

2010



SOYBEAN CHECKOFF

Investments In Soybean Research



MICHIGAN SOYBEAN CHECKOFF

Effective. Efficient. Farmer-Driven.



2010

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North Central Soybean Research Program

Ed Cagney, Michigan Soybean Producer and President of the NCSRP board
Funded at a level of \$100,000

While each state faces unique soybean production challenges addressed locally, many challenges are not state specific and a coordinated multi-state effort to avoid duplication is needed. Since its inception in 1993, the NCSRP has been an example of how twelve mid-western states have formed an alliance to cooperatively address common challenges. By forming this alliance, not only is duplication avoided but collectively projects can be addressed that would be impractical for an individual state to undertake.

Recurring NCSRP Objectives:

1. To coordinate twelve states to collectively leverage both human and financial resources for addressing common challenges.
2. To involve and coordinate researchers in all twelve states in common projects.
3. Restrict research grants to addressing agronomic challenges being faced by soybean producers.
4. To identify other sources of leveraged funds to augment NCSRP funding.
5. To facilitate the governance by a grower board representing all member states which is independent of individual states and the United Soybean Board.

2010 Projects Involving Michigan:

1. Soybean Aphid (SBA) Management, Bio-control, and Host Plant Resistance
2. Sudden Death Syndrome (SDS) Research Alliance
3. Improving Management of Soybean Cyst Nematode (SCN) through Extension Demonstration and Outreach
4. Soybean Genes for Controlling SBA
5. Improved Management of White Mold in the North Central States

For more information, access the NCSRP web site at www.planthealth.info.

Increasing the Amount of Soybean Meal in Diets of Yellow Perch

Maria S. Sepulveda, (project leader) Purdue University, and Coordinated by Indiana QSSB
Approved Michigan funding level up to \$9,549
(Cooperatively funded with other states at a level of \$67,881)

Soybean meal (SBM) contains crude protein and essential amino acids concentration similar to those found in fish meal; therefore, may be a viable replacement for fish meal in fish feeds. The long-term objective of this project is to increase the amount of SBM as a replacement for fish meals in feeds for the commercial production of perch. The yellow perch industry in the U.S. continues to expand; thus, formal evaluations of perch diet and strain interactions are warranted.

Initial research will be done at Purdue University's Aquaculture Research Laboratory in West Lafayette, Indiana. An eight week feeding trial will be used to assess the ability of different strains of yellow perch to utilize SBA as crude protein.

Objectives for October 1, 2009 through September 30, 2010:

1. Compare nutritional performance, evaluate the morphology of the hind-gut, identify sequences of genes known to regulate energy utilization, compare expression patterns of these genes, evaluate the morphology of the levels and compare digestibilities.
2. Tissue samples for genetic analysis have been collected and stored for later analysis. Intestinal tissues for histological analysis have been submitted for analysis.

2009 Results to Date:

1. Purdue researchers have identified/obtained two strains of yellow perch. All fish have been stocked and are acclimated to culture conditions. All diets have been formulated and manufactured.
2. At the conclusion of the study (9-30-10); weight gain, percent weight gain, feed efficiency and specific growth rate will be analyzed for % SBM inclusion in diets.
3. Genetic/molecular analysis will be analyzed.

Potential Herbicide Interactions in Double and Triple Stacked Herbicide Resistant Soybeans

Don Penner (project leader), Michigan State University

Approved funding level up to \$20,000

The appearance of glyphosate resistant weeds along with the availability of the multiple stacked herbicide resistant seed will be a motivating factor for using herbicide combinations. Historically, herbicides used in combination have shown the mode of action of one herbicide may antagonize the other's effectiveness. The underlying hypothesis is that soybean producers will continue using glyphosate and when/if glyphosate resistant weeds appear will apply herbicide combinations commensurate with any herbicide resistant seed trait.

Initial research will be done in the greenhouse where controlled conditions can be best attained to investigate any potential interactions between these herbicides associated with herbicide trait developed seed.

2009 Objectives:

1. Document whether interactions, synergistic or antagonistic, occur from combinations of post emergence applications of glyphosate and glufosinate, glyphosate and chlorimuron and glyphosate and the combination of glufosinate with chlorimuron.
2. Determining the basis for any interactions.
3. Evaluate the combinations on weeds common to soybean production in Michigan.

2009 Results:

1. Again in 2009, the study showed that antagonism occurred across combinations of glyphosate, glufosinate and chlorimuron on common ragweed, yellow mustard, Canada thistle, giant foxtail, common lambsquarter, and velvetleaf.
2. Seven days after treatment (DAT) synergism was apparent at high rates of glyphosate and glufosinate on giant foxtail, common lambsquarter, velvetleaf, and Canada thistle.
3. Fourteen DAT the synergism turned to no-effect or antagonism; likely due to re-growth from Canada thistle roots, tillering from the growing point of giant foxtail and axial bud growth on common lambsquarter and velvetleaf.

This portion of the study is now complete.

