

2012 Report

W-2128: Microirrigation for Sustainable Water Use

Participants:

1. Loring, Steve (Administrative Advisor) (sloring@nmsu.edu) – NMSU
2. Bralts, Vince (bralts@purdue.edu) – Purdue University
3. Prestwich, Clarence (Clarence.prestwich@por.usda.gov) - NRCS, WNSTC
4. O’Neil, Michael (moneill@nmsu.edu) - NMSU
5. Shukla, Manoj K (Chair) (shuklamk@nmsu.edu) – NMSU
6. Fares, Ali (afares@hawaii.edu) – University of Hawaii
7. Smeal, Dan (dsmeal@nmsu.edu), NMSU
8. Schwankl, Lawrence (schwankl@uckac.edu) – UC
9. Stanley, Craig (cdstan@ufl.edu) – UFL
10. Porter, Dana (dporter@tamu.edu) – Texas AgriLife Research
11. Shock, Clinton (Clinton.shock@oregonstate.edu) – Oregon State University
12. Nandwani, Dilip (Secretary) (dnandwa@uvi.edu) – University of The Virgin Islands
13. Lamm, Freddie (flamm@ksu.edu) – KSU
14. Garcia y Garcia, Axel (Vice Chair) (axel.garcia@uwyo.edu) - University of Wyoming
15. Neibling, Howard (hneiblin@uidaho.edu) – University of Idaho

Orlando, FL, 2012

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Objectives

1. Compare irrigation scheduling technologies and develop grower-appropriate scheduling products
2. Develop design, management and maintenance recommendations
3. Develop best management practices for application of agrochemicals
4. Evaluate use of non-potable water through microirrigation

Minutes Summary

November 1, 2012

The 2012 meeting was organized at Orlando, FL. Manoj Shukla, Chair, called the meeting to order at 8.05am and welcome the participants. Dr. Steve Loring, the administrative officer welcomed the attendees and mentioned about the new proposal (2014), and nomination for multistate excellence award. He spoke about reporting needs for the meeting as per the USDA's new tweaks. There were few questions on final report and on nomination. The annual reports should include leveraging activities, especially grants for collaborations among W-2128 participants. Include impact statements, photos, etc. to promote value of this project. Dr. Loring mentioned that USDA wants to know results of this interaction in quantifiable, measurable impacts and also have new reporting system. The current project will expire Sept. 30, 2014. He suggested begin planning on writing new proposal, develop objectives and finalize new proposal by next year's meeting. The deadline for submission is January 2014.

Freddie suggested a logo for the project followed by discussion. He talked few ideas and group discussed on the logo design, color and made some suggestions. Group agreed nice to have a logo.

Craig Stanley talked about the field trip tomorrow to tropical foliage, Epcot center, Citrus growing areas and irrigation, lunch and registration fee (\$75). Participants introduced themselves.

State/Regional Presentations

Larry Schwankl (UC) led a discussion of the microirrigation maintenance website. He requested more photos, and indicated he expects the website to be available after the first of the year.

Dr. Schwankl also discussed microirrigation of blackeye peas and SDU irrigation of blueberries and blackberries in California.

Clint Shock (OSU) discussed drip irrigation of sweetpotato. Most of the work presented earlier followed by Q&A on disease problems, sub surface drip, planting, water use etc. Discussion held about rodent controls. Netafim has a chemical to repel rodents. Rodents are huge problems in alfalfa seed production.

Clarence Prestwich presented the USDA-NRCS Microirrigation Design Tool. This tool is spreadsheet-based, and can be used for design or evaluation. He mentioned that 160 practices that are eligible for financing, 16% were in microirrigation (391, 900 acres) Major portion is in California, Texas, NM, Kansas, Oklahoma and all others in Cotton, and all crops. This is available at www.irrigationtoolbox.com/ia. Brief discussion led by Freddie, Larry and others on measurement on flow variation and measurement, emitter management (emitter spacing and selection) and lateral hydraulics.

Dan Smeal (NMSU) presented an update of his work on low pressure microirrigation with harvested rainwater. Low pressure microirrigation could be useful for irrigating potential gardens by hand, so looking into drip irrigation to irrigate vegetable or landscape gardens from rainwater catchment. He talked about the problem, the head provided by the elevated water vessels is lower than the specific drip manufacturers, tried 20 different emitters or tested, elevated tanks, water application uniformity. Half of the 20 point source emitters evaluated exhibited WAUs > 0.90 at both 1.7m and 17.6m of head under conditions of this study. Potential use of microirrigation in soil reclamation.

