate or resist soil diseases and can efficiently explore the soil to absorb water and nutrients, said Jifon, who researched the effectiveness of grafting melon crops. Several rootstocks currently exist for grafting commercial melon and watermelon varieties, but scion-rootstock compatibility is critical to fruit yield and quality.

"Grafted vegetable seedling transplants are widely used in Spain, Israel, Korea, and Japan, where intensive cultivation with minimal rotation is common," Jifon said. "The use of grafted transplants in the United States has been limited, in part, due to the relatively high cost of grafted seedling, about $0.85 to $1.50 per seedling, but also due to insufficient information on efficient grafting techniques, suitable rootstocks, potential yield benefits and cost savings associated with grafting."

Jifon's grafting research, conducted in commercial fields in the Lower Rio Grande Valley, demonstrated that grafting watermelon cultivars on rootstocks with vigorous root systems can improve tolerance to water deficit stress and vine-decline caused by soil-borne diseases.

"Vines of grafted watermelon plants were longer than those of non-grafted plants, and grafted plants consistently had higher leaf water potentials compared to non-grafted plants, especially during the fruit maturation periods when adequate water supply was most critical," Jifon said. "In one disease-infested field, fruit yields from plots with grafted plants were significantly higher than those from plots with regular non-grafted plants, because additional harvests were possible from the former."

Demonstrated by Jifon's work, the significant benefits of employing RDI and grafting techniques could potentially help Valley growers maintain profitable melon crops, even in the midst of diseases and drought.

"These strategies should allow growers of high-value, nutrient/phytochemical rich crops such as melons not only to remain profitable, but also to adopt environmentally friendly production practices that will enable them to compete favorably with other production regions," Jifon said.

Photos courtesy of John Jifon

Effect of cover crops

Evaluating onion on-farm irrigation management in Southern New Mexico

By Mark Uchanski, C. Cramer, S. Walker, and Anthony Rios

Sustainable cultural practices in the arid southwest are crucial in order to ensure the Rio Grande's limited water resources. The use of killed cover crops as a pre-plant practice may be one way to moderate water use in spring-sown onion (*Allium cepa)* production. Other added benefits include increased organic matter, improved stand establishment, and increased yields. Four cover crop species of two cold-sensitive species and two cold tolerant species were tested at the New Mexico State University Leyendecker Plant Science Research Center. The cold-sensitive species included oats (*Avena sativa* 'Monida') and ryegrass (*Lolium multiflorum*), and cold-tolerant species consisted of winter rye (*Secale cereale*) and winter wheat (*Triticum aestivum* 'Promontory'). In addition, an in-furrow application of wheat straw was used as a fifth cover treatment.

Preliminary data indicates that a killed cover crop reduces water loss in addition to reducing virus disease pressure. However, one cover crop species tested (rye) may be incompatible with spring-sown onion production due to competition issues. Implementing these modified cultural practices in commercial onion production may prove to be part of the water conservation puzzle in New Mexico. Graduate student (M.S.) Tony Rios said, "With funding from the RGBI, alternative cultural practices such as these would probably not be attempted by local growers due to the perceived risks. The research being conducted takes the risk out of the equation, and may lead to increased adoption of these techniques by onion producers in the state." Rios completed his first season of fieldwork in the summer of 2009 and is preparing for a second planting this fall.

Graduate student Tony Rios (right) and agronomy undergraduate Samuel Diaz (left) adjust the leaf chamber used to measure plant gas exchange in onions. Data collected in this experiment was used to quantify plant stress, photosynthesis rates, and water use efficiency.

From field to fuel

Water requirements for oilseed production

By Craig Runyan and Manny Encinas

Throughout the country producers are interested in diversifying cropping systems to include oilseed crops for bio-fuel production. In water scarce regions, one leading consideration in oilseed production is the consumptive water use requirement. Dr. Manny Encinas, New Mexico State University Cooperative Extension Service beef cattle specialist at the Corona Agricultural Research Center, is attempting to help answer related questions through a Rio Grande Basin Initiative (RGBI) project addressing Camelina production for oilseed.