Use of Adjuvants to Solve Problem Interactions in Double Stacked Herbicide Resistant Soybeans

Don Penner (project leader), Michigan State University

Approved funding level up to \$17,900

Weeds resistance to the most commonly used soybean herbicide, glyphosate, appears to be more prevalent. To offer producers management solutions, varieties stacked with resistance to glyphosate, glufosinate and ALS inhibiting herbicides will be sold. Can this offer soybean producers an opportunity to tank mix herbicides for weed control applications to varieties containing these stacked traits?

Two years of research funded by the soybean checkoff indicates an antagonistic effect of herbicide combinations could result. Since the concept is a reality, can judicious use of adjuvants solve the antagonism.

2010 Objectives:

1. Test the hypothesis that antagonistic, undesirable interactions of a fast acting herbicide and a slower acting herbicide can be solved with the proper selection of tank-mix adjuvants.
2. A controlled greenhouse environment will be used for evaluations.
3. Treatments will be evaluated on velvetleaf, common lambsquarter, and giant foxtail.

Impact of Winter Annual Weed Populations on Early-Season Pest in Reduced and No-till Soybean

Christy Sprague (project leader), Chris DiFonzo, Michigan State University
Approved funding level up to \$20,000 (last year of the project was the 2009 season)

Conservation tillage systems (ex. No-till) and the reduced use of residual herbicides, most likely have contributed to increased presence of winter annual weeds in Michigan soybean fields. Soil-borne insects and SCN have presented challenges in reduced tillage systems in recent years. The growth habit of winter annuals may act as a “green bridge” for the survival of next year’s insects and diseases.

2007 and 2008 Results:

1. From the fifty-five no-till fields sampled:
 - a. Common chickweed, purple deadnettle and Shepherd’s purse were the most common winter annuals identified.
 - b. Three fields had wireworms present and ten had grubs present.
 - c. Asiatic garden beetle (2), European chafer (3), Japanese beetle (8) and true white grubs (6) were present upon sample analysis.
 - d. Approximately half of the root samples have root lesion nematode with only one sample having any SCN (purple deadnettle).
 - e. Only four fields had SCN present in the soil samples with the root/soil analysis from the field with SCN infected purple deadnettle having a moderate number of SCN present.
2. The effect of timing for winter annual weed management was investigated for soybean yield, insect survival, etc.
 - a. A residual (Canopy EX+2,4D ester) and no residual (glyphosate +2,4D ester) were spring applied at two locations.
 - b. Mid season biomass analysis results indicated a significant benefit with the application of a residual herbicide across all but one timing application.
 - c. Only root lesion nematode was present in weed and soybean roots in this study.

2009 Objectives:

1. Continue a survey of early-season pests (SCN) associated with winter annual weeds in conservation tillage-throughout Michigan.
2. Determine the suitability of several winter-annuals as hosts for SCN in Michigan.
3. Investigate the effect of timing of winter-annual weed management and effects on soybean yield and early season pests for conservation tilled fields.

2009 Results:

1. None of the field plot locations had high populations of SCN present in the soil nor was any SCN found in any of the winter annual weed roots collected from any location. Growth chamber studies using resistant and susceptible soybeans as comparison revealed: common lambsquarter, common chickweed, horseweed, and shepherd’s purse had no SCN and field pennycress and henbit were found to have some SCN. Although the SCN numbers were much lower than the soybean checks, any reproduction indicates that SCN is able to feed/reproduce on the roots of these winter annuals.
2. Herbicide treatments involved fall applications as well as spring applications with Spring applications prior to flowering (to avoid weed seed).
3. Mid season weed biomass sampling indicated that residual treatments and later applied no residual treatments significantly reduced weeds biomass when compared to the fall or earliest spring no-residual treatment.
4. Despite reduced weed control in the earlier no-residual treatments and increased weed biomass, yields were not significantly different except early season weeds were not controlled.

2009 was the last year for this project.

Long Term Management of Dandelion in a Corn and Soybean Rotation

Christy Sprague (*project leader*), Jim Kells, Michigan State University

Approved funding level up to \$5,400

Previous research (Kells and Renner, MSU) demonstrated reasonable management levels of dandelion in a no-till corn and soybean rotation could be attained with proper application and herbicide selection. Without investigating tillage options, control could only be attained to an 85% acceptable level. At this level, dandelion can still be a problem for subsequent crops. Because of this, dandelion population dynamics need to be examined over a long time frame for sustainability of no-till production when considering control with both chemical and tillage options. To this end, the long term study was established in 2006 and will end with data from the 2009 crop (four years).

2009 Objectives:

1. Examine population dynamics and various weed management strategies of seedling and established dandelion in no till corn and soybean rotations.
2. Determine the effect of tillage and herbicide combinations on the establishment and population dynamics of dandelion.
3. Analyze the net return of grain yield for various dandelion control strategies.