Manoj Shukla (NMSU) presented his work on partial root zone drying strategies in pecan irrigation. He also presented results on transpiration rates, soil temperature, root length, plant height. Discussion held on transpiration rates, shallow root depth and water save (30%) in chili pepper plant. Larry and Freddie commented about 100% and 70% water use. Report concluded no significant differences were noted in the RLD between PRD treatments and control.

Mick O'Neal (NMSU) presented an update on his work in microirrigation of hybrid poplars done in Farmington in 2007. He discussed poplar trial using surface drip irrigation and reported problems with chlorosis and nitrogen availability. He talked about four water applications in poplar clones and presented data on BDH and height from 2007-2011, water use efficiency and Q&A follows on 100% ET.

Ali Fares (UH) presented his report on irrigation water requirements for some major crops in response to potential climate change scenarios. Predict water requirement in major crops in potential climate change. He also presented model IMANYSYS database for data presentation on crops, irrigation, soil, water loss etc. He also presented ArcMap. Scenarios were simulated using IManSys for 27 year after adjusting precipitation, soil evapotranspiration. Discussion held on water management in crops presented through the models. In summary, total 25 scenarios were generated based on IPCC AR4 projections under current, B1, A1B1 and crop model to estimate crop yield for irrigation scenarios analysis of optimal crop choice to adopt climate change.

November 2, 2012: Field trip

Trip guided by Craig Stanley, UFL. The whole day was dedicated to field trip. The morning trip included a visit to the Mercer Botanicals (9.15am). Wayne Mercer talked about the foliage industry in FL. Established in 1987, successfully running drip irrigation to ornamentals in greenhouses. He provided some details on sensors, prototypes. Craig and Axel asked questions about any problems/issues in irrigation. He answered growers create problems for themselves

due to proper knowledge and expertise in pH, light, root problems, too much irrigation etc. Irrigation depends on pot sizes, tissue culture liners, seeds comes from Mexico, cuttings from Guatemala and Costa Rica. USDA regulations are strict and need import permit.

Next stop was Jain Irrigation Inc. at Haines City. Jain Irrigation is a manufacturer of drip irrigation products for the agricultural, turf, greenhouse, nursery, industrial and landscape markets and offering the widest selection of micro-irrigation products including emission devices, continuous flow path drip tape, discrete emitter drip tape, integral emitterline, fittings, filters, air vents, injectors, accessories and tubing. The facility in FL established in 1960's and current facility is 12 yr. old and manufactures main line and automated packaging of drip line.

Participants had lunch and then visited Water Conserv II district, the largest reuse project of its kind in the world, combining agricultural irrigation with aquifer recharge via rapid infiltration basins (RIBs). This is an example of engineering ingenuity, creativity, and state-of-the-art technology of cooperative water reuse which irrigates up to 2,737 acres of citrus annually. The primary focus is agricultural irrigation for City of Orlando and Orange County. The RIBs are used for recharge of Florida's primary drinking water source, the Floridan aquifer, with daily flows that are not needed for irrigation and excess flows during wet weather periods. Water Conserv II is also the first reuse project in Florida permitted by the Florida Department of Environmental Protection (FDEP) to irrigate crops produced for human consumption with reclaimed water. The project's reclaimed water meets FDEP's public access reuse standards and is permitted for use on all public access sites including residences and golf courses, food crops, foliage and landscape nurseries, tree farms, pasture land, the production of soil cement, and can also be used for fire protection.

Last stop we made at Disney's EPCOT and toured aquaponics, hydroponics, aeroponics, IPM laboratory and greenhouses. Over 175 kinds of fruits and vegetables are grown in controlled environment and hydroponically such as banana, dragon fruit, miracle berry, melon, pumpkin etc. Some featuring a latticed weigh support above the plant, include eggplant, potato, and tomato. A tomato plant currently holds the world record in annual yield, producing 32,192 fruit from the same plant in a period of one year. Herbs and greens were grown in NFT (Nutrient Film Technique), where precise measurements of nutrients the plants need are recirculated in very shallow waters. Herbs can be seen grown vertically via a drip method. All produce are shipped directly to Disney EPCOT's restaurants. Epcot offers student internship opportunities every year in the area of entomology, biotechnology, aquaponics and greenhouse technology.

