Cover Crops and Cotton in the Texas High Plains: SSARE research summary, 2007-2009

One can't talk about agriculture in the Texas High Plains without including "water" in the same sentence. The Ogallala Aquifer, which has kept ag production humming for nearly a century, is running low. Agriculture in the Texas Panhandle and Southern Plains is adapting to decreased water availability.

For nearly two decades, researchers and producers across the Texas High Plains have been developing integrated crop/livestock production systems that address the growing need for water conservation, while keeping soils fertile, crop yields profitable, cattle production thriving, and surrounding communities viable.

Funded through nearly $1.5 million in Southern SARE Research & Education, Large Systems and Graduate Student grants, the results showcase long-term alternative production systems, and how those results are being translated into practical field production practices and sustainable agriculture applications.

This model of sustainable agroecosystems in the Texas High Plains is changing the face of agriculture in the region and helping to conserve water, improve soil health, boost ag profits and keep the High Plains region thriving for generations to come.

This bulletin highlights SSARE-funded work from 2007-2009 (**GS07-056**, *"Allelopathic Effects of Small Grain Cover Crops on Cotton Plant Growth and Yields"*).

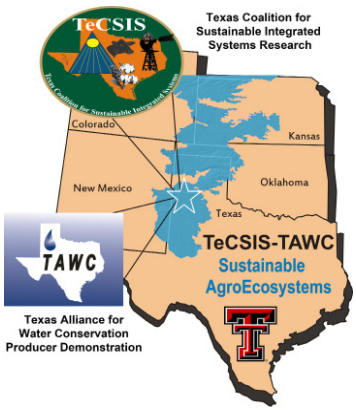

Photo credit: Texas Tech University

Introduction:

Cotton is an important crop in the Texas High Plains; roughly 25 percent of the total U.S. cotton crop is produced in this region, using irrigation mainly from the Ogallala Aquifer. However, declining water reserves in the Ogallala Aquifer require research efforts to find solutions for alternative agricultural systems that reduce overall water use.

The use of small grain cover crops, like rye and wheat, is important across the region in reducing soil erosion, managing weeds, and retaining soil nutrients and organic matter. In long-term integrated crop/livestock production systems research where cotton was grown in alternate rotation with small grains, research results showed that rye or wheat cover crops reduced the growth and lint yield of cotton compared to a monoculture cotton production system. Researchers suspected that the production of allelopathic compounds, a known phenomenon in small grains, was suppressing cotton production.

In a Southern SARE-funded Graduate Student Grant (**GS07-056**), "*Allelopathic Effects of Small Grain Cover Crops on Cotton Plant Growth and Yields,*" Texas Tech University researchers investigated allelopathy as the possible cause of the observed suppression and livestock grazing as a means of reducing the allelopathic effects on the cotton crop.

Photo credit: Texas Tech University TeCSIS

Research Summary:

Research findings verified that allelopathy – a biological phenomenon where one plant can have a harmful effect on another plant – was suppressing growth and yield of cotton in rotation with small grain cover crops. Known allelopathic compounds in rye and wheat were detected in the soils and plants. Effects may be further pronounced in the semi-arid climate of the Texas High Plains region when water is limited because of slow decomposition in dry soils.

Grazing by livestock may offer opportunities to utilize the cover crops while reducing the allelopathic effects. In the research study, grazing the cover crops reduced the allelopathic effects and increased the yield of the cotton crop in rotation with the small grains cover crops by as much as one half a bale (250 lbs) per acre compared with cotton grown where the cover crops were not grazed, but were harvested as hay.

Research Objectives:

The overall objectives were to identify the cause of small grain cover crop suppression on the growth of cotton, and to alleviate this suppression through grazing management and/or selection of small grain species and varieties that minimize this effect.

Research Results:

The initial study was conducted within the SARE-funded, long-term integrated crop-livestock system, which began in 1997 to investigate differences between a cotton monoculture and an integrated crop/livestock production system. In the graduate student grant project, soil samples were collected from the treatment areas to detect the presence of allelopathic compounds. The collection of soils in the field, as well as off-site greenhouse studies that measured the effect of ground rye and wheat on cotton germination, were used to verify allelopathic effects of the small grains on cotton production.

In addition, the effects of grazing vs. non-grazing of rye on the growth of the following cotton crop was studied. Results showed that higher concentrations of allelopathic compounds in rye were found in the soil where rye was ungrazed, compared to grazed areas, suggesting that grazing reduced the amount of the chemical in the soil.

In both rye and wheat cover crops, and following a hail event, plant survival and initial growth of cotton were greater compared with no cover crop. However, at harvest, yields of both cotton lint and seed were higher where no cover crop was planted compared with where wheat or rye was planted.