2007, 2008, and 2009 Results:

1. Dandelion populations are essentially zero in systems that were intensively managed (treated with Roundup Weather Max + 2, 4D ester + AMS in the fall and spring) in both crops.
2. In the tillage component of the study, tillage reduced dandelion populations by 98% or greater.
3. In 2007, when corn was planted in the rotation and dandelion was treated in the spring only, corn yield was reduced by 52 bu/a (NOTE: treatments reduced dandelion populations; however, may have depleted early season soil moisture.)
4. In 2008, when soybeans were planted in the rotation, soybean yields were similar for all treatments except for unmanaged dandelion plots where dandelions reduced soybean yields by 35%.
5. After just two years, the benefits of intensively managed dandelion has resulted in markedly reduced dandelion populations and preservation of crop yield.
6. In 2009, unlike previous years, dandelion numbers began increasing in the “spring only” treatment.

Summary:

From the research, dandelion can be effectively managed. Systems that include a fall herbicide application in combination with a spring or post herbicide that has dandelion activity have provided the best management.

Screening for Herbicide Resistant Weeds in No-Till Soybean Production Systems

Christy Sprague (project leader), Michigan State University

Cost will be reimbursed on a billing basis at a rate of \$30.00 per sample analysis.

At the end of any growing season, there are several weeds that escape control. Common lambsquarters, grant ragweed, common ragweed, horseweed (marestail) and velvet leaf are the most commonly mentioned. Herbicide resistant weed concerns are heightened by the widespread use of glyphosate. Suspected herbicide weed resistant samples can be tested, free of charge to soybean producers, at the MSU Plant Diagnostic Center.

2009 Objective:

To confirm field diagnosis of suspected herbicide weed resistance in a soybean field, a mature seed head of the suspected resistant plant must be submitted to the MSU Plant Diagnostic Center for a greenhouse grow-out analysis.

2009 Results:

1. Five mature seed heads were submitted consisting of common ragweed (1), powell amaranth (2), lambsquarter (1), and horseweed (1) for analysis.
2. Screening results were based on each submitted weed species as compared to a non-treated control and a susceptible biotype of each weed species.
 - a. No sample was resistant to a triazine, glyphosate or glufosinate
 - b. The ragweed and both pigweed samples were resistant an ALS-inhibitor
 - c. The common lambsquarter and horseweed samples were not resistant to on ALS-inhibitor

For 2010, this project will continue:

- Research efforts are based on the original premise
- Same involved researchers
- Reimbursed at the \$30.00 per sample rate

2010 Objective:

To confirm field diagnosis of suspected herbicide weed resistance in a soybean field, a mature seed head of the suspected resistant plant must be submitted to the MSU Plant Diagnostic Center for a greenhouse grow-out analysis.

Weed Control and Yield Comparisons in New Herbicide Resistant Soybean Varieties
Christy Sprague (project leader), Michigan State University
Approved funding level up to \$22,000

Many claim the widespread use of glyphosate as the cropping herbicide choice has resulted in a number of weeds in Michigan that escape control. Implementation of other weed management strategies is generally used to manage weed escapes that have increased tolerance to glyphosate. In 2006 and 2007, the soybean checkoff researched and helped promote residual herbicides for weed control.

With the recent introduction of Liberty Link™, and the Roundup Ready 2 Yield™ seed traits, soybean producers are increasingly asking about yield, economics and weed control comparisons when using these newer technologies as compared to non GMO and the older glyphosate seed technology. Because of the different companies involved in differing seed traits, background genetics are not similar; therefore, isolines cannot be compared. For this research, four similar maturity soybean varieties for each seed trait will be evaluated.

2009 Objectives:

1. Evaluate weed control from different weed management systems in Roundup Ready 2 Yield™, conventional glyphosate, Liberty Link™ and non GMO.
2. Compare yields and economic returns from Roundup Ready 2 Yield™, conventional glyphosate, Liberty Link™ and non GMO.

2009 Results:

1. Field studies were conducted at MSU farms in Richville and E. Lansing. All plots were seeded 175M/A in 15" rows by mid May. Weed pressure at Richville was only one weed per m² and over 800 per m² at E. Lansing. Because of a 4 inch rainfall event in E. Lansing, soybeans were injured from the pre-application.
2. Averaged across all varieties, yields for RR2, RR and Liberty Link were not significantly different at Richville; however, the non-GMO has significantly loss yield. At E. Lansing, within each herbicide program there were differences in yield between traits; however, in all management systems the Liberty Link and RR2 yields were always among the highest. Economic returns (considering technology cost and non GMO premiums) indicated there were no differences across the four traits at either location. Keep in-mind, this is only one years' data with a comparison of only one RR2 variety.

For 2010, this project will continue:

- Research efforts are based on the original premise (four RR2 varieties will be evaluated)
- Same researchers will be involved
- Approved funding level up to \$24,800.00

2010 Objectives:

1. Evaluate weed control from different weed management systems in Roundup Ready 2 Yield™, conventional glyphosate, Liberty Link™ and non GMO.
2. Compare yields and economic returns from Roundup Ready 2 Yield™, conventional glyphosate, Liberty Link™ and non GMO.

