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2003 KSU Summer Research Projects

Jason DaVee
Sociology
"The Increase of Female Criminality and its Relationship to Abuse"

***Hollie Davis**
Animal Science & Industry
"What effect does elapsed time and methods of handling have on the amount of atresia and quality of mRNA contained in the bovine ovarian follicle?"

Carmelita Goossen
Agricultural Education
"Effective Methods of Recruiting Minority Students to the Kansas State University College of Agriculture"

***Tara Hacker**
Kinesiology / Nutrition & Exercise Science
"Barriers to Moderate Physical Activity in Hispanic Women with Arthritis"

***Kristy Morales**
Biology / Pre-Medicine
"Interaction between late expression factors 8 and 9 in a virally-encoded RNA polymerase"

Derek Schoenthaler
Kinesiology
"Kinematic Comparisons of the Overhead Forward Pass in Football Quarterbacks during Various Levels of Development"

***Aaron Wech**
Mathematics / Physics
"Electron Capture from Atomic and Molecular Hydrogen by O^{8+} at Low to Intermediate Impact Energies"

***Kai Wai Wong**
Electrical Engineering
"Low Cost Microwave Network Analyzer"

****Russell Yarnell**
Civil Engineering
"Determining Nitrogen and Phosphorus Losses from Urban Lawns"

**abstract appears in journal*
***article appears in journal*

Determining Nitrogen and Phosphorus Losses from Urban Lawns

Russell Yarnell, Scholar
Philip Barnes, Ph.D., Mentor

Introduction

During rainfall, storm runoff contributes large volumes of runoff to the nation's rivers. Storm water enters sewers from urban areas bypassing treatment and flowing into streams and lakes. If the water is rich in nutrients, aquatic plant life grows rapidly, producing large amounts of organic matter that die and deposit on the bottom. Over time, the mass builds up and reduces the depth of the stream or pond. This process, known as eutrophication, prematurely fills up the stream leaving it debilitated (Masters 1998). Agricultural runoff became the first studied contamination due to the large amount of fertilized land area. Today, nutrient pollution still exists in many of America's rivers (Gilliom et al., 2001) and identifying sources of these pollutants is important in restoring river quality.

In 1998, 97,000 km^2 of residential lawns covered the U.S. (Roberts and Roberts, 1998). Each year, homeowners and lawn care specialists apply tons of fertilizer to America's lawns. Treatments range from granular mixtures applied with a spreader to liquid formulations that require spray treatments. Morton (1988) noted that homeowners apply 122 kg ha^{-1} yr^{-1} while commercial operators apply 220-293 kg ha^{-1} yr^{-1}. Along with the applications rates, over-watering increases potential nitrogen losses in runoff. Petrovic (1990) noted that runoff and leaching were not contributing to elevated levels of nitrate in the water supply for granular mixes. Using golf courses for studies may provide inaccurate results since amending sand to the soil increases infiltration (Petrovic 1990). Construction of homes requires heavy equipment that consolidates the soil and reduces infiltration rates of the lawn (Partsch 1993). Sprinkler systems also apply water at a rate greater than sandy loam soil can infiltrate (Jeffries 1990). Barnes (1977) noted in Wheatland, WY, irrigation of lawns averaged 156% of the evapo-transpiration rate. Winje (1986) noted that in Colorado, outdoor use contributes to 50% of treated water use. In addition, after a water shortage crisis ended, water usage rose to pre-crisis levels with most of the water applied in excess. While problems may exist with urban lawns, sampling runoff in a storm water system is difficult due to lack of sampling access and isolating sources of contaminants in the runoff (Lee 1995). In Korea, residential zones carried much higher pollutant loads than industrial areas (Choe 2002). Identifying new sources and their significance toward pollution will continue to reduce the nutrient runoff and increase the efficiency of fertilizer applied. Gaining knowledge about the contribution urban lawns make on the nation's rivers is important.

Many fertilizer products recommend pre-wetting of a lawn prior to application. The pre-wetting increases the soil moisture and decreases infiltration capacity. Rainfall or irrigation immediately after fertilization may contribute to increased nutrient loading in the runoff. This study examined the significance of soil moisture to nutrient loading in runoff from lawns.

Procedures

Test Equipment and Layout

In May 2003, a 30 ft. by 60 ft. plot was planted to Kentucky bluegrass at the Kansas State University animal science research farm. Along with watering and mowing, an application of fertilizer and herbicide blend aided the growth of the grass in early June. Once the grass was established, a series of randomized 1.5 m x 1.5 m (5 ft. x 5 ft.) plots were selected. Replicated treatments were randomly applied to these plots to achieve soil moisture ranging from dry to normal to excessively moist.

The first study was performed on August 18, 2003. Soil moisture was measured prior to the test. Next, the fertilizer was applied and the rainfall simulation immediately followed. A rainfall simulator constructed of aluminum railing with a solenoid operated nozzle at 4.5 m (15 ft.) above the ground. The simulator application ran for 1 hour at a rate of 5 cm (2 inches) hr^{-1}. To prevent disturbance from the wind, tarps covered adjacent sides of the simulator. For the tests, metal strips inserted into the soil created an edge around the plot. The edging captured water that entered the plot from the sprinkler and prevented any water from running onto the plot. On the down slope side, a cut in the edging allowed the water to flow into a sump constructed of PVC pipe and end cap. A sump pump moved water into 5-gallon containers for measuring flows and nutrients. Sampling of the captured rainfall occurred every 18.9 liters (5 gallons). Along with the sampling, recording of pond time, runoff time, and time for each 18.9 liters runoff samples produced hydrographs for compari-

son. After the simulation ended, plots continued to produce runoff for 3-5 minutes.