Cotton no-till planted into a previously ungrazed rye cover crop had lower plant populations, fewer boles per plant, and lower lint yield than when cotton was planted into rye that was previously grazed during the spring by stocker steers. Livestock grazing offers opportunities to utilize the cover crops while reducing the allelopathic effect giving producers a management strategy to reduce this suppression while taking advantage of the benefits cover crops afford.

For a more detailed analyses of the research results, visit the national SARE projects database and search by project number **GS07-056**, "*Allelopathic Effects of Small Grain Cover Crops on Cotton Plant Growth and Yields.*"

High Plains Water Conservation Resources

General Information

Texas Coalition for Sustainable Integrated Systems (TeCSIS)
http://www.orgs.ttu.edu/forageresearch/

Texas Alliance for Water Conservation
http://www.depts.ttu.edu/tawc/

TAWC Solutions
http://www.tawcsolutions.org/

Texas Water Development Board
http://www.twdb.texas.gov/groundwater/aquifer/majors/ogallala.asp

Texas High Plains Water District
http://www.hpwd.org/

USDA-ARS Ogallala Aquifer
http://ogallala.ars.usda.gov/

Publications

High Plains Water Conservation Bulletin No. 1: Water Conservation in the Texas High Plains

High Plains Water Conservation Bulletin No. 2 : Sustainable Crop/Livestock Systems in the Texas High Plains Phase I

High Plains Water Conservation Bulletin No. 3: Sustainable Crop/Livestock Systems in the Texas High Plains Phase II

High Plains Water Conservation Bulletin No. 4: Sustainable Crop/Livestock Systems in the Texas High Plains Phase III

High Plains Water Conservation Bulletin No. 5: Diversifying in the Texas High Plains

High Plains Water Conservation Bulletin No. 6: Agroecosystems Economics in the Texas High Plains

High Plains Water Conservation Bulletin No. 7: Soil Quality of Integrated Crop/Livestock Systems

High Plains Water Conservation Bulletin No. 8: Texas Alliance for Water Conservation

High Plains Water Conservation Bulletin No. 9: Water Use of Old World Bluestems in the Texas High Plains

High Plains Water Conservation Bulletin No. 11: Agroecosystems Research in the Texas High Plains

Grant Projects

GS15-152 Evaluation of Winter Annual Cover Crops Under Multiple Residue Managements: Impacts on Land Management, Soil Water Depletion, and Cash Crop Productivity

LS14-261 Long-term Agroecoystems Research and Adoption in the Texas Southern High Plains: Phase II

LS11-238 Long-term Agroecosystems Research and Adoption in the Texas Southern High Plains: Phase I

LS10-229 Integrated Crop and Livestock Systems for Enhanced Soil Carbon Sequestration and Microbial Diversity in the Semiarid Texas High Plains

LS08-202 Crop-livestock Systems for Sustainable High Plains Agriculture

LS02-131 Forage and Livestock Systems for Sustainable High Plains Agriculture

GS07-056 Allelopathic effects of small grain cover crops on cotton plant growth and yields

GS02-012 Optimizing Water Use for Three Old World Bluestems in the Texas High Plains

LS97-082 Sustainable Crop/Livestock Systems in the Texas High Plains

Journal Articles

Acosta-Martinez, V., T.M. Zobeck, and V.G. Allen. 2004. Soil Microbial, Chemical and Physical Properties in Continuous Cotton and Integrated Crop-Livestock Systems. *Soil Society of America Journal* 68:1875-1884.

Allen, V.G, C.P. Brown, R. Kellison, E. Segarra, T. Wheeler, P.A. Dotray, J.C. Conkwright, C.J. Green, and V. Acosta-Martinez. 2004. Integrating Cotton and Beef Production to Reduce Water Withdrawal from the Ogallala Aquifer in the Southern High Plains. *Agronomy Journal* 97:556-567.

Allen, V.G., C.P. Brown, R. Kellison, E. Segarra, T. Wheeler, P.A. Dotray, J.C. Conkwright, C.J. Green, and V. Acosta-Martinez. 2005. Integrating Cotton and Beef Production to Reduce Water Withdrawal from the Ogallala Aquifer. *Agronomy Journal* 97:556-567.

Philipp, D., V.G. Allen, R.B. Mitchell, C.P. Brown, and D.B. Wester. 2005 Forage Nutritive Value and Morphology of Three Old World Bluestems Under a Range of Irrigation Levels. *Crop Science* 45:2258-2268.

Philipp, D., C.P. Brown, V.G. Allen, and D.B. Wester. 2006. Influence of Irrigation on Mineral Concentrations in Three Old World Bluestem Species. *Crop Science* 46:2033-2040.

