Ogallala Aquifer
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Project Plan from FY2016
(Fiscal Years 2016-2017)

Research Priority Area: Letter code 16SubObj1

Title
Quantification of Water and Nutrient Use by Invasive Weed Species in Limited Irrigated Production Systems to Optimize Water Use Efficiencies and Economic Returns

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Summary
In the Southern Ogallala Aquifer region, irrigated crop production is transitioning from irrigation scheduled to maximize crop production at 100% of the crop water demand to limited irrigation at less than 100% of the crop water demand as well as to dryland production. As production potentials decline with decreased irrigation, production inputs such as herbicides are reassessed in order to maximize net returns. Because intensive herbicide programs can cost producers more than $100 per acre per cropping season, under limited irrigation and dryland production, producers often minimize herbicide expenses by using lower application rates, generic herbicides, and relying on standard triazine and growth regulator chemistries. However, under heavy weed pressure, water and nutrient resources are partitioned by weed species resulting in reduced crop leaf area, photosynthetic activity and economic yield further reducing the potential net return. We propose to evaluate the resource allocation of different weed species and the economic threshold of intensive herbicide programs to optimize weed control, crop production, water use efficiencies and net return in water limited production systems.

Project Narrative

a. Objectives
The objective of the proposed research is to quantify resource allocation (water, nutrients and light) in limited irrigated corn and grain sorghum under various pre-plant, pre-emergent and post-emergent herbicide treatments to quantify the economic threshold of strategic herbicide programs in a water limited region to optimize crop water use efficiencies and economic returns.

b. Rationale/Literature Review/Conceptual Framework
With declining well capacities across the Southern Ogallala Aquifer region, stored soil moisture is critical under irrigated production to meet the crop water demand at critical

growth stages and optimize crop production. Invasive weed species are more competitive than agricultural crops during early vegetative development. For example, the number of rows per corn ear is determined between V5 to V6 in corn, and in grain sorghum, the number of seeds per panicle is determined at growing point differentiation (7- to 10-leaf sorghum). Consequently, resource acquisition including water, nutrients and light by invasive weeds at early developmental stages can significantly affect the final yield potential and economic return. There has been significant research in the Southern Ogallala Aquifer region evaluating management strategies to improve crop water use efficiencies under both irrigated and dryland production systems in addition to herbicide trials evaluating the correlation between weed control and yield loss; however, resource utilization by weed species has not been quantified. Research in the corn producing regions of the Midwest has revealed that the economic threshold for crop production associated with weed competition varies by weed species, region and the environment (Linquist et al., 1999; Sadeghi et al., 2007). As well capacities in the Southern Ogallala Aquifer region continue to decline, it is critical that management strategies also include herbicide management that is optimized to maximize crop water use efficiencies. Weed pressure increases the spatial variability in crop production, but this can be mitigated by site-specific herbicide applications. As improvements in precision agriculture are continually made, the spatial variability in stored soil water and nutrient uptake associated with weed pressure often negate the benefit of precision technologies to improve crop water and nutrient use efficiencies. Well managed herbicide programs minimize the spatial variability associated with weed pressure enhancing crop productivity and water use efficiencies.

Generic growth regulator and triazine herbicide chemistries are often cost effective. However, production issues have been associated with these chemistries including documented resistance to triazine and growth regulator chemistries as well as crop injury associated with the off-site drift of growth regulator herbicides. Although more intensive herbicide chemistries are proven to be effective options due to fewer herbicide resistant weed species and reduced herbicide injury associated with off-site drift, they can be cost prohibitive under dryland and limited irrigated production. However, in many cases, the yield losses associated with resource acquisition by weed species can often justify a more rigorous herbicide program to minimize economic losses and reductions in crop water use efficiencies. An assessment of the economic threshold of intensive herbicide programs would provide producers a valuable resource for making herbicide purchasing and application decisions.

c. Plan of Work/How will the objectives be met

Field experiments will be conducted at the Texas A&M AgriLife, James Bush Research Farm at Bushland, TX. Experimental plots will be established in both corn and grain sorghum irrigated at 50% evapotranspiration (ET) as determined by the soil water balance in a replicated, randomized complete block design. Experimental plots will be pre-seeded with weeds in order to ensure uniform evaluation of resource allocation by weed species. Planted weed plots will include Redroot Pigweed (*Amaranthus retroflexus*), Tumble pigweed (*Amaranthus albus*), Kochia (*Kochia scoparia*), Russian Thistle (*Salsola kali*), Morning Glory (*Ipomoea sp.*), and Barnyard Grass (*Echinochloa crus-galli*).