Weed Control Systems in Non-GMO Soybeans
Christy Sprague (*project leader*), Gary Powell, Michigan State University
Approved funding level up to \$5,200

Based on non-GMO premiums paid to grower and the advent of glyphosate resistant weeds, recent years have seen a gradual shift to more non-GMO soybean acreage. Weed control remains the primary challenge to non-GMO soybean production. Key non-GMO weed control practices remain; starting with a clean seed bed, use of residual herbicides, making timely post emergence applications and identifying the weed species present. With a known effective non-GMO weed control system, additional producers may decide on non-GMO production offering additional profit opportunities and reducing the likeliness of specific herbicide resistance weed species.

2010 Objectives:

1. Develop and evaluate the effectiveness of several weed control programs for non-GMO soybean production.
2. Determine the economic returns of the weed control programs tested.
3. Provide the research data to producers in a timely manner at meetings, through media, etc.

2010 Michigan Soybean Cyst Nematode Survey

George Bird (*project leader*), *Sasha Kravchenko, Fred Warner, Martin Chilvers, and Lesley Schumacker-Stid, Michigan State University*
Approved funding level up to \$28,900

There has never been a statistically valid survey of Michigan soybean acreage for SCN. Since it was first discovered in Michigan in the 1980's we know it is widely spread throughout our state (40 counties) and has been managed by crop rotations and host plant resistance. The success of such management depends on the selection of a resistant variety with its resistance source effective on the fields SCN type. This project is important for the development of future high quality SCN management and educational programming.

2010 Objectives:

1. Determine incidence of occurrence of SCN at both the farm and field level.
2. Assess density levels associated with soybean production.
3. Evaluate aggressiveness of SCN populations by using the SCN type test.
4. Determine the incidence of occurrence of both the root lesion nematode and SDS based on sub-sampling of the SCN samples.

MSU Diagnostic Services Free SCN Soil Testing/Communications

George Bird (*project leader*), *Fred Warner, Michigan State University*
Approved funding level up to \$22,550.00

Diagnosticians at MSU will provide free SCN soil testing for SCN presence and provide individualized grower recommendations for management practices in the event of a positive identification. The overall analysis results (individual producer results remain anonymous) will be made accessible to producers through meetings/mailings/etc. indicating counties of concern.

2009 Results:

1. 726 samples of suspected SCN infected soils were submitted representing 33 counties.
2. Data analysis indicates 53% of the samples were positive for SCN with an average SCN population density/county of 24,583 per 100 cm³ soil.
3. 10.5% more samples were submitted than were submitted in 2008 with 18 counties represented by more than 10 submitted samples.

For 2010, this project will continue:

- Research efforts are based on the original premise
- Same involved researchers
- Approved funding level up to \$25,800.00

2010 Objective:

The program will continue with greater communication relative to SCN management options by soybean producers.

Soybean Cyst Nematode Management Research and Education

George Bird (*project leader*), John Davenport, Michigan State University, Joe Scrimger, BioSystems,
Tom Kendle, Farm Cooperator
Approved funding level up to \$7,400

Soybean Cyst Nematode (SCN), a key pest of soybean, is managed through the planting of resistant varieties. Even though three sources of resistance may be available, one source, PI88788 predominates. Since it has been shown that continual use of one source can result in virulent SCN populations causing less effective SCN control resulting in lower soybean yields, the result of using one source needs to be analyzed. It has also been shown that the most common plant parasitic nematode in Michigan, the Root Lesion Nematode, can breakdown SCN resistance.

2009 Objectives:

1. This is the final year of the project with a main objective of the development of management practices designed to slow or prevent highly virulent SCN populations.
 - a. When using resistant varieties and a two year corn-soybean rotation lower SCN populations to levels where a susceptible variety can be grown.
 - b. Determine if resistant sources PI 88788 or PI 437654 can be used.
 - c. Determine any impact glyphosate resistant soybean production may have on SCN populations.
 - d. Determine any impact soil enhancement practices may on have SCN development
2. Relate results of this year study to growers for assisting them in making future SCN management decisions.

2007-2009 Results:

This project is now complete with the reported results encompassing the whole project.

1. During the higher rainfall growing seasons (greater than 18") the top five yielding SCN varieties out-yielded the susceptible by 45%.
2. During the lower rainfall growing seasons (less than 18" = average of 13") the top five yielding SCN varieties out-yielded the susceptible by 52%.

To understand the 2009 soil quality restoration project, a review of the earlier research is necessary.

1. 2004-06 summary includes: a two year rotation with wheat, SCN susceptible and different genetic sources of resistance, and soil quality enhancement practices.
 - A highly resistant SCN variety planted in 2004 (wheat in 2005) followed by a susceptible variety in 2006 yield significantly ($P=0.05$) greater (25%) than an SCN susceptible planted in 2004 followed by an SCN susceptible in 2006. In short, the resistant "clean-up bean" works!
2. 2007-09 data result included; a two year rotation with corn, SCN control of both conventional and RReady varieties.
 - An SCN resistant variety following a resistant variety in 2007 (corn in 2008) still showed a 16% yield increase over the control.
 - There was no statistically significant difference between the response of RReady and conventional varieties.