Allen, V.G., M.T. Baker, E. Segarra, and C.P. Brown. 2007. Integrated Irrigated Crop-Livestock Systems in Dry Climates. *Agronomy Journal* 99:346-360.

Philipp, D., V.G. Allen, R.J. Lascano, C.P. Brown, and D.B. Wester. 2007 Production and Water Use Efficiency of Three Old World Bluestems. *Crop Science* 47:787-794.

Marsalis, M.A., V.G. Allen, C.P. Brown, and C.J. Green. 2007. Yield and Nutritive Value of Forage Bermudagrasses Grown Using Subsurface Drip Irrigation in the Southern High Plains. *Crop Science* 47:1246-1254.

Allen, V.G., C.P. Brown, E. Segarra, C.J. Green, T.A.Wheeler, V. Acosta-Martinez, and T.M. Zobeck. 2008. In Search of Sustainable Agricultural Systems for the Llano Estacado of the U.S. Southern High Plains. *Agriculture, Ecosystems and Environment* 124:3-12.

Acosta-Martinez, V., S. Dowd, S. Yung, and V. Allen. 2008. Tag Encoded Pyrosequencing Analysis of Bacterial Diversity in a Single Soil Type as Affected by Management and Land Use. *Soil Biology & Biochemistry* 40:2762-2770.

Dudensing, J., J. Johnson, P. Johnson, and C. Villalobos. 2008. Grazing Alternatives in the Face of Declining Groundwater: A Case from the Southern High Plains of Texas. *Texas Journal of Agriculture and Natural Resources* 21:60-72.

Maas, S.J., and N. Rajan. 2008. Estimating Ground Cover of Field Crops Using Medium-resolution Multispectral Satellite Imagery. *Agronomy Journal* 100(2):320-327.

Wheeler-Cook, E., E. Segarra, P. Johnson, J. Johnson and D. Willis. 2008. Water Conservation Policy Evaluation: The Case of the Southern Ogallala Aquifer. *Texas Journal of Agriculture and Natural Resources* 21:89-102.

Johnson, J., P. Johnson, E. Segarra, and D. Willis. 2009. Water Conservation Policy Alternatives for the Ogallala Aquifer in Texas. *Water Policy* 11:537-552.

Acosta-Martinez, V., G. Burrow, T.M. Zobeck, and V.G. Allen. 2010. Soil Microbial Com

munities and Function in Alternative Systems to Continuous Cotton. *Soil Science Society of America Journal* 74:1181-1192.

Acosta-Martinez, V., Bell, C.W., Morris, B.E.L., Zak, J., and Allen, V.G. 2010. Long-term Soil Microbial Community and Enzyme Activity Responses to an Integrated Cropping-Livestock System in a Semi-arid Region. *Agriculture, Ecosystems and Environment* 137:231-240.

Acosta-Martinez, V., Dowd, S.E., Sun, Y., Wester, D., and Allen, V.G. 2010. Pyrosequencing Analysis for Characterization of Soil Bacterial Populations as Affected by an Integrated Livestock-Cotton Production System. *Applied Soil Ecology* 45:13-25.

Maas, S.J., and N. Rajan. 2010. Normalizing and Converting Image DC Data Using Scatter Plot Matching. *Remote Sensing* 2(7):1644-1661.

Rajan, N., S.J. Maas, and J.C. Kathilankal. 2010. Estimating Crop Water Use of Cotton in the Texas High Plains. *Agronomy Journal* 102:1641-1651.

Allen, V.G., C. Batello, E.J. Berretta, J. Hodgson, M. Kothmann, X. Li, J. McIvor, J. Milne, C. Morris, A. Peeters, and M. Sanderson. 2011. An International Terminology for Grazing Lands and Grazing Animals. *Grass and Forage Science* 66:2-28.

Zilverberg, C.J., P. Johnson, J. Weinheimer, and V.G. Allen. 2011. Energy and Carbon Costs of Selected Cow-calf Systems. *Rangeland Ecology and Management* 64(6):573-584.

Zobeck, T.M., V.G. Allen, J.J. Cox, and D. Philipp. 2011. Variation of Soil and Plant Characteristics Among Old World Bluestem Species. *Agricultural Sciences* 2:347-356.

Davinic, M., L.M. Fultz, V. Acosta-Martinez, F.J. Calderon, S.B. Cox, S.E. Dowd, V.G. Allen, J.C. Zak, and J. Moore-Kucera. 2012. Pyrosequencing and Mid-infrared Spectroscopy Reveal Distinct Aggregate Stratification of Soil Bacterial Communities and Organic Matter Composition. *Soil Biology & Biochemistry* 46:63-72.