Various herbicides will be evaluated according to the herbicide label and compared to an un-treated check. These include basic triazine and growth regulator herbicides in addition to more intensive herbicide protocols including Acetochlor, Bromoxynil, Clopyralid, Fluthiacet-methyl, Glyphosate, Isoxaflutole, Mesotrione, Nicosulfuron, Pyroxasulfone, and Pyroxtopramezone. To quantify changes in crop water use and schedule irrigations, soil water contents will be evaluated weekly with the neutron probe at depths from 0- to 230-cm. Soil fertility will be evaluated at planting and harvest. Biomass and leaf area index will be measured by destructive sampling in both weed and crop stands. Final yield will be determined with hand samples and combine harvest. Yield components (grain number and mass) will be determined. Microlysimeters will be used to partition soil evaporation and plant transpiration to determine crop water use of the primary crop and individual weed species. Following harvest, crop and weed samples will be analyzed for nutrient composition (nitrogen and phosphorus). Partial budget analysis will be utilized to evaluate results. Sensitivity analysis will then be conducted on commodity prices, yields and control costs to estimate economic thresholds for weed control.

Schedule of Proposed Work

Spring 2017: Plant weed seed and prepare for summer plots

Summer 2017: Summer field work including: planting, establish herbicide plots, monitor crop water use for changes in soil water dynamics and seasonal irrigation scheduling, partition evaporation and transpiration using microlysimeters, quantify weed pressure in the all plots using plant transects.

Fall 2017: Harvest and process samples

Winter 2017: Compile data analyses and final reports.

Spring 2018: Plant weed seed and prepare for summer plots

Summer 2018: Summer field work including: planting, establish herbicide plots, monitor crop water use for changes in soil water dynamics and seasonal irrigation scheduling, partition evaporation and transpiration using microlysimeters, quantify weed pressure in the all plots using plant transects.

Fall 2018: Harvest and process samples

Winter 2018: Compile raw data analyses, conduct economic analysis, prepare final reports and publications

Expected Outcomes including Publications, Economic Assessment and Technology Transfer

Results from this study will provide an economic analysis of herbicide programs positioned corn and sorghum for the Southern Ogallala Aquifer region. This analysis will provide producers an economic threshold to optimize herbicide purchasing and application decisions. Results will be available for Texas A&M AgriLife Extension programs. Data will be complied and submitted to both scientific journals and Texas A&M AgriLife Extension publications. Results will also be disseminated through AgriLife Today. This study will serve as a thesis project for a Master’s student at West Texas A&M University.

Relevant Publications

Bell, J., Q. Xue, P. Sirmon and T. Brown. 2014. Texas Panhandle Weed Control Report. Texas A&M AgriLife Research Publication.

Brandon, R.E., **Q. Xue**, B.W. Bean, B.C. Plainerrock, C. Blaser, and **J.Bell**. 2016. Palmer amaranth (Amaranthus palmeri) control and grain sorghum 1 (Sorghum bicolor) 2 injury with pyrasulfotole plus bromoxynil and tank mixtures. Crop Forage and Turf Grass Management. *In press*

Stougaard, R.N., **Q. Xue**, and L. Strang. 2008. Annual Report of the Nortwestern Agricultural Research Center. Montana Agricultural Experiment Station, Montana State University. http://agresearch.montana.edu/nwarc/reports-pdf/NWARC2008Report.pdf

Literature Cited

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Sadeghi, A.M., J.L. Starr, J.R. Teasdale, R. C. Rosrance, and R.A. Rowland. 2007. Real-time soil profile water content as influenced by weed-corn competition. Soil Science. 172(10)759-769.