The first tests consisted of 10-10-10 formulation of granular fertilizer. The nitrogen source consisted of 39.1% ammoniacal nitrogen and 60.9% urea. The phosphorus source used P_2O_5 phosphate. Following directions on the bag, the rate of application was 488 kg/ha. This rate required 11,340 mg (0.25 lb.) of fertilizer for one plot. The second test used a 20-20-20 liquid soluble fertilizer. The nitrogen content consisted of 19.4% ammoniacal, 30.6% nitrate-nitrogen, and 50.0% urea nitrogen. Phosphorus source for the liquid fertilizer was the same as for the dry fertilizer. Dividing the application rate by two and dissolving 5,670 mg (0.125 lb.) with 1 L of deionized water produced a 10-10-10 liquid fertilizer formulation.

Data Analyses

To achieve proper soil moisture, preparation of the plots soil moisture began two to three days before simulation. The dry plots were not watered and most contained visible cracks in the soil. For the normal plots, regular watering continued, and small cracks in the soil were visible upon close inspection. The moist plots were soaked with water prior to testing and no soil cracks were visible. After collecting the runoff samples, the KSU Agronomy soil-testing laboratory analyzed the samples for phosphorus (P), ammonium (NH_4^+), and nitrate (NO_3^-).

Results

Results from the lab displayed the samples as concentrations. Multiplying the concentration by the volume produced the mass lost. Expressing a ratio of the amount of nutrients lost through runoff to total mass of fertilizer applied calculates the loss in terms of a percentage. After calculating total loss of nitrogen and phosphorus from each plot, an analysis of variance and F-protected tests ($p = 0.05$) on least square means were performed using ProL mixed (SAS, 2003). Data from the results are shown in Table 1.

Dry fertilizer

Soil moisture for the dry, normal, and moist plots was 6.84%, 13.69%, and 20.33%, respectively. As expected, the runoff and infiltration displayed a negative correlation. Figures 1 and 2 show soil moisture and the runoff-infiltration relationship, respectively. The water samples contained small amounts of nitrate for each soil moisture. The nutrient loss from nitrates was insignificant, therefore supporting observations noted by Petrovic (1990) for granular fertilizers. Support for this observation exists since the nitrogen source consists of ammonical and urea nitrogen. Ammonia and phosphorus loss was significantly different for the dry plots. Losses for the normal and moist plot were approximately twice the losses of the dry plot. Results are shown in figure 3. From this observation, refraining from irrigation prior to fertilization would reduce losses to runoff for dry fertilizer.

Liquid Fertilizer

Soil moisture for the dry, normal, and moist plots was 12.49%, 27.44%, and 30.88%, respectively. Figure 4, below, shows nutrient runoff versus soil moisture range. Figure 5 displays the runoff and infiltration versus the soil moisture range. For all three nutrient losses, a statistical significance exists. Phosphorus showed the greatest difference with all three moisture categories being significant. Ammonium and nitrate for the moist plots was statistically different. The change in nitrate for liquid versus dry fertilizer is due to 6.11% nitrate-nitrogen concentration in the liquid fertilizer. Graph 6 shows the nutrient loss for the liquid fertilizer versus moisture ranges.

Soil moistures for the liquid plots were higher for their respective moisture range. Testing of the dry fertilizer occurred in the late summer while the liquid fertilizer tests occurred in the fall, where evapo-transpiration was less and the plots retained soil moisture. From the results, the least loss occurred for the dry plots. All three of the nutrients analyzed increased significantly, as soil moisture increased. These results suggest that the lowest soil moisture produces the least amount of runoff.

Summary

All nutrients, except nitrates in dry fertilizer, produced a statistical difference versus soil moisture. The plots applied with dry fertilizer showed significance in phosphorus and ammonium for the dry plots. The plots applied with liquid fertilizer showed significance, in all nutrients, for the moist soil range. Phosphorus showed significance between all three moisture ranges. Losses in phosphorus for the dry fertilizer were 2.96%, 6.50%, and 6.24% for the dry, normal, and moist plots respectively. Losses for the liquid fertilizer were 1.20%, 6.65%, and 16.52% for the dry, normal, and moist plots, respectively. Total nitrogen loss for the dry fertilizer was 2.25%, 3.98%, and 4.09% for the dry, normal, and moist plots, respectively. Total loss of nitrogen for the liquid fertilizer was 0.73%, 4.52%, and 11.55% for the dry, normal, and moist plots, respectively.

Conclusions

Losses of nutrients for the dry plots were lowest, but only significantly lower for the dry fertilizer. In the liquid fertilizer applications, the

run-off from moist plots was significantly higher. In the recommendation of the proper soil moisture before fertilization would be dry soil moisture for granular fertilizer, and dry or normal soil moisture for the liquid fertilizer. Overall, significance has been determined between N and P runoff for urban lawns. Implementing application procedures relative to this finding will increase fertilizer efficiency and may lower nutrient loads in America's streams and rivers.