Water shortages and rising fuel prices provided the impetus to study what water inputs were needed for New Mexico producers growing Camelina. In cooperation with Union County Extension Agent,

see **Field to Fuel** *on page 7*

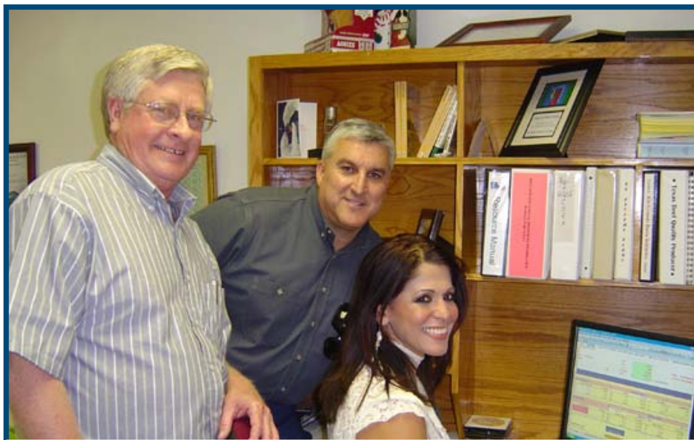
Determining the cost

RGBI economics team efforts assist in decision making

By Danielle Supercinski and Allen Sturdivant

A team of agricultural economists from Texas AgriLife Extension Service and Texas AgriLife Research have been making innovative advancements in the water world through the Rio Grande Basin Initiative for the past eight years.

Dr. Edward Rister, Allen Sturdivant, Dr. Ronald Lacewell, and several current and former students in the Texas A&M University Department of Agricultural Economics, including Emily Seawright, Chris Boyer, Andrew Leidner, Callie Rogers, and Shauna Yow, have been working on issues that required the development of a series of interrelated computer models.



Rusty McDaniel of Hidalgo County Irrigation District (ID) #1, Sonny Hinojosa of Hidalgo County ID #2, and Sonia Lambert of Cameron County ID #2 working with VIDRA in Weslaco.

The models have a common financial/economic approach, which combines all the costs incurred throughout the life of a project into a comprehensive $/acre-foot (ac-ft) value. Because of the methodology, the results can be used for *apples to apples* comparisons across projects, facilities, and/or technologies, regardless of size, location, or expected useful life.

To help South Texas irrigation districts determine which infrastructure projects are the most economical at saving water, the team developed RGIDECON© (Rio Grande Irrigation District ECONomics). Results show rehabilitating canals and pipelines to prevent leakage and installing metering equipment to improve water management saves over 58,000 ac-ft/year at an average life-cycle cost of $45/ac-ft. "This model was our first effort at helping others with water planning in South Texas," said Rister, professor and associate department head for the Department of Agricultural Economics.

"To accommodate growing populations, some municipal water planners can consider desalination as an alternative to conventional surface-water treatment for supplying potable water," said Lacewell, assistant vice chancellor for the College of Agricultural and Life Sciences. To help determine which is the most economical, the economics team developed the DESAL ECONOMICS© model, and its companion CITY H_2O ECONOMICS©. Both are built on the same methodological platform and design standards, which allow experts to analyze which technology, facility design and/or asset configuration provides the lowest long-term cost of potable water. The results are robust and unique because the life-cycle cost for one entire facility can be analyzed, or up to 12 individual facility segments can be detailed and studied.

"To our knowledge, and from a literature search, this life-cycle cost capability to individually look at the well field, the main facility, other components, and/or the entire facility appears unique among cost models directed at desalination and/or surface-treatment facilities," Sturdivant said. "Both models are custom-built and useful for analyzing any facility, regardless of size or location. They are particularly useful in the early planning and design phases of projects."