Mapping Distribution of Soybean Sudden Death Syndrome Caused by *Fusarium Virguliforme* and Assessment of Pathogen Virulence and Fungicide Sensitivity to Facilitate Management and Breeding Efforts

Martin Chilvers (*project leader*), *Dechun Wang, Bradley Serven, and Jan Byrne,*
Michigan State University
Approved funding level up to \$15,000

Sudden Death Syndrome (SDS) is a soil-borne disease that infects soybean roots and produces a toxin(s) that affects the foliage. Quantifying yield losses can be difficult and varies from year to year. Although SDS disease severity may be increased in plants co-infected with SCN, it can and does develop in absence of SCN. Management of SDS could be enhanced if we had a better understanding of such factors as; the type and aggressiveness of the infecting agent, a better understanding of its distribution by county, its association with SCN in Michigan, and a better educational program to relate findings to producers. This project provides a pro-active approach to addressing SDS in Michigan.

2010 Objectives:

1. Verify SDS presence in Michigan and to map its location to the county level.
2. Once identifying the SDS isolate, we plan to characterize its genotype and phenotype essential to selecting isolates for screening/treatment measures.
3. Improve SDS management through producer educational meetings stressing symptoms, distribution, and epidemiology.

Soybean Aphid Management – The Next Step

Christina DiFonzo (*project leader*), *Dechun Wang, Michigan State University*
Approved funding level up to \$14,000

Over the last six years, a core group of mid-western scientist including Dr. DiFonzo at MSU have conducted research on the soybean aphid (SBA). Successful research has addressed threshold recommendations (250 SBA/plant), bio-control and host plant resistant evaluations as well as the development of a suction trap network for researching predictive models.

Since host plant resistance has now been identified by several universities, much of the earlier research is now needed when using resistant soybean germplasm. With well established inoculation methods, the screening of various host plant resistant sources must be evaluated across environments.

2009 Objectives:

1. Collect data to determine any need to modify thresholds in SBA resistant germplasm.
2. Examine the relationship between SBA resistance and K deficiency.
3. Continue to screen host plant resistance when exposed to natural SBA population conditions.
4. Follow-up/initiate any new biological control releases.
5. Maintain the suction trap network for the development of a predictive model.

2009 Results:

1. Even though field infestations were nearly 10%, SBA's per plant were low (24 SBA/plant). The average yield of the sprayed (Warrior, two times) and the unsprayed were not statistically different. The RAG1 variety (LD 6060) variety was used in the trial.
2. Even under K deficient soils, the MSU source of SBA host plant resistance did not break down. NOTE: Number of SBA in this plot in 2009 was low.
3. When caged (bio-control absent) the SBA resistant lines had significantly less SBA's – bio-control made a substantial difference in SBA control on susceptible lines.
4. No 2009 impact so far of the biological control release (SBA parasitic wasp) in 2008.
5. Five suction traps were maintained in Michigan in 2009. Perhaps with natural predation more common on the SBA, the trapping network may not be a good predictor of future SBA levels.

For 2010, this project will continue:

- Research efforts are based on the same premise.
- Same involved researchers.
- Approved funding level up to \$21,500.

2010 Objectives:

1. Continue the multi-state effort to investigate threshold levels of SBA resistant varieties.
2. Examine the relationship of SBA resistance and K deficiency.
3. Continue to monitor natural bio-control and host plant resistance and evaluate new releases of permitted SBA parasitoids.
4. Evaluate/maintain the suction trap network.

Field Application of Contans to Control White Mold in Michigan
Jianjun Hao (project leader), Martin Nagelkirk and Bruce MacKeller,
Michigan State University
Approved funding level up to \$9,000

From 2007-2009, the soybean checkoff provided funding to evaluate the effect of commercially available soil applied bio-control products to control white mold. All products were to target the sclerotia of the pathogen in the soil. The bio-product Contans fully controlled apothecial germination in the greenhouse. Field plot results also showed that Contans had the best effect on reducing disease incidence with the effect being more significant if fall applied. With superior performance (when compared to other bio-control products) of Contans, we have confidence in now performing on-farm, field scale tests.

2010 Objectives:

1. Evaluate the efficacy of Contans under field conditions both with and without irrigation opportunities and fall applied as well as spring applied.
2. Distribute the results to Michigan soybean producers.

Optimizing the Conditions for Soybean White Mold Control by Using Cultural Practices and Biological Control Agents

Jianjun Hao (project leader), Willie Kirk, Michigan State University
Approved funding level up to \$18,900

While research has demonstrated the biological control material Contans has been effective in controlling the sclerotia of white mold in the greenhouse and research plots (field scale plots are planned for 2010), factors effecting Contans efficacy need further testing (such as soil moisture, temperature, fertilizer, pesticide, etc.). In addition, newer products are being released and need an independent evaluation.

2010 Objectives:

1. Evaluate factors that affect the application and effectiveness of biological control agents.
2. Evaluate the effectiveness in the greenhouse and field research plots of new biological control agents.

