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Decomposition and Composition Analysis of Sibling *Bt* Corn and Non *Bt* Corn

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Literature suggested that *Bt* corn has higher lignin concentration compared to its sibling non-*Bt* corn. It was hypothesized that an increase in lignin concentration would result in a decrease in rate Bt corn decomposed compared to its non-*Bt* sibling. Reduced decomposition may result in increased residue, which could reduce erosion. However, persistence of *Bt* corn in the soil may also mean an increase in residence time of toxin, increasing potential hazard to non-target organisms and increasing selection potential for toxin-resistant target insects. This study determined the biochemical composition (soluble sugars, starch, hemicellulose, cellulose, lignin, total C and total N) and the rate of decomposition of stover from *Bt* and non-*Bt* corn on stover (2 mm). The ground stover was incubated in a Barnes soil at 25°C and 60% WFPS. Gas chromatograph was used to measure the total respired CO_2 of amended soil periodically over 120 d. A two-component exponential decay model was used to describe the decomposition of the corn residue. The more quickly decomposing material are referred to at the active fraction and the slower component as the passive fraction. The half-life of the active component was 10.6 days for *Bt* corn and 11.4 for the non-*Bt* sibling. The passive component had a half-life of 1066 for Bt corn and 1366 for the non-Bt corn. Suggesting that the Bt corn may decay slightly faster than the non-Bt corn. In the field corn stover will also be subjected to predation by macro and meso-fauna, which could alter rate of decomposition.

Decomposing Plants—Does Composition and Plant Part Affect Decomposition Rate?

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Understanding decomposition of plant residue is vital to understanding C and N cycling, both in terms of plant nutrient needs and global change. Roots typically constitute less than half the total plant biomass but literature suggests they contribute 1.4 to 1.8 times as much C to the soil as above ground plant biomass. This study addresses the related issues of plant composition, residue decomposition, and C and N cycling. The first objective was to compare the biochemical composition of roots, both among species and with leaves and stems. The second objective was to evaluate the decomposition rates of roots, leaves and stems among species and relate those rates to biochemical composition and to C and N mineralization rates. Plant materials from C3 and C4 species were collected at physiological maturity. Structural and nonstructural components from roots, stems and leaves were measured. Decomposition of plant material in soil was monitored as evolved CO_2 at 25°C and 60% water-filled pore space. Chemical composition and decomposition varied among species and plant organs.

Corn Stover as a Biofuel

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Corn stover is one of several feedstocks being considered as a biofuel. Although corn stalks currently are not harvested routinely, the huge amount of biomass produced annually makes corn a potential commercial biofuel. Removal of crop residue from the field needs to balance against preventing soil erosion, maintaining soil organic matter levels, and preserving or enhancing productivity. After corn stover is fermented to produce ethanol, the remaining residue is about 70% lignin. Lignin decomposes slowly, which can help stabilize soil structure. One use of fermentation by-product would be as a soil amendment, thereby minimizing some of the negative impacts of stover removal on soil structure. Laboratory studies show that by-product of stover fermentation increased microbial biomass and soluble C by 20% compared to soil with out amendment. In the severely eroded soil, humic acid concentration (r^2=0.84, p<0.0001) and aggregate stability (r^2= 0.35, p< 0.001) increased linearly with increased fermentation by-product concentration. Thus, laboratory results suggest that this fermentation by-product has potential as a soil amendment. Returning by-product to the field may slow the loss of soil organic matter caused by removing corn stover. Careful management of stover removal (avoiding eroded or erosion prone areas) and selective placement of the by-product could contribute to a sustainable use of corn stover for ethanol production.

Annual Medics (*Medicago* spp.) Can Help Develop Sustainable Agriculture in the Upper Midwest.