Table 1 - Nutrient losses in runoff from a recently fertilized lawn maintained at different soil moisture ranges.

Lawn Runoff Study - Dry Fertilizer					
Treatment	Phosphorus	Ammonium	Nitrate	% P Loss	% N Loss
	----------mg----------				
Dry	336.5a†	327.7a	3.2a	2.96	2.25
Normal	737.2b	576.8b	17.2a	6.50	3.98
Moist	707.9b	596.1b	7.5a	6.24	4.09
Lawn Runoff Study – Liquid Fertilizer					
Treatment	Phosphorus	Ammonium	Nitrate	% P Loss	% N Loss
	----------mg----------				
Dry	135.9a	93.0a	44.5a	1.20	0.73
Normal	754.1ab	489.9a	585.5a	6.65	4.52
Moist	1872.8b	1172.2b	1770.3b	16.52	11.55

º Values within a column followed by the same letter are not different at the 0.05 level according to Duncan's multiple range test.

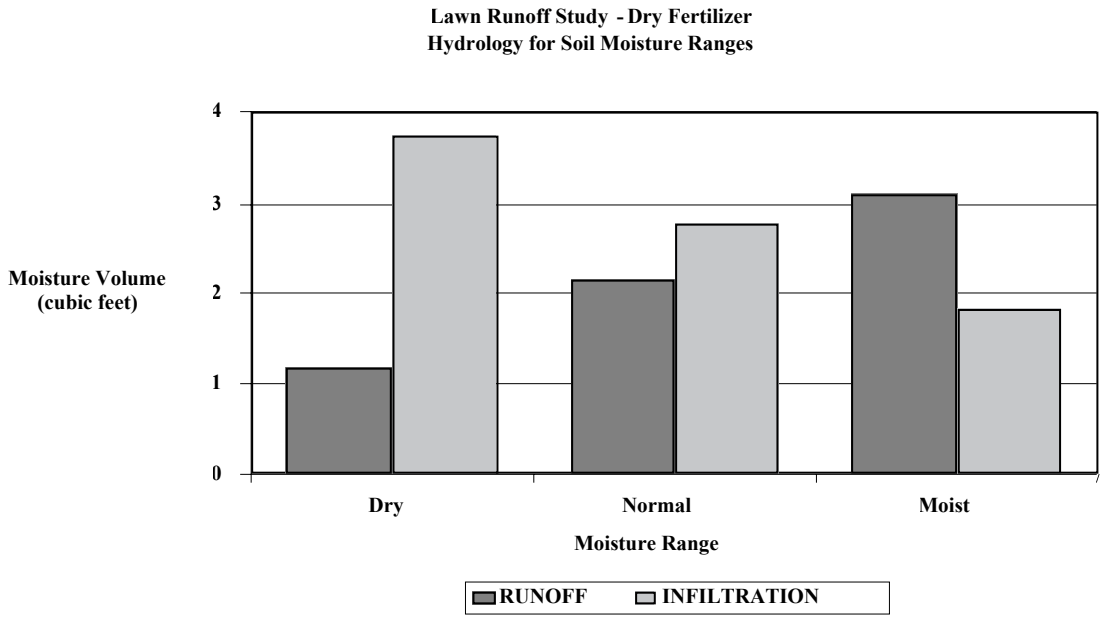

Figure 1 – The graph shows measured runoff and infiltration, which show the negative correlation between runoff and infiltration.

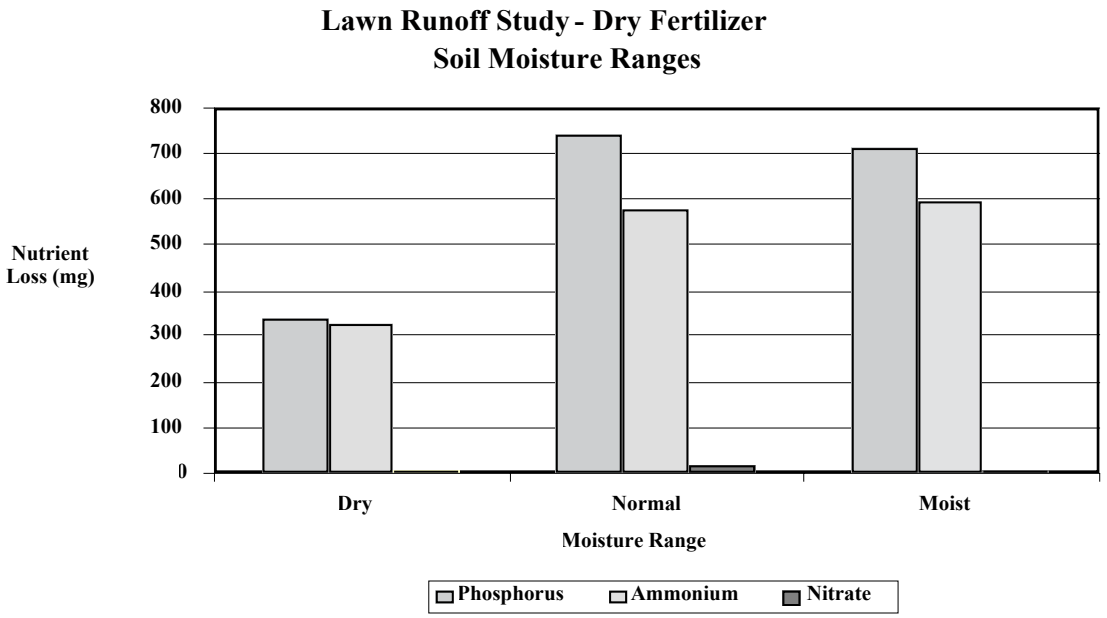

Figure 2 - Average nutrient losses for moisture ranges in dry fertilizer study.