Using Biological Agents to Control Soybean White Mold
Jianjun Hao (*project leader*), *Dechun Wang, Ray Hammerschmidt,*
Michigan State University
Approved funding level up to \$20,000

White mold is said to be the second most important “pest” of soybean in Michigan and continues as a challenge to Michigan soybean production. Partial resistant varieties and agronomic practices are relied upon for control measures. This project will research the possibilities of using commercially available biological control of soil sclerotia to disrupt the disease cycle.

2009 Objectives:

1. Plant tolerant and susceptible varieties after sclerotia soil infestation for greenhouse soil and plant disease evaluations after applying Contans bio-control product.
2. Use the greenhouse for evaluating the effects of soil temperature and moisture on the efficiency of bio-control agents.
3. Use commercially accepted row spacing and populations for field scale testing of bio-control agents where sclerotia was added to the soil for evaluating soybean yield and sclerotia survival.

2009 Results:

1. Greenhouse study:
 - a. Again in 2009, the bio-control product Contans out-performed others tested.
 - b. Increasing rates of Contans were no more effective – apparently these beneficial bacteria can be easily moved by any force to reach the pathogen.
2. Field plot study:
 - a. As expected, the highest number of apothecia was observed in non-treated plots.
 - b. The apothecia number was again lowest when Contans was applied.
 - c. The Contans treatment effects correlated to the highest soybean yield.
 - d. It appears as though a single (fall or spring) application persists and moves in the soil to allow its pathogenicity.

2009 was the final year for this project.

Soybean Yield Contest for Michigan

Ned Birkey (project leader), *Mike Staton*, Michigan State University
Approved funding level up to \$8,000

Success in implementing a Michigan soybean yield contest has been minimal in past years. The decision to re-initiate such an effort in 2006 was to build upon the Michigan Soybean 2010 project. With the commitment of MSUE to be supportive of Soybean 2010, we are pleased of their interest in promoting the Yield Contest to augment Soybean 2010. With four years of “yield contest experience”, we now can eliminate mistakes and build upon the successful aspects.

2009 Objectives:

1. Achieve a goal of 100 completed entrees.
2. Secure sponsorship of five commercial seed companies.
3. Involve fifteen county MSUE in securing at least one entry.
4. Again, complete a data analysis comparing all four years of contest entrees.
5. Hold a recognition luncheon to honor the division winners and to share their agronomics in producing their yields.

2009 Results:

There were 41 producers involved that submitted 54 entries from 19 counties.

- a. The average yield of the 5 class winners was 71 bu/a, which was 2.5 bu/ac higher than the previous year.
- b. According to the MASS, Michigan's 2009 soybean average yield was 39 bu/ac.
- c. The highest class yield was the Group II Irrigated with a yield of 75.8 bu/ac.
- d. A four year summary reveals:
 - Those with the highest yield planted earlier, performed tillage prior to planting, utilized 15" singulated planting delivery and had a slightly lower final plant population (162M vs. 175M).

For 2010, this project will continue:

- Same coordinators
- Approved funding level up to \$8,000.00

2010 Objectives:

1. Obtain 100 statewide yield contest entries.
2. Solicit corporate sponsorship for entry fee.
3. Combine the 2010 data with the previous four years for trend considerations.
4. Increase publicity of results data.

Strip Testing At Regional Sites (STARS)

Dave Pratt (project leader), Michigan State University
Approved funding level up to \$6,000

Within the last ten years, growers have increasingly expressed interest in a coordinated effort to test new management opportunities on a replicated, field scale, strip trial basis. Initiated in 2008 was a program called Strip Testing At Regional Sites (STARS) designed to test in this manner. We are aware that many growers were doing some testing on their farm; however, it was not well coordinated for similar testing protocol nor subjected to statistical scrutiny.

In 2008 such an effort was begun through the investment of your soybean checkoff and the cooperation of MSUE.

2009 Objectives:

1. Only under irrigation, again test a foliar fungicide spray at the R3 stage with the same protocol.
2. Using standardized protocol, evaluate soybean performance at differing population levels.
3. Evaluate foliar fertilizer spray at multiple locations with standardizing testing procedures.
4. Provide statistically sound results to every Michigan soybean producer through the *Michigan Soybean News*.