November 3, 2012

Freddie Lamm (KSU) presented results from his work in corn irrigation, matching SDI irrigation capacity with nitrogen applications. He discussed N application in corn yield in 2010 and 2012 growing seasons and concluded that Kernels/ear was considerably higher in the normal year than was previous year. Timing of N fertigation, conjunctive management of both irrigation and in season N fertigation are important for corn production with SDI.

Dana Porter (Texas A&M) discussed education/outreach efforts, programs and products for traditional and emerging agricultural irrigation audiences. She presented no significant differences in yield or lint value. Presented second study on `Subsurface drip irrigation pre-pant

irrigation timing effects on germination and cotton yield (Halfway/Helms farm)’. Cotton response to irrigation level as affected by field topography using subsurface drip irrigation (SDI Halfway/Helms Farm). Brief discussion by Larry and Clint on small amount of water. Another study she presented on Farm scale yield comparisons of subsurface drip irrigation.

Howard Neibling (Idaho) discussed comparisons of alternate furrow surface drip irrigation and sprinkler irrigation of corn. He used time-lapse photography to document crop response.

Dilip Nandwani (UVI) discussed his work in microirrigation of vegetables. He presented cultivar evaluations in tomatoes, cucumbers, hot and sweet peppers using drip irrigation. Drip irrigation has been very beneficial for the farming community and in vegetable production in the US Virgin Islands.

Business Meeting

Manoj brought a motion for Minutes of 2011 report. Minutes approved unanimously.

Discussion on next steps for the regional project group held on next proposal. Suggestions for topics (subject matter) and comments included, project must be on microirrigation, Education/Technology Transfer, Microirrigation to mitigate effects of limited irrigation capacities, Economic analyses, Microirrigation of corn SDI with lagoon effluent, Microclimate effects of microirrigation, Small-scale irrigation (related to USAID RFP; applications in subsistence farming systems), SDI of poplars, Small scale irrigation is important globally, Irrigation X nutrient management, Integrating scheduling to optimize irrigation, Irrigation scheduling with sensor technologies, Microirrigation strategies to deal with nutrient management issues (dairies, etc.), Drip irrigation of vegetables – gravity-based, low-pressure, low-input, Scale X irrigation, Aquaponics – aquaculture, drip irrigation, Urban landscape irrigation (dealing with limited water), Emitter performance under low head, Irrigation scheduling with low flow rates, Low irrigation rates for native plant seed production, Native species establishment, Nitrogen/fertigation practices with SDI in sweetpotato, Root water uptake; salinity issues; pot and field studies, Why (why not) do producers adopt microirrigation?, SDI and precision farming, Optimizing nutrient management (applications in organic ag), Water use and water use efficiency with SDI; irrigation scheduling, BMPs – microirrigation as a nutrient management practice, Applications in High Tunnels, Salinity issues with microirrigation etc. Freddie Lamm will provide leadership in coordinating the proposal, with assistance from “Objective” leaders.

Election of officers held: Chair- Axel Garcia; Vice-Chair- Dilip Nandwani; Secretary- Ken Shackel.

Manoj opened the floor for discussion on the upcoming meeting location. There were few locations Wyoming, Nevada, Virgin Islands and Colorado suggested. Dilip, upcoming vice-chair, talked about the pros and cons of holding the 2013 meeting in the Virgin Islands, including the cost of airfare, and limitation for the technical/field trip. Denver, CO was proposed and approved for 2013 meeting location, considering central place and convenient to the attendees.

The tentative date for the 2013 meeting was proposed November 19-21, 2013 in the Denver, CO.

Accomplishments

Objective 1: Compare irrigation scheduling technologies and develop grower-appropriate scheduling products.

California

A commercial in-situ psychrometer for automated, in-situ measurement of plant stress (stem water potential, SWP) was evaluated in almond and grape under field conditions and corn under laboratory conditions. This technology is promising, but there have been occasions of both good and poor agreement between the psychrometer and the pressure chamber, and additional work will be needed to identify the sources of errors.