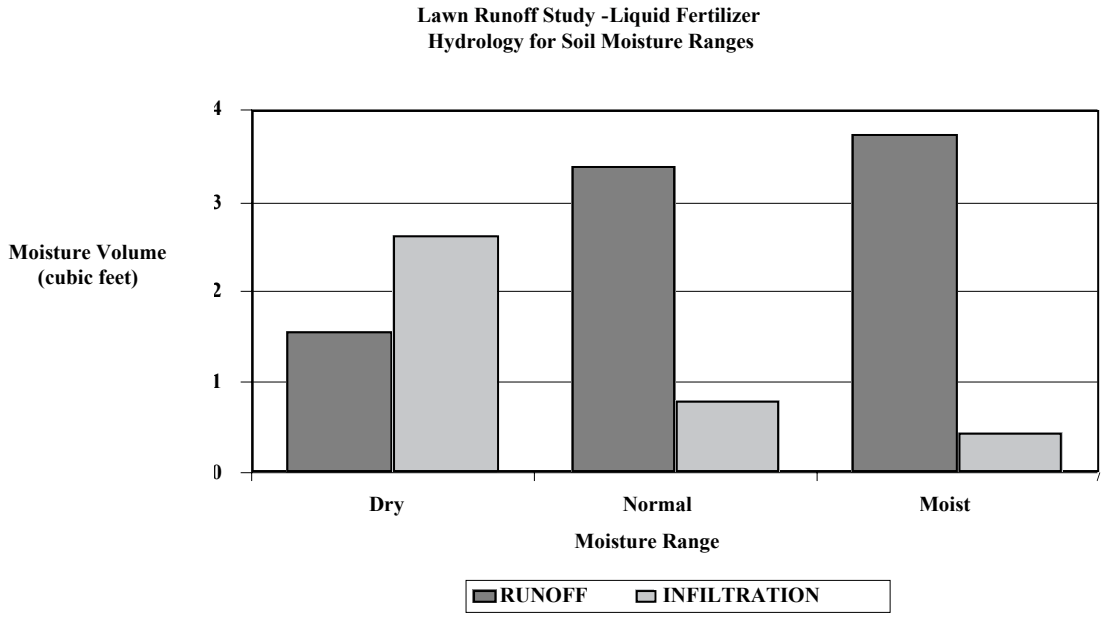

Figure 3 - The graph shows measured runoff and infiltration, which show the negative correlation between runoff and infiltration of plots fertilized with liquid formula.

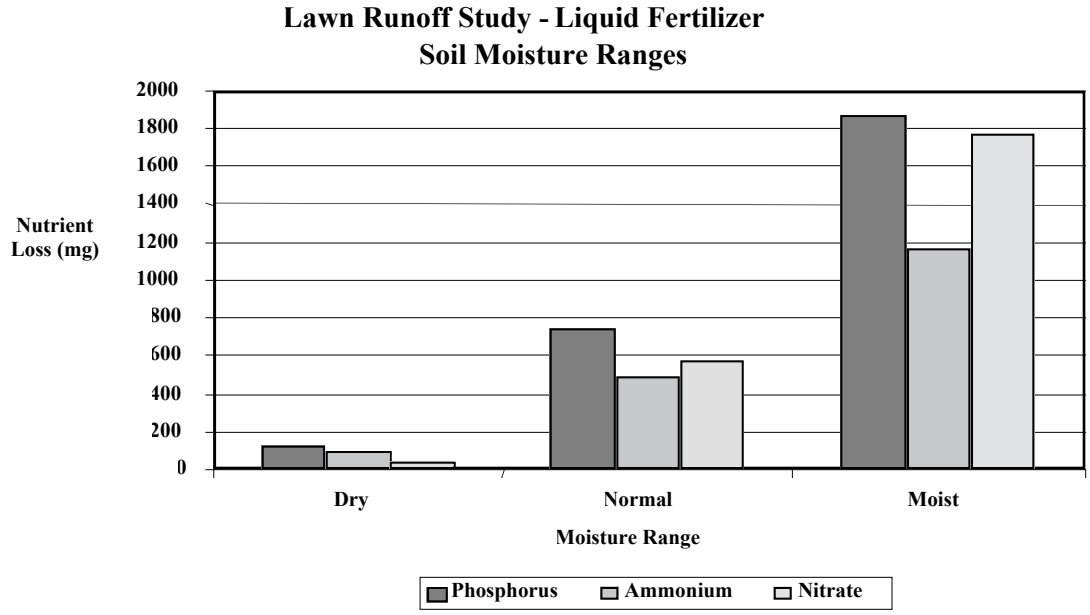

Figure 4 - Average nutrient losses for moisture ranges in liquid fertilizer study.