Another model incorporating life-cycle cost analysis is ArundoEcon© led by graduate student Emily Seawright, who is researching the economic impacts of using biological controls (i.e., beneficial insects) on *Arundo donax* (a.k.a. giant reed), a perennial, non-

see **Economics Team** *on page 6*

Economics team

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native invasive weed that consumes large quantities of water along riparian areas of the Rio Grande. "*Arundo* is estimated to consume 4.37 ac-ft/acre/year, in addition to decreasing riparian diversity, altering the water stream, and choking irrigation canals," Seawright said.

Results from ArundoEcon© show the life-cycle cost to save water to be $44/ac-ft/year, along with a benefit cost ratio between $4.38:1 and 8.81:1, meaning social benefits are between $4.31 and $8.81 for every $1 spent on the biological-control project.

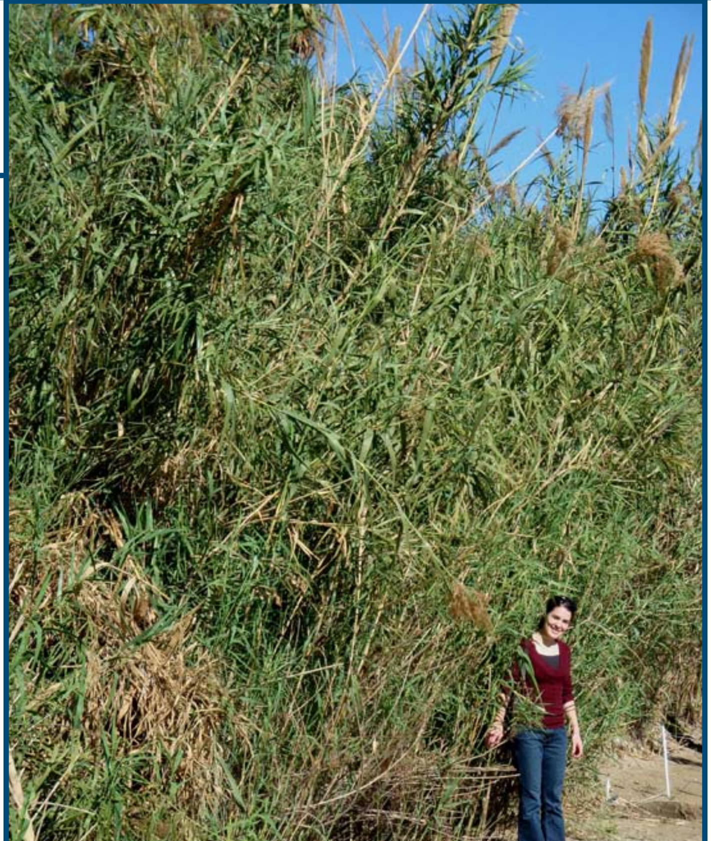
Additional noteworthy accomplishments are economics team student Shauna Yow and her undergraduate thesis, "An Investigation of Unintended Consequences of Legislation."

"Shauna furthered work done by Callie Rogers and Chris Boyer in their theses, which used the DESAL ECONOMICS© and CITY H_2O ECONOMICS© models to calculate life-cycle costs for municipal water-treatment facilities and investigate the economies of size issue," Lacewell said.

"Using the earlier work by Rogers and Boyer as a base, Yow analyzed the change brought about by Floor Amendment 60 of Senate Bill 3," Rister said. "It established the price for which municipalities purchase converted irrigation water rights associated with the urban development of irrigated agricultural land at 68 percent of the current market rate."

Lacewell said, "Her results reveal the involved conventional surface-water treatment facilities (i.e., municipalities) and the general public benefit, at the expense of the involved irrigation districts and the region's desalination industry."

So, if the objective is to add water to the region's supply in the most efficient manner, one could compare life-cycle cost results for **saving** raw water with RGIDECON© to life-cycle costs for **manufacturing** potable water using DESAL ECONOMICS©, to life-cycle cost results with



Emily Seawright in front of one of many tall stands of Arundo donax in Laredo, Texas, January 2009.