Iowa

In Iowa, an improved method for interpolating soil moisture data was also developed (but not yet fully tested or validated) to generate a high-resolution soil moisture map from low-resolution observed data from sources like in situ sensors or satellite imagery. Using sparse point-based spatial data, we were able to create a highly detailed map that captures more of the true spatial pattern of soil moisture than traditional spatial interpolation techniques such as inverse distance weighting. The improved approach uses characteristic similarity rather than spatial proximity to weight observed data in the interpolation. In this way, areas that have similar topography and soil characteristics to observed sampling locations are mapped similarly, regardless of how far apart they are in the field.

New York

Calculation and Delivery of Improved Apple Irrigation Needs (NY-G) – We recently developed an apple-specific Penman-Monteith (P-M) equation to provide locally-validated estimates of water use for irrigation scheduling for the Northeast climate. The apple P-M model has been programmed into the daily calculations of the Northeast Climate Center at Cornell University to provide daily crop basal ET based on weather inputs from stations in apple-growing regions of NY. Commercial use has begun in 2012. Comparison tests are underway in commercial orchards between grower standard method (based primarily on observation and experience) and the new P-M output.

Development of a microfluidics-based microsensor for continuous monitoring of soil and plant water potential – To allow continuous monitoring of plant water stress, we have continued the development and testing of a microtensiometer (final size about 2x5 mm) that is basically the same principle as current soil tensiometers. It is based on microfluidics (liquid volume about 10 microliters) and nanofabrication of an exchange surface and a pressure transducer. It is designed to embed in the trunk of perennial plants to directly measure stem water potential and as a sensor in a soil tensiometer. The sensor has the primary advantages of very large range, easy continuous recording and low cost due to silicon wafer micromanufacturing (probably about \$5 per sensor) to allow for many sensors, needed in variable soil conditions. Prototypes have been built and tested successfully to -35 bars in lab tests. Application-specific packaging (form, protection, power, data logging) is being developed. Thresholds for grapevine irrigation based on the relationships between vine stem water potentials and shoot growth and berry development in grapes have been developed. Shoot growth rate was

found to be inhibited by about 70% before leaf photosynthesis was reduced, allowing for irrigation thresholds to regulate vine growth and function. Relationships between vine water relations and grape flavors are being investigated.

Oregon

Due to commercial interest in the manufacturing sweet potato fries, sweet potatoes were grown with various drip irrigation SWT criteria (40, 60, 80, and 100 kPa) were for potato yield and grade. Sweet potato yield and grade data was highest at 40 kPa. Since yield and grade continued to increase to the wettest criteria, an irrigation criteria of 25 kPa was added in 2012.

Corn lily (*Veratrum californicum*) was grown with automated drip irrigation at soil water tension (SWT) irrigation criteria of 5, 10, 20, and 30 with 4 replicates at each of two locations at 2,150 and 4,900 feet elevation in Ontario, OR and McCall, ID, respectively. Results show that irrigation at 5-10 kPa provides reasonable growth but water use efficiency at 5 kPa was very low.

Irrigation criteria was being examined for seed production of 20 native perennial plant species that the US Forest Service and BLM have determined would be highly desirable for rangeland restoration. Each species was being grown in a semi-arid environment at Ontario, OR using subsurface drip irrigation in replicated plots with three irrigation treatments (0, 100, and 200 mm/yr total irrigation) repeated over years. Species requirements for optimal seed yield differed tremendously between species from 0 to 200 mm. None of the species needed more than 200 mm to optimize seed yield. In years of considerably above average rainfall (more than 300 mm) fewer species responded positively to irrigation.

The interaction of onion population by irrigation system demonstrated that onion yield and grade varied with population, but did not vary in 2011 by irrigation system.

The performance of soil moisture sensors for irrigation scheduling instruments were compared in a very sandy soil in McCall, ID. Sensor performance is being measured through wetting and drying cycles at different temperatures. Instruments being compared include tensiometers, granular matrix sensors (GMS), hybrid sensors, thermocouple psychrometer readings, and capacitance probes.

Results of A-D above were communicated to growers by means of field days, workshops, grower meetings, written, and “on line” reports.

Texas

Evapotranspiration-based irrigation scheduling tools have been developed through USDA-ARS Ogallala Aquifer Program funded projects. The Texas High Plains Evapotranspiration Network team secured funding to extend information delivery and related educational programs through August 2014. These programs support ET-based irrigation scheduling and regional water planning efforts throughout the Texas High Plains (Panhandle, South Plains and Rolling Plains).

USVI

In US Virgin Islands, work initiated on vegetable production using drip irrigation and fertigation. Tomatoes, cucumbers, hot and sweet peppers were grown using 8 or 10ml low flow drip tape.