Allen, V.G., C.P. Brown, R. Kellison, P. Green, C.J. Zilverberg, P. Johnson, J. Weinheimer. T. Wheeler, E. Segarra, V. Acosta-Martinez, T.M. Zobeck, and J.C. Conkwright. 2012. Integrating Cotton and Beef Production in the Texas Southern High Plains I: Water Use and Measure of Productivity. *Agronomy Journal* 104:1625-1642.

Zilverberg, C.J., V.G. Allen, C.P. Brown, P. Green, P. Johnson, and J. Weinheimer. 2012. Integrating Cotton and Beef Production in the Texas Southern High Plains II: Fossil Fuel Use. *Agronomy Journal* 104: 1643-1651.

Trojan, S, and C. West. 2012. Conserving Water and Maintaining Economic Viability by Grazing Introduced Perennial Grasses. *Rangeland Issues* 1(3):1-7. National Ranching Heritage Center, Texas Tech University, Lubbock.

Song, Cui, V.G. Allen, C.P. Brown, and D. B. Wester. 2013. Growth and Nutritive Value of Three Old World Bluestems and Three Legumes in the Semi-arid Texas High Plains. *Crop Science* 53:1-12.

Johnson, P., J. Zilverberg, V.G. Allen, J. Weinheimer, C.P. Brown, R. Kellison, and E. Segarra. 2013. Integrating Cotton and Beef Production in the Texas Southern High Plains III: An Economic Evaluation. *Agronomy Journal* 105:929-937.

Davinic, M., J. Moore-Kucera, V. Acosta-Martinez, J. Zak, and V. Allen. 2013. Soil Fungal Groups' Distribution and Saprophytic Functionality as Affected by Grazing and Vegetation Components of Integrated Cropping-Livestock Agroecosystems. *Applied Soil Ecology* 66:61-70.

Fultz, L.M., J. Moore-Kucera, T.M. Zobeck, V. Acosta-Martinez, and V.G. Allen. 2013. Aggregate Carbon Pools After 13 Years of Integrated Crop-Livestock Management in Semi-arid Soils. *Soil Science Society of America Journal* 77(5):1659-1666.

Li, Y., V.G. Allen, F. Hou, J. Chen, and C.P. Brown. 2013. Steers Grazing a Rye Cover Crop Influence Growth of Rye and No-till Cotton. *Agronomy Journal* 105: 1571-1580.

Li, Y., V.G. Allen, J. Chen, F. Hou, C.P. Brown, and P. Green. 2013. Allelopathic Influence of Wheat or Rye Cover Crop on Growth and Yield of No-till Cotton. *Agronomy Journal* 105: 1581-1587.

Fultz, L.M., J. Moore-Kucera, T.M. Zobeck, V. Acosta-Martinez, D.B. Wester, and V.G. Allen. 2013. Organic Carbon Dynamics and Soil Stability in Five Semi-arid Agroecosystems. *Agriculture, Ecosystems and Environment* 181:231-240.

Benson, A., and C. Zilverberg. 2013. A Bioeconomic Model for Sustainable Grazing of Old World Bluestem Under Uncertainty. *Natural Resources* 4:362-368.

Rajan, N., S. Maas and C. Song. 2013. Extreme Drought Effects on Carbon Dynamics of a Semi-arid Pasture. *Agronomy Journal* 105:1749-1760.

Zilverberg, C.J., C.P. Brown, P. Green, M.L. Galyean, and V.G. Allen. 2014. Integrated Crop-Livestock Systems in the Texas High Plains: Productivity and Water Use. *Agronomy Journal* 106 3:831-843.

Song, Cui, C.J. Zilverberg, V.G. Allen, C.P. Brown, J. Moore-Kucera, D.B. Wester, M. Mirik, S. Chaudhuri, and N. Phillips. 2014. Carbon and Nitrogen Responses of Three Old World Bluestems to Nitrogen Fertilization or Inclusion of a Legume. *Field Crops Research* 164:45-53.

Zilverberg, C.J., and V.G. Allen. 2014. Repeated Grazing Affects Quality and Sampling Strategies of 'WW-B. Dahl' Old World Bluestem. *Texas Journal of Agriculture and Natural Resources* 27:84-87.

Zilverberg, C.J., and V.G. Allen. 2014. Technical Note: Repeated Grazing Affects Quality and Sampling Strategies of 'WW-B.Dahl' Old World Bluestem. *The Texas Journal of Agriculture and Natural Resources* 27:84-87.

Zilverberg, C., P. Brown, P. Green, V. Allen, and M. Galyean. 2015. Forage Performance in Crop-Livestock Systems Designed to Reduce Water Withdrawals from a Declining Aquifer. *Rangelands* 37:55-61.

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