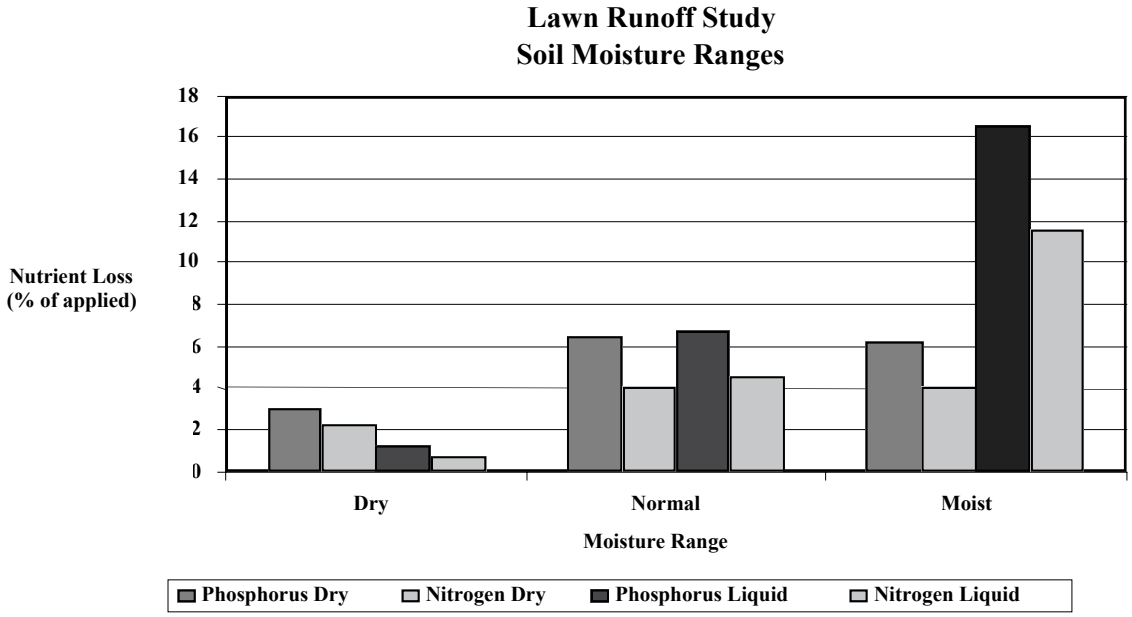

Figure 5 - Comparison of nitrogen and phosphorus losses, in percentage, for the dry and liquid fertilizer mixes versus the soil moisture range.

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Russell Yarnell is from Lucas, in north-central Kansas. In May of 2004, Russell earned his bachelor's degree in civil engineering and immediately began work toward a master's degree in biological and agricultural engineering at Kansas State University, where he continues to work with his McNair mentor, Dr. Philip Barnes. Russell plans to work for an engineering firm in Kansas, to gain applied experience in water and wastewater treatment plants, before continuing his graduate studies.

What Effect Does Elapsed Time and Methods of Handling Have on the Amount of Atresia and Quality of mRNA Contained in the Bovine Ovarian Follicle?

Hollie Davis, Scholar
Timothy Rozell, Ph.D., Mentor

During early development of the ovary, granulosa cells combine with germ cells to form oocytes, which will eventually develop into follicles. Of the approximately 2 million healthy follicles present at birth only about 300,000 remain at sexual maturity. At all stages of development, follicles may undergo atresia. Through microscopic examination it is possible to observe physical changes in the follicle as it undergoes atresia. Initially cells with dark, stained nuclei can be seen amongst the granulosa cells, a sign of impending cell death. As atresia progresses, the granulosa cell will fragment, cellular debris will be free floating and leukocytes will invade the follicle completing the deterioration. In the final stages of atresia, the follicle has shrunk till it has almost completely disappeared.

Follicle stimulating hormone (FSH) is the main hormone that stimulates follicular growth. Associated with each new wave of follicular development, the rise in FSH concentration occurs over a period of 1 to 2 days to initiate each new wave of follicular growth. Where initial stages of follicular growth occur independently of gonadotrophic hormones; antral follicles will become responsive to and eventually dependent on FSH. FSH concentrations increase before the follicle emergence and return to a basal level about 16 hours after the follicle emerges.

In order for FSH to regulate the growth of follicles it has to be able to first bind its receptors at the appropriate location and time. The follicular growth cycle starts with coordination between the anterior pituitary gland and the ovary. Once released into the bloodstream, FSH binds to its specific receptor (FSHR) located in the granulosa cells.

The FSHR protein is manufactured in the ovaries by the granulosa cells, but in order for the cells to produce the receptor, the DNA has to first be transcribed into messenger RNA (mRNA). A common method used to study the role of the FSHR in early follicular development is to acquire bovine ovaries from a slaughterhouse, then to measure mRNA from the receptor within total RNA from follicular cells.

Our preliminary hypothesis is that visual assessment of atresia is altered by a prolonged delay between harvest and examination. Additionally, storage temperatures will also affect the quality of follicles or degree of atresia. Subsequently, we feel that varying storage conditions as well alters measurement of mRNA. The increased degradation of mRNA due to time elapsed or handling methods, will affect the ability to detect FSHR mRNA in granulosa cells as assessed by Northern Blot Testing.