2009 Results:

1. Even though cooperators interest was expressed early-on, foliar fungicide application at the R3 stage under irrigated conditions did not either yield data and/or usable data.
2. Four replications of each of three planting populations, 120M, 160M, and 200M, were compared for a final yield. Six locations reported final yields.
 - a. The average of the four replications at six statewide locations were:
 - 120M (planted) 47.45 bu/a
 - 160M (planted) 47.00 bu/a
 - 200M (planted) 47.88 bu/a
 - b. Statistical interpretation of the plot data revealed (LSD 7.2 bu/a) no significant difference in yield at any population level.
3. Foliar application of Alpine fertilizer materials was the focus of one of the 2009 STARS program involving 33 cooperators producing usable data.
 - a. Treatment: 3:18:18 @ R1 – 1 gal/ac with 3:18:18 @ R3 – 2 gal/ac
 - 15 yield comparisons with four replications of treatment compared to control
 - Statewide average of treatment was 43.0 bu/ac as compared to the check yield of 42.7 bu/ac
 - Statistically interpretation of plot data revealed (LSD 0.6 bu/ac) no yield difference
 - b. Treatment: 3:16:16 @ R1 – 1 gal/ac TMR (1 qt liquid sugar) and 3:16:16 @ R3 – 1/2 gal/ac enhanced CRN and 1 qt/ac liquid sugar.
 - 18 yield comparisons with four replications of treatment compared to control
 - Statewide average of treatment was 50.0 bu/ac as compared to the check yield of 49.2 bu/ac
 - Statistical interpretation of plot data revealed (LSD 0.6 bu/a) a significant (at 0.05 level) yield advantage to the treatment
 - With such data, consideration should be given to net profit when considering product and application cost.

For 2010, this project will continue:

- Use of the same Alpine foliar fertilizer treatments / population study
- Attempt to involve the same cooperators
- In 2010, coordinated by Mike Staton
- Approved funding level up to \$6,000.00

2010 Objectives:

1. Using standardized protocol evaluate similar planting population as in 2009.
2. Using Alpine Plant Food's product to evaluate the same foliar fertilizer program in 2010.
3. Disseminate data to every Michigan soybean producer.

Experimental Soybean Production (ESP) in S.W. Michigan

Dan Rajzer (*project leader*), Michigan State University

Approved funding level up to \$2,930

With the perception/reality of the Michigan soybean yield trend not “keeping-up” with other rotational crops, interest has been expressed by the MSUE in Cass County and local producers to research Experimental Soybean Production (ESP) in hopes of identifying yield limiting factors. The initial effort will address agronomic, not economic yields.

Two S.W. Michigan soybean producers along with MSUE are adopting the “Kip Cullers” concept of using a small acreage to experiment for high yields. The premise for such an ESP effort is the need for a paradigm shift in the next decade to a yield goal of 70-80 bu/A.

2010 Objectives:

1. Planting options:
 - High populations/twin rows/early planting/seed treatment
2. Post treatments:
 - Foliar fertilizer/insecticide/fungicides
3. Irrigation:
 - “Spoon” feed plant to avoid stress
4. Uncommon practices:
 - Vinegar, sugar, glycerin, clipping buds, extremely late maturity

Overcoming the Barriers to Higher Soybean Yields – A Soybean 2010 Project

Mike Staton (*project leader*), Michigan State University

Approved funding level up to \$12,500

With Michigan soybean yields declining by 8.7% comparing a time period of 1990-1994 vs. 2000-2004, when compared to increase of 35.1% for wheat and 8.4% for corn, a program called Soybean 2010 was established to reverse this trend by the year 2010. A soybean 2010 survey in 2005 clearly shows differences when comparing management practices of higher yields to lower yields. This was confirmed with a follow-up survey conducted in 2008. Efforts are needed to work with producers for increased soybean management.

2009 Objectives:

1. Through two grower meetings held on the west side of Michigan (2009 the meetings were on the east side), disseminate the latest information on equipment trends such as planters, combines, GPS, etc.
2. Since this will be the final year of Soybean 2010, grower input will be gathered for future direction.

2009 Results:

1. Over 400 attended the two producer meetings held on February 3 and 4, 2010 in West Michigan.
2. A survey of attendees indicated that over 80% returning a completed survey learned information to be used in 2010.
3. The Soybean 2010 web site (<http://web1.msue.msu.edu/soybean2010/>) has been updated with the latest soybean news.
4. The Soybean 2010 web site reported over 7,000 “hits” in 2009.

This is the last year for this project.

Soybean 2010 On-Farm Research and Demonstration Trials

Mike Staton (project leader), Dave Pratt, Dan Rossman, Paul Gross, Bruce MacKellar, Dan Rajzer, and Ned Birkey, Michigan State University
Approved funding level up to \$22,000

When comparing Michigan crop yields for wheat, corn and soybeans for a ten year period (1990 – 1994 vs. 2000 – 2004), wheat increased 17.4 bu/ac (35.1%), corn 9.4 bu/ac (8.4%) and soybean -3.2 bu/ac (-8.7%). The declining soybean yield appears to be unique to Michigan as nationally an increase of 6.8% has occurred for the same time frame. The Soybean 2010 project was created to determine any yield limiting factors for Michigan. The research, education and demonstration addressed in this project are designed to help growers overcome any identified barrier.

2009 Objectives:

1. Evaluating the yield potential of soybean varieties grown across Michigan's environments.
2. Maximize soybean yield by researching the yield effect of a combination of recommended treatments.
3. Evaluating the yield potential of non GMO specialty trait soybean varieties.
4. Continuing research designed to compare performance of determinant vs. non-determinant soybeans grown under irrigation in S.W. Michigan.
5. Evaluating the economics of seed treatment and of inoculants.
6. Evaluating the economic effect of the placement of potassium fertilizer on soybean performance.