ArundoEcon© – although certain adjustments are needed to properly compare raw water from infrastructure rehabilitation, or invasive weed removal, with potable water obtained from desalination.

Another model developed by the team, which receives lots of use, is VIDRA© or the Valley Irrigation District Rate Analyzer. "VIDRA© is largely analogous to an income statement," said Rister, "which enables irrigation districts to analyze likely financial outcomes to changes in expenses, rates for irrigation or municipal delivery, non-operating revenues, water-delivery parameters, or a host of other items."

"While hosting some workshops on *The Value of Water*, we found out not all districts were using *full-cost accounting* to determine their delivery rates," said Sturdivant, Extension associate economist with Texas AgriLife Extension Service. "That's where the need for VIDRA© became apparent."

The area is growing rapidly and with much of the land in irrigation districts converting from agriculture to municipal land use, the clientele base for districts is changing, Lacewell said.

"So far, VIDRA© has been customized for eight districts and has increased managers' awareness of the impacts from energy-cost shocks and inflation, and has prodded them into re-thinking their business and budgeting strategies," Sturdivant said. "It really provides a focal point for managers and their boards to direct their meeting agenda."

Having the ability to objectively compare different water supply projects and make capital investment decisions will become more important over time as populations increase, input costs rise, and water supplies become relatively scarcer, Sturdivant said. "As such, sound analyses of finance and economics should be considered an extension of engineering-related tasks for capital project alternatives involved in a region's water-resource planning, or in establishing sustainable rates for irrigation districts," he said.

D. Delaunay in the Southmost Desalination Facility in Brownsville, Texas.

These are just a few of the economics team's projects over the past several years. The team continues its various efforts, and looks ahead to more projects and results in the future. For additional information on the economics team as well as publications, please search the RGBI Web site at http://riogrande.tamu.edu.

Field to fuel

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David Graham, 30 acres of fall-sown Camelina grown under center pivot irrigation were established to study yield responses under varying irrigation rates. Total water applied, including precipitation, was 2.51, 13.51, and 24.51 acre-inches. Resulting plant heights from the applications amounted to 11.4, 13.6, and 16.1 inches, respectively, at five months maturity.

Dr. Manny Encinas and assistants collect field samples from the Camelina plots. Samples will be measured for yield and oil content.

Subsequent cold weather resulted in losses ranging from 45 to 90 percent.

A second spring planting of Camelina was used to test yield from two watering schemes, dryland and 50 percent of a common forage irrigation rate. Stands from the spring planting were harvested in late August 2009 and are currently being measured and analyzed. Seed from the spring planting will be evaluated for oil content and as a substrate for biodiesel production. Results will be available by the end of the year. A project field day will be scheduled to demonstrate findings from the spring crop study.

Initial results from this study will help producers start to see where, or if, oilseed crops for biofuel have a place in their cropping plan. Additional studies, locally and nationally, will be needed, but where fuel sources can be produced using less than conventional water amounts, there is bound to be interest.

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Increasing Irrigation Efficiency in the Rio Grande Basin through Research and Education

Through education and research efforts, Texas AgriLife Research, the Texas AgriLife Extension Service and the College of Agriculture and Life Science at Texas A&M University, and counterparts at New Mexico State University Agricultural Experiment Station and Cooperative Extension Service are implementing strategies for meeting present and future water demands in the Rio Grande Basin. These strategies expand the efficient use of available water and create new water supplies. This federally funded initiative is administered by the Texas Water Resources Institute and the New Mexico State University Water Task Force with funds from the National Institute of Food and Agriculture, formerly the Cooperative State Research, Education and Extension Service.

Rio Grande Basin Initiative Outcomes
November 2009, Vol. 8, No. 2

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This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture under Agreement No. 2009-34461-19772 and Agreement No. 2009-45049-05492.