The bovine ovaries were tested after three different time intervals: 2 hours, 24 hours, and 48 hours. The ovaries tested after 2 hours were kept at 25. The ovaries tested after 24 and 48 hours were divided into 3 test groups: one stored at 25 degrees, one at 4 degrees, and one at –70 degrees. The timing began when the ovaries were harvested from the heifer at the slaughter facility. All recorded temperatures were measured in Celsius.

After the designated storage time the follicles were microscopically examined and graded using the methods described by A.A. de Wit (May 2000).

Based on the results from the experiment, the ideal time and temperature to aspirate and grade ovaries seemed to be 2 hours post harvest and storage at 25 C. This group yielded the most evenly distributed numbers for grades. In past experiments consistent results were not being achieved when a RT-PCR or Northern Blot was run. This could be due in part to the fact that the increase of time between slaughter and receiving the ovaries may have allowed the mRNA to start its degradation process. By running this experiment we should have been able to conclude that time and storage conditions are important factors that need to be considered in future experiments.

Hollie Davis is originally from New York, NY, but due to her military family background has spent the majority of her life in Europe. Hollie graduated from Kansas State in December of 2004 with a bachelor's degree in Animal Science and Industry. She plans to earn a doctorate in Veterinary Medicine and become a board-certified small animal orthopedic surgeon.

Barriers to Moderate Physical Activity in Hispanic Women with Arthritis

Tara Hacker, Scholar
Nancy Gyurcsik, Ph.D., Mentor

Arthritis is one of the most common chronic diseases in the United States, affecting 70 million Americans. In Kansas, arthritis affects 634,000 people, with 13% being Hispanic. Since no cure exists for the over 100 different types of arthritis, the negative health impacts can be tremendous. For example, individuals with arthritis experience increases in pain and depression and decreases in abilities to perform activities of daily living. Regular physical activity is one recommended strategy to self-manage negative health impacts of arthritis. However, epidemiological data indicate that of the adults who were inactive in Kansas in the year 2000, 52% were Hispanic. To compound this low rate of activity, individuals with arthritis are less active than individuals without arthritis. Thus, examination of correlates of physical activity in individuals with arthritis is critical with a future goal of examining the efficacy of programs aimed at influencing these correlates. Barriers to physical activity may be one such correlate. Although research in both healthy and diseased populations (e.g., cardiovascular disease) has found that as barriers increase, physical activity decreases, no research has examined barriers to physical activity in people with arthritis. Therefore, the purpose of this study was to examine barriers to regular moderate physical activity in adult Hispanic women with arthritis. Moderate physical activity was defined as activities lasting at least 10 minutes, for a total of 30 minutes on five or more days a week, which caused small increases in breathing and heart rate while still being able to carry on a conversation. Participants were 14 Hispanic women (Mage = 68.07 years, SD = 13.69) who had arthritis for 3.27 years (SD = 1.95 years) and who were not regularly, moderately active. Subjects participated in one of two focus groups. Each was led by a moderator who asked open-ended questions beginning with: (1) What are some things that you think, feel, or have going in on your life, (2) How do people in your life, (3) Is there anything in your community, (4) Are there any public policies, followed by "... that make(s) it difficult or stop(s) you from being moderately physically active?" Follow-up and probe questions were asked to elicit additional information. Qualitative analyses of the data revealed that participants identified a number of intrapersonal (e.g., pain from arthritis), interpersonal (e.g., family responsibilities), institutional (e.g., cost of exercise facilities), community (e.g., safety), public policy (e.g., lack of city council attention to physical environmental barriers), and physical environmental (e.g., poor sidewalks) barriers to engaging in moderate physical activity. From a public health perspective, findings may have implications in the design of physical activity interventions to have a larger impact on the health of Hispanic women with arthritis by taking a multi-pronged approach to alleviate a breadth of barriers. To do so, future research must identify the most salient barriers to moderate physical activity in Hispanic women with arthritis. Further, through the identification of salient barriers that are similar among other populations, interventions can be developed to alleviate such barriers and reach a much larger audience and have significant positive impacts on national participation rates in moderate physical activity.

Tara Hacker, from Overland Park, Kansas, is a senior at Kansas State University with a double major: Kinesiology, and Nutrition & Exercise Science. Her campus activities include serving as treasurer for the Hispanic American Leadership Organization. After receiving her bachelor's degree in 2005, she plans to enter a graduate program in the area of health administration and policy. Her career goal is to provide services for low-income and underrepresented individuals at a health clinic that emphasizes wellness through environmental and behavioral prevention.

Interaction between late expression factors 8 and 9 in a virally-encoded RNA polymerase

Kristy Morales, Scholar
A. Lorena Passarelli, Ph.D., Mentor

Baculoviruses are arthropod-specific viruses with double-stranded circular DNA genomes that are widely used as gene expression vectors. Autographa californica nucleopolyhedrovirus (AcMNPV), the best-characterized baculovirus, has been sequenced and encodes about 150 genes.

Three main transcriptional phases of gene expression can be distinguished during infection of permissive cells: early, late, and very late. Unlike many eukaryotic viruses, baculoviruses use two different RNA polymerases to transcribe their genes. Transcription of genes in the early phase is carried out by the host RNA polymerase II. In contrast, late and very late genes are transcribed by a novel virus-encoded RNA polymerase that consists of four viral proteins: Late Expression Factor-4 (LEF-4), LEF-8, LEF-9, and P47.