One crop of each vegetable was planted, four varieties of tomato, twenty varieties of hot and sweet peppers evaluated using drip irrigation. In cucumber one variety (Eureka) was evaluated in varying rates of irrigation on the yield and growth. Water needs by using drip irrigation and fertigation in vegetables continued. A poster was presented at the Caribbean Food Crop Society Annual meeting in Cancun, Mexico.

Wyoming

Three alfalfa cultivars for hay production are being grown on a sub-surface drip irrigated field using four irrigation strategies: 25, 50, 75, and 100 percent of ET with four replicates. The experiment is conducted at the University of Wyoming Research & Extension Center in Powell, WY, which is located at an elevation of 4,370 ft. Irrigation amounts are estimated using the ETo x Kc approach. Soil water depletion is monitored with a neutron probe every 8 inches to a depth of 40 inches. Watermarks for irrigation scheduling were installed at depths of 12, 18, 24, and 36 inches. Preliminary results show that Watermarks at the depth of 18 inches provide good indication as potential tools for irrigation scheduling for conditions of limiting and non-limiting water supply. Further steps (2013 growing season) include to set up irrigation scheduling criteria based on different soil water tensions at the depth of 18 inches. Our results are being communicated to producers through field days, field day bulletins, and grower meetings.

A corn experiment is being conducted on sub-surface and on-surface drip irrigated fields. Canopy temperature using infra-red thermometers is monitored at different irrigations strategies. Soil moisture depletion is monitored with a neutron probe to a depth of 50 inches. Our results show that canopy temperature is a promising tool for irrigation scheduling. Preliminary results were presented at the 2012 ASABE meeting and a technical paper was published.

Objective 2: Develop design, management and maintenance recommendations

California

A website is being developed to assist growers and professionals deal with maintenance of microirrigation systems. This web site is a joint effort of L. Schwankl of California, F. Lamm of Kansas, and D. Porter of Texas. Schwankl is taking the lead.

The Maintenance of Microirrigation Systems website will be an immediate benefit to those using and involved with microirrigation systems. Microirrigation users will be able to use the website to predict clogging problems, evaluate their microirrigation systems for clogging, and find solutions to clogging problems.

Maintenance of Microirrigation Systems website: <http://ucanr.edu/sites/Microirrigation/>. Currently web site is password protected while final changes are made to it.

In addition to developing the microirrigation maintenance website, the PI made 10 presentations related to microirrigation, contacting approximately 450 growers and professionals, we given.

Idaho

A subsurface drip irrigation (SDI) system was installed in a center pivot corner in May, 2012 using support from a USDA-NRCS Conservation Innovation Grant to determine the suitability of SDI for corn silage production under Idaho soil, climate, and harvest conditions. Three drip tape

depths and 2 tape spacings were installed. First year drip-irrigated corn silage yield exceeded the farm center pivot average while eliminating surface runoff that was present under most of the farm pivots. System performance and crop yield and quality will be measured for at least 3 years and the system will serve as a demonstration site for this technology.

Texas

A manual, "Irrigation for Small Farms," and supporting presentations (curriculum package) were developed to provide irrigation educational support for small acreage landowners. These materials were developed as deliverables for a Texas Water Development Board Agricultural Water Conservation Program sponsored project, "Youth Education on Rainwater Harvesting and Agricultural Irrigation Training for Small Acreage Land Owners." The manual and subsequent support fact sheets will be published with funding support from the USDA-ARS Ogallala Aquifer Program. The curriculum materials have been used to conduct three workshops, and portions have been used in various Extension educational meetings.

Objective 3: Develop best management practices for application of agrochemicals

California

A field study is conducted in an almond orchard at Paramount Farms, CA. The main objective of this project is to develop optimal irrigation and fertigation practices for micro-irrigation (drip and micro-sprinkler) systems for almond using HYDRUS, to improve water and nutrient use efficiencies, and to reduce leaching and gaseous losses of nitrates, using a wide range of possible management scenarios (water, fertigation, salinity). For that purpose, extensive field data are collected, such as soil hydraulic and textural properties with soil layering, monitoring of soil moisture and soil water potential, soil temperature and nitrate solution concentration for selected treatments, in addition to data already being collected as part of a larger nutrient management project.