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Recent interest in sustainable cropping systems has renewed interest in legumes as forage, cover, N-fixing, weed smothering, living mulch crops, and to reduce soil erosion. Annual medics, *Medicago* spp. closely related to perennial alfalfa, grow rapidly, produce large amounts of biomass with many pods, supply nitrogen through nitrogen fixing bacteria, are adapted to a wide range of soil types, and have hard seeds that remain viable in the soil. Medics do have potential uses in sustainable agriculture systems, however, additional research is needed to clearly define their niche, especially in the upper Midwest. A large (>500 accessions) germplasm collection was assembled from international sources and is being screened, characterized and evaluated for adaptation, growth rate, biomass production and carbon sequestration capability under the short-growing season of the upper Midwest. The objectives of this study are to identify adapted accessions with the maximum combination of: 1) rapid growth rate, high nitrogen fixation rate in symbiosis with the soil bacterium *Sinorhizobium*, and large biomass production, 2) adequate levels of *Phytophthora* root rot resistance required under cool, wet soils, 3) dual utilization as forage or hay, 4) shade tolerance as companion crops, and 5) high below ground carbon storage capacity.

DEVELOPMENT OF *CUPHEA* AS A UNIQUE OILSEED CROP FOR THE U.S.

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Saturated plant oils composed of small and medium-chain triglycerides (i.e., C8:0 to C14:0) are extensively used in the chemical manufacturing industry. Yet, in the U.S. there currently are no crops grown to meet industrial demands. Several species from the genus *Cuphea* produce large quantities of such oils and some have potential for agronomic domestication. Recently, semi-domesticated lines developed from an interspecific cross between *C. viscosissima* and *C. lanceolata* have been shown to be successfully grown in west central Minnesota. Cuphea offers to be a true alternative crop that could be used in rotations that are already lacking in diversity. Our research with semi-domesticated cuphea has focused on developing agricultural management practices for its production and identifying potential environmental and agronomic limitations. Utilizing row-cropping equipment common to Midwest farmers, we have been relatively successful in establishing cuphea, and producing seed yields as high as 1.0 Mg ha^{-1}. We have found that cuphea may be susceptible to drought, and heat-stress when incurred at reproductive phase. Difficulties associated with weed control, seed harvesting and processing still exist. Although some obstacles still remain, results appear favorable for agronomic production of cuphea in the near future.

SIMULATION MODELING TO PREDICT THE ADOPTION AND ECONOMIC VALUE OF A CROP TECHNOLOGY INNOVATION

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Simulation modeling is a useful tool for identifying the potential impacts of technology innovations. The use of simulation modeling in this capacity is illustrated for the case of a temperature-sensitive polymer seed coating that has recently been introduced. This information is important both to a company who is trying to market the new technology and to the potential users of the technology. For this analysis, we take the perspective of a typical farmer as a potential user of the technology. Simulation modeling is used in three ways in the analysis. The effect of random weather events and cropping system are used in the EPIC simulation model to: 1.) identify field conditions that determine *when* the technology can be used and 2.) identify crop yields and production costs that quantify *what* happens when the technology is used. Finally, an economic model is constructed using a decision-tree approach to 3.) incorporate the *when* and *what* into the user's management plan to see *how* the technology will be used. Integrating these three components provides a framework for predicting the extent to which this new technology will be used, the effect of the technology on cropping practices, and the economic value of the technology to crop producers.

SALT AFFECTED SOILS IN SOUTH DAKOTA

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Throughout much of the central Corn Belt, soil salinity problems seldom are a significant impairment to the production of agronomic commodities. However, as we look to the western edge of the Corn Belt, the area where evapotranspiration exceeds precipitation, we find that because drainage is less developed, salts are less apt to be carried out of a watershed, and soil salinity problems can and do occur more frequently. Naturally high levels of soil salinity are often found, farming tillage practice induced soil salinity has been documented, and irrigation induced salinity has been responsible for causing cropping system failures. An overview of how salinity can naturally cause problems and how man has contributed to Salinization problems will be discussed. A discussion of how management can be used to minimize salt problems concludes the discussion.