LEF-9 and LEF-8 have each a conserved motif homologous to those found in other known RNA polymerases. Both of these motifs have been associated with the catalytic center of the Escherichia coli RNA polymerase. In LEF-8 this sequence is composed of 13 residues. The motif in LEF-9 (NADFDGD) contains 5 identical residues out of 7 also present in the motif of the large subunits of other DNA-directed RNA polymerases. Previous work has shown that the motif in LEF-8 is required for function, and this report assesses the importance of the motif in LEF-9. In addition, we are determining whether LEF-8 and LEF-9 interact. There is preliminary evidence that LEF-8 and LEF-9 interact the related baculovirus Bombyx mori nucleopolyhedrovirus.

To assess whether the motif in LEF-9 was important for function, mutagenesis was performed on the motif NADFDGD changing each aspartate (abbreviated D) to alanine (A) to generate 3 clones. To determine if the changes in the primary LEF-9 sequence altered expression, we detected the proteins by immunoblotting. The altered proteins resulting from the three mutations in lef-9 were expressed to comparable levels as the unaltered lef-9.

To assess the functionality of LEF-9 mutants, a late promoter controlling a reporter gene chloramphenicol acetyl-transferase (cat) was transfected into insect cells with the other lefs required to activate this late promoter and unaltered lef-9, lacking lef-9, or substituting the unaltered lef-9 with a lef-9 mutant. Substitution of unaltered lef-9 with any of the mutants resulted in a drastic reduction in late promoter activity, suggesting that this motif is important for function and may be part of the catalytic site.

A co-immunoprecipitation experiment will test the interaction of LEF-8 and LEF-9. lef-8 and lef-9 were cloned containing a polyhistidine tag, and differential epitope tags at the N-terminus. One set of constructs, pHSEpiHislef-8 and pHSEpiHislef-9, contain the immunogenic hemagglutinin (HA) influenza virus peptide sequence tag. The other set, pHSflagHislef-8 and pHSflagHislef-9, each contain the flag immunogenic tag.

Briefly, after transfection of these plasmids into insect cells, the tags will be used to identify the presence of each polypeptide individually or as an interacting complex. If differentially tagged LEF-8 and LEF-9 interact, one protein can be purified by co-immunoprecipitation, along with the interacting partner. The interacting partner can be later identified by immunoblotting with the other tag antibody.

It has been established that LEF-8 contains a conserved motif necessary for late gene promoter activation, and this report shows that LEF-9 also contains a motif necessary for late gene expression. Completion of LEF-8 and LEF-9 interaction studies will allow us to determine how the transcription complex is structured and if the motifs interact with any of the subunits in the complex. This work will give insight into the structure and function of this novel, virus-encoded RNA polymerase, as well as supplement studies of other eukaryotic polymerases.

The baculovirus RNA polymerase is simpler than other eukaryotic RNA polymerases, and the predicted amino acid sequence of the genes is different to that of other polymerases with the exception of the putative catalytic motifs in LEF-8 and LEF-9. However, given that the three dimensional structure of different types of polymerases is conserved, it would be of interest to know if the three dimensional structure of this evolutionary diverse polymerase is also conserved.

Kristy Morales graduated from Kansas State University in May, 2004 with a bachelor's degree in biology. At K-State she was active in the Multicultural Student Honor Society, the Hispanic American Leadership Organization, Sigma Lambda Gamma Sorority, the Developing Scholars Program, and many service trips to Mexico. After college she entered medical school at Creighton University on an Air Force Health Professions Scholarship.

Electron Capture from Atomic and Molecular Hydrogen by O^{8+} at Low to Intermediate Impact Energies

Aaron Wech, Scholar
Charles Cocke, Ph.D., Mentor

Heavy ions with very high charge at low energies are rare in nature, but are encountered in fusion energy devices and astrophysical objects. Electron capture is well identified as being a primary channel for low velocity interactions between multiply-charged ions and neutral atoms.

A significant amount of theoretical work has been dedicated to understanding this electron capture interaction. At low velocity interactions, the classical over-barrier model is very successful in describing such collisions. This model describes a general electron capture reaction through the use of Coulomb potential wells. The over-barrier model describes the quasi-molecular motion of the electron being caught in the potential well of both the projectile ion and the target atom.

In this paper we use cold-target recoil-ion-momentum spectroscopy (COLTRIMS) to study low energy electron capture by highly charged ions from the single electron target, hydrogen. This COLTRIMS technique permits the simultaneous examination of final quantum state distributions, angular distributions for each corresponding final state, and reaction window behavior. An important feature to this approach is that it allows for high-resolution studies, with good statistics in our low-velocity range.

Theoretical calculations have been performed to determine the relative cross section ratios of capture in various quantum states. This theory has been successful in accurately predicting such results as were experimentally determined in electron capture of Ar^{8+} from He [4], and the process was thought to be well understood. However, the recent research performed by Erge EdgŸ-Fry at Kansas State University of electron capture of Ar^{8+} from atomic hydrogen did not completely agree with predictions made by this theory. This evidence came as a surprise because the reaction is much more elementary reaction due to the existence of only one target electron. A possible flaw in the calculation could lie in the assumption that Ar^{8+} acts as a bare nucleus. This may be an ambitious perturbative assumption because electrons around the nucleus fill the 1s, 2s, and 2p quantum states potentially causing some non-negligible error in the calculations.