A conceptual modeling framework was developed to assist in the design and management of subsurface drip irrigation systems for alfalfa that maximize yield, while minimizing deep percolation water losses to groundwater. Our approach combines numerical modeling using HYDRUS-2D with a nonlinear optimization technique. The HYDRUS-2D model was used to simulate spatial and temporal distributions of soil moisture content, root water uptake, and deep drainage in response to drip-line installation depth and distance, emitter discharge, irrigation duration and frequency, while the optimization algorithm explores tradeoffs between water application, irrigation system parameters, and crop transpiration, to evaluate best management practices for subsurface drip irrigation systems in alfalfa.

A soil moisture sensor installation device was designed, developed and tested, allowing sensor installation at depths below 1 m, using a hand-operated horizontal jack, in conjunction with a miniature camera to monitor installation progress. The sensor installer was part of Decagon's booth during the 2012 AGU meeting in San Francisco, and is considered for commercialization.

The University of California Center for Water Resources appointed a workgroup (J. Letey, UC Riverside, Chair) to review the development of steady-state analyses and transient-state models, and to determine whether the current recommended guidelines for leaching requirement based on

steady-state analyses need to be revised. The workgroup concluded that the present guidelines overestimate the leaching requirement and the negative consequences of irrigating with saline waters, especially at low leaching fractions.

New Mexico

Comparative effects of the compensated (under water stress conditions using drip-irrigated partial root zone drying (PRD) techniques) and non-compensated (no water stress) root water uptake pattern were evaluated for chile plants (NuMex *Joe Parker*; *Capsicum annuum*). Results suggest that chile plants under these two drip-irrigated PRD treatments could compensate for water stress in one part of the vertical or lateral root zone profile by taking up water from less water-stressed parts of the vertical or lateral root zone regions, without affecting transpiration or photosynthetic rates to meet peak water demand. No significant differences were noted in the root length distributions and plant heights between PRD treatments and control. Either of the two drip-irrigated PRD techniques have a great potential to be adopted as water saving practices in chile production especially for environments with limited water.

Texas

Research-based recommendations have been developed for fertility management of subsurface drip irrigated cotton in the Texas Southern High Plains. These recommendations have been extrapolated to address inquiries regarding fertigation/chemigation through other microirrigation systems and crops. Additional information will be assembled to develop and expand recommendations for additional crops and conditions.

Objective 4: Evaluate use of non-potable water through microirrigation

New Mexico

Pecan roots were planted in pots during 2008-2010 and were drip irrigated with solutions of EC of 1.5, 3, 5.5, and 7.5 dS/m. The project aimed to evaluate the effects of different salinity levels on physiological properties of Pecan roots including bud break, canopy development, nitrogen and chloride uptake and salt tolerance. A lab test on scorched leaves did not detect the presence of bacteria (*Xylella fastidiosa*) responsible for Pecan Bacterial leaf spot, therefore, it was confirmed that the leaf scorching was only due to salt stress imposed on plants. No leaves were observed in the second year plants irrigated with water of salinity $>5 \text{ dS m}^{-1}$. The plants became stunted with decreasing stem diameter and nitrogen and chloride uptake increased with increasing salinity of irrigation water.

Impact Statements:

1. In California, It is tentatively concluded that (a) micro-irrigation leaching rates are largely controlled by irrigation type and soil heterogeneity (texture, layering), with irrigation frequency and applied water being the same, and (b) tensiometers are the critical sensors in monitoring leaching rates. Regarding the latter, a new tensiometer design is being developed for real-time 24/7 soil water potential monitoring at depths below the rooting zone.
2. As part of an ongoing Almond Board of California irrigation sustainability project, a survey of 198 almond growers representing 36,000 acres, indicates that 38% of almond growers now

use the pressure chamber and midday stem water potential (SWP) to manage irrigation, comparable to the 43% of growers using real-time ET. This represents a major impact on industry practice. There has also been a markedly increasing rate of use of the term “stem water potential” in the scientific literature, reaching a cumulative value of about 170 in 2010. This also represents a major shift in academic interest in this method.

