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Annual Report for FY22

Sustaining rural communities through new water management technologies

Progress Report

The Ogallala Aquifer Program (OAP) is a research and education consortium seeking solutions to problems arising from declining water availability from the Ogallala Aquifer on the Southern High Plains. The consortium includes Kansas State University, Texas A&M AgriLife Research and Extension Service, Texas Tech University, West Texas A&M University, and the USDA ARS NP211 research projects at Bushland and Lubbock, TX. OAP funding is from the USDA ARS at Bushland, and OAP management is led by ARS at Bushland with cooperation of a management team composed of the principle investigators for the funding agreements with the four universities.

University and ARS collaborators in the OAP produced 20 publications in FY22 and in prior years that were not reported previously. These are listed in the publications for this research project. These publications support the five substantive accomplishments reported here.

Accomplishments

Infrared thermometers on center pivots or stationary in the field yielded comparable results that were different from those from a drone. Freshwater available for irrigation is decreasing, especially in regions where water for irrigation is from aquifers with limited recharge like the Ogallala; therefore, there is a need to maximize the efficient use of irrigation water. There is growing interest in using feedback from sensors that monitor crop canopy temperature to aid irrigation scheduling, primarily via the use of infrared thermometers (IRTs). However, sensors located on a moving center pivot irrigation system are not widely practiced and there is some skepticism about the practicality of ground-based sensor platforms relative to satellite or aerial platforms. Researchers at ARS Bushland, Texas, and the University of Nebraska compared measurements of canopy temperature from IRTs mounted on the sprinkler lateral with measurements from IRTs that were stationary in the field, and with measurements from a thermal camera mounted on an unmanned aerial system (UAS). Results showed that canopy temperature measurements from the IRTs mounted on the sprinkler lateral were similar to those from stationary IRTs in the field. Canopy temperature measurements from the UAS disagreed with those from the IRTs by approximately 7 F. These results should instill confidence in researchers and others to utilize a moving sprinkler system as a platform for IRTs for the purpose of monitoring crop canopy temperature and bring into question the use of IRTs mounted on drones.

Corn growing on the Texas High Plains gets the vast majority of its water from the top 2.5 feet of soil. Producers often experience sizable yield losses in corn because irrigation cannot meet demand. This has become a common occurrence in the semiarid Texas High Plains where irrigation supply from the Ogallala Aquifer is in decline. Drought tolerant corn hybrids may reduce yield losses during periods of water stress by using soil water so that it is more available during sensitive growth periods. However, little is known from where in the soil profile do these drought tolerant corn hybrids take up their water. Therefore, scientists from ARS (Bushland, Texas) and Texas A&M AgriLife studied the effects of irrigation level and planting rate on soil water use by three maize hybrids, two of which were considered drought tolerant. Only 4% of the seasonal water use of the crop was extracted below a soil depth of 2.6 feet. Water use during the growing season did not differ among hybrids. Two conclusions were: 1) irrigation on the Texas High Plains needs to be managed to prevent significant accumulation of soil moisture below 2.6 feet; 2) development of corn hybrids that extract water from deeper in the soil profile may promote drought tolerance or avoidance.

New equations for predicting soil water holding capacity from soil organic content. There are growing concerns that as climate changes, the frequency of drought in many areas of the world may increase. The impact of drought can be decreased by increasing the water holding capacity of soils. Some studies suggest that water holding capacity (WHC) can be increased substantially by increasing soil organic carbon (SOC), but more data are needed to support this conclusion. ARS scientists from multiple locations and scientists from the Soil Health Institute's North America Project to Evaluate Soil Health Measurements participated in a project to relate changes in SOC to the measured soil water content. New functions improved WHC predictions over previous functions and showed that WHC increased as SOC increased, averaging 3% increase in WHC for every 1% increase in SOC across all soil texture classes. These new functions may help incentivize adoption of management practices that increase SOC and build drought resilience.

Use of a water allocation framework boosts crop water productivity and net returns. Reduced water availability for agriculture and increased energy costs make it necessary to improve crop water productivity, which is the economic yield per unit of water consumed. Under water-scarce conditions, crop water requirements often cannot be met throughout the growing season, which can occur frequently in semi-arid regions like the Texas High Plains and interior of Spain. Scientists from ARS (Bushland, Texas), Texas A&M AgriLife Research, and University of Castilla La Mancha (Spain) developed a strategy to allocate a limited volume irrigation water to one or more crops to maximize crop water productivity, not necessarily crop yields. The researchers reported on studies to maximum crop productivity for garlic production in Spain and for corn and cotton production on the Texas High Plains. Crop water productivity was greatest when the volume of water applied was approximately 70% of full irrigation. Concentrating irrigation water tended to support greater crop water productivity and thus higher returns. These results demonstrate the benefits of this framework by which water resources can be allocated to different crops to maximize returns from applied irrigation water, and thus, are of interest to stakeholders in other areas facing water scarcity issues, including the Texas High Plains.

Zebra chip infected potatoes use irrigation water poorly. Zebra chip (ZC) virus is a relatively new disease that has a devastating impact on potato production in the western United States, including the Southern High Plains. Reduction in tuber yield and crop water productivity have gone unreported and it is unknown if irrigation level influences disease severity. In a two-year study, ARS (Bushland, Texas) and Texas A&M AgriLife scientists investigated the effects of three irrigation levels on ZC diseased plants and non-diseased potato plants by comparing tuber yield, seasonal crop water use, crop water productivity (CWP), and irrigation water use efficiency. It was determined that ZC disease significantly reduced tuber yield and CWP by 20-55% depending on the year. Irrigation level did not lessen disease severity. This information indicates that once areas of ZC diseased potatoes are detected within in a field, irrigations should be withheld over these areas to prevent water wastage.

Publications

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