O^{8+}, on the other hand, is a bare nucleus; therefore, the reaction cannot be disturbed by any electron interaction. Performing an electron capture experiment from hydrogen with O^{8+} gives us a better understanding of the strength or shortcomings of this electron capture model calculation. Similar to the Ar^{8+} experiment, we use low to intermediate projectile velocities varying from 0.5 a.u. to 0.95 a.u., which are clearly in the classical-barrier region.

This experiment measured single electron capture from atomic and molecular hydrogen targets by O^{8+} ions at projectile velocities ranging from 0.5 to 0.95 a.u. The energy gain as well as the projectile transverse momentum gain was recorded through the use of cold target recoil-ion momentum spectroscopy. For this capture reaction, the reaction window was found to increase as the projectile energy increased. The angular distributions for the atomic hydrogen interactions center at the half Coulomb angle over the lower velocity range, but higher scattering angles for the lower energy gains were found at higher velocities (v_p = 0.95 a.u.). These higher scattering angles for lower energy gains were also prevalent over the entire projectile velocity range studied in the molecular hydrogen interaction. In the atomic hydrogen collisions at all velocities, the n = 5 states were dominantly populated, as predicted by close coupling calculations (Teck Lee). In accordance with the Ar^{8+} experiment, however, the n = 6 state was much more heavily populated. This was the main discrepancy between theory and experiment which prompted the O^{8+} electron capture investigation. Also, differing from theoretical predictions, the presence of both n = 7 and n = 4 populations were measured at all velocities with the relative cross section of each increasing with increasing velocities. The close-coupling calculations for the over-the-barrier model are able to accurately describe the dominant channel of capture, but this theory shows little evidence of its ability to accurately describe the relative cross sections of the final captured states.

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Low Cost Microwave Network Analyzer

Kai Wai Wong, Scholar
William B. Kuhn, Ph.D., Mentor

In today's high technology market, manufacturers are looking to build better products for wireless applications such as mobile phones, pagers and cordless equipment. All of these products require high frequency components for their circuitry. High frequency components benefit from high quality factor characteristics and excellent microwave performance.

Testing of these high frequency components requires a Microwave Network Analyzer, which costs around $45,000 or more. To generate such large amount of funding is a major obstacle for many researchers and designers at engineering colleges. This paper provides a way to own a similar set of instruments with about one tenth of the funding.

This older set of instruments is built in the pre-computer era consists of an HP 8350A/B Sweep Oscillator Mainframe with HP 862XXA RF Plug-ins, an HP 8410B Network Analyzer with HP8414A Polar Display Plug-in, an HP 8743B Transmission-Reflection Test Unit with HP 8411A Harmonic Frequency Converter, and a National Instrument PCI-6024E DAQ card with an addition of a personal computer with LabVIEW 6i.

LabVIEW is a user friendly, graphical programming language. LabVIEW programs are called Virtual Instruments, or VIs for short. LabVIEW VIs can used within other VIs as sub-VIs because they are hierarchical and modular. The frequency control VI and the DAQ VI can be used as top-level programs because they can function on their own. They, however, are considered as sub-VIs because they are used within our project VI. The frequencies of the HP 8350 Sweep Oscillator are controlled by the frequency control VI via the HPIB (Hewlett-Packard Interface Bus) interface, as the Short, Open, and Load (SOL) calibrations are performed.

A SOL calibration procedure is used to characterize the errors created by the effects of the connectors, cables, and directional couplers within the analyzer before performing measurements of the device under test (DUT). Our project LabVIEW VI is used to perform SHORT, OPEN, and LOAD calibrations for the HP 8410B Network Analyzer. After the calibrations, measurements for the DUT are made. The measured data is corrected according to the calibration data and then displayed on a Smith Chart on the LabVIEW front panel.

This paper shows that a LabVIEW program can take the place of the computer control unit because it can perform SOL calibrations and acquire/display the reflection coefficients of the device under test on the computer screen in a Smith chart. With the addition of a LabVIEW program to our older Hewlett-Packard network analyzer set, calibration correction factors can be applied, we have a computer controlled Microwave Network Analyzer set which can help us accomplish the same task as today's one-piece system, but at very low cost.

Comparing the SOL standards re-measured after completing the calibration results to our theoretical results of the SOL standards, this paper shows that they were well matched. Comparing the measurement taken with the reference plane modified using the 8743B line-stretcher to our theoretical values, this paper concluded that our LabVIEW program is working accurately with our network analyzer set. For the economical reason, the tradeoff of our system is taking more time than the modern machine to calibrate the network analyzer and collect the data points of the device under test is acceptable. Since our project LabVIEW VI only applies to One Port calibration, further enhancement is needed to make it available for Two Ports, so that it will be a complete "microprocessor-equipped" Microwave Network Analyzer set.

In December of 2003, Kai Wai Wong earned a bachelor's degree from Kansas State University in electrical engineering, and immediately began graduate work in electrical engineering at K-State, with a primary research interest in microwave and radio frequency circuits design. As a graduate student, he continues to work on research with his McNair mentor, Dr. William Kuhn, Professor of Electrical Engineering at KSU. His research work includes writing code and building circuits to perform "automatic tuning" of a fully integrated Q-enhanced LC filter. Kai has called Topeka (KS) home since he and his family emigrated from mainland China when he was in high school.