3. In Idaho, Crop yields were 33 T/ac for the 30-inch tape spacing and 27 T/ac for the 44 inch spacing. Farm-average yield this year was about 32 T/ac. Recent average yield for the farm is about 28 T/ac under center pivot irrigation. The yield with SDI was more remarkable than the raw numbers suggest because the SDI area was planted about 3 weeks later than the other fields of corn. The adjacent pivot corn was about 6 inches tall at the time of planting on the SDI area. Initial measurements indicated some reduction in tape flow on drip lines installed at the 6 inch depth, but the more relevant indicator is flow next spring after a winter of soil free/thaw conditions. Damage from rodents was present but appears to be at a manageable level.
4. If SDI can be shown to be a cost-effective irrigation system for corn production on center pivot corners, it will provide additional conveniently-located acres to help meet demand for corn silage while minimizing labor, energy use, and water use on the SDI area. It will also protect surface and ground water as well or better than any other irrigation system.
5. In Iowa, using only several sensors in judiciously selected locations, we can provide more detailed maps of soil moisture content. While we have not tested the impacts of improved data mapping on irrigation, we believe that our approach will improve irrigation efficiency through two means: enabling precision irrigation while minimizing the number of sensors necessary, and by providing an improved estimate of field average for uniform irrigation applications.
6. In New Mexico, the experimental results showed that partial rootzone drying technique has the potential to be adopted as water saving technique in chile production system in NM. The bud break in Pecan roots, development and survival of young Pecan trees is sensitive to the soil salinity.
Funding sources
 - A. USDA specialty crop initiative
 - B. VPR NMSU GREG grant
 - C. USDA Hatch grant
7. In New York, direct measurements of apple and grape basal ET and magnitude of water stress in the cool humid climate of NY has provided NY growers with general guidelines for irrigation. The new model ET model for apples has been incorporated into an automated online system for NY growers to optimize irrigation.
8. In Oregon, irrigation scheduling by soil water tension allows growers to use water more precisely. Calibration of soil moisture instruments promotes improved irrigation scheduling with greater precision and confidence. Crop yields have increased and water is being conserved. Groundwater nitrate contamination has decreased.

9. Better use of irrigation systems and irrigation criteria for onions are increasing onion yields and reducing environmental consequences of onion irrigation. Drip irrigation is used locally on 42 percent of the acres and accounts for approximately 50 percent of local production. Combining drip irrigation with careful irrigation scheduling reduces the negative environmental consequences of onion production: water and nutrient applications are very close to the actual needs of onion and nitrate does not leach to groundwater. Groundwater water quality is improving in Oregon over the entire onion production region of the Treasure Valley.

Funding sources

- A. Sweet potato research was supported by industry and foundation grants for \$25,000 for 2012.
 - B. Corn lily research was supported by the pharmaceutical industry by \$250,000 for 2012.
 - C. Wildflower seed production research was supported with \$40,000 from the US Forest Service and BLM.
 - D. Onion irrigation system and plant population was supported by \$5,000 from the onion growers.
 - E. Information transfer was supported the Oregon Watershed Enhancement Board as a component of a much larger watershed education project at over \$30,000.
10. In Texas, surveys of participants in irrigation workshops for dairy producers and small acreage landowners indicated very favorable response to the educational quality and content of the events. Overall increases in knowledge (by category/topic) were indicated in survey responder self-assessment indicators. Surveys also indicated high percentages of intent to adopt efficient irrigation technologies and best management practices addressed in the curriculum and workshop events. Respondents indicated increased knowledge in crop water requirements (86%); soil moisture characteristics and management (86%); irrigation technologies BMPs and water use efficiency (100%); applicability of irrigation technologies and BMPs to individual operations (90%); water quality issues and management (81%); and information resources available (76%). All respondents (100%) indicated the information presented in the workshop would be helpful in their irrigation decisions, and 81% indicated they would make changes as a result of what they learned in the workshops. Most indicated intent to adopt featured technologies and practices, including irrigation scheduling based upon crop water requirements or soil moisture management (75%); microirrigation (52%); BMPs to improve efficiency (75%); and BMPs to prevent contamination of water resources (75%).
11. In USVI, drip irrigation has been very beneficial for the farming community and our variety trials of vegetables. The use of drip irrigation is a great asset when it comes time for the application of fertilizers.
12. In Wyoming, irrigation scheduling allows for a more efficient use of water. Irrigation scheduling based on soil water tension seems to be a viable strategy for alfalfa producers to use water more precisely.

13. With advances on the development of infrared thermometers, canopy temperature is becoming a promising tool for irrigation scheduling. The technology has potential to be used in near-real time; this prospect is encouraging but further research is still needed.

Publications

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