2009 Results:

1. 30 Group 2.2 or earlier and 31 Group 2.3 to 2.6 glyphosate resistant varieties were compared in the Thumb area, statistically analyzed with the data published for producer reference.
2. 17 non-GMO and special use soybean varieties were compared for yield in Gratiot and Isabella counties. Data was statistically analyzed and published for soybean producers.
3. In St. Joseph county, a determinant growth habit and an indeterminate growth habit Group III soybean varieties were compared for yield and disease. Statistically analyzed data was published for producers.
4. Isabella county tested seed treated with Apron Maxx or Cruiser as compared to non treated seed. Statistically analyzed data was published for producers.
5. The performance of SCN resistant compared to susceptible varieties was conducted at 5 locations in Gratiot County. Statistically analyzed data was published for producers.
6. Leverage insecticide and Stratego fungicide treated plots were compared to untreated plots at two locations in Monroe and Washtenaw counties. Statistically analyzed data was not possible due to plot location and number replications.
7. Four replications of planted populations, 80M, 120M, 160M, and 200M of Cruiser Maxx seed were to be compared to a 180M planted non treated check variety. Heavy rains after planting accompanied by a wet harvest rendered the data unusable.
8. Three projects titled; *Economic Effects of Potassium Fertilizer Placement in Soybean*, *Economic Effect of Soybean Inoculants*, and *The Use of Tramlines in Soybean Production* were not researched.

For 2010, this project will continue:

- Research efforts are based on the original premise
- Same research coordinator
- Approved funding level up to \$23,100.00

2010 Objectives:

1. Evaluate the yield potential of varieties grown in the Thumb area.
2. Evaluate the yield and economics of non-GMO and special use soybeans in mid-Michigan.
3. Measure the effect of different conservation tillage tools on soybean production (yield & economics).
4. Analyzing the effects of planting dates and populations on soybean economics.
5. Measure the effects of foliar insecticide and fungicide on soybean economics on S.E. Michigan.
6. Comparing the yield/economics of SCN resistant and susceptible varieties in central Michigan.
7. Evaluating on an irrigated, field scale basis the interaction of SCN with SDS.
8. Irrigation impact on determinate and indeterminate soybean varieties in S.W. Michigan.

Foliar Manganese Recommendations for Michigan Soybeans on Chronically Mn Deficient Soils

Kurt Thelen (*project leader*), *Tim Boring, Michigan State University*

Approved funding level up to \$18,300

The characteristics of many of Michigan's calcareous lake-bed and muck soils render soil applied Mn fertilizer ineffective so foliar Mn applications are necessary for optimal growth. Presently, Michigan soybean producers do not have adequate information on optimal rates, products or timings of Mn applied to soybeans on chronically Mn deficient soils. This project will research and develop recommendations specifically for soybeans grown on Michigan's calcareous lake-bed and muck soils while developing components of application and evaluating products.

2009 Objectives:

1. Evaluate current and potential management scenarios for Mn application in order to maximize soybean yield while minimizing application expenses.
2. Evaluate the effectiveness of differing Mn forms in different management scenarios.
3. Develop environmental and/or physiological indicators by which to base preventive Mn applications.

2009 Results:

1. First year results indicated significant effects for yield occurred:
 - a. The lake bed soil sites had yields that did not respond to preventative Mn applications.
 - b. The muck soil sites were responsive and yield the greatest when Mn was applied separately from glyphosate and as MnSO₄: rather than Mn-EDTA.
2. Analyzed trifoliolate tissue samples following Mn fertilizer application were generally greater for MnSO₄ compared to Mn-EDTA.
3. It appears soybean genetics (varieties) have a greater influence on Mn utilization than environmental and/or physiological factors.

For 2010, this project will continue:

- Research efforts are based on the original premise plus variety efficiency evaluation
- Same involved researchers
- Approved funding level up to \$19,900.00

2010 Objectives:

1. Evaluation of Mn fertilizer formulations, including broad spectrum products.
2. Comparison of Mn application rates.
3. Screening of Mn varieties to select for greater Mn use efficiency.

The Development of a Strategic Management Strategy for Profitable Soybean Production in Southeast Michigan

Tom Van Wagner (project leader), *Lenawee Soil Conservation District,*
Blain Baker & Tim Stutzman, Cooperators
Funded at a level not to exceed \$9,500

The concept of using precision agriculture technologies on Michigan Soybean producer farms is not a new concept. However, the use of research on a field scale basis while incorporating these technologies that results in field variability recommendations is an emerging concept. Many growers have the technologies of variable rate technology, GPS receivers, yield monitors, field grid systems, either through grid sample or Veris machine readings, aerial imaging, etc. to allow zone management within fields. This is often referred to as spatial management within a single field.

With increasing frequency, soybean producers who have the proper technologies are asking for agronomic recommendations to treat spatially. With the cooperation of identified soybean producers and technology consultants, your soybean checkoff will research management concepts to allow agronomic decisions to be made spatially with a field.

2009 Objectives:

1. Equate final yields and the resultant economics to three final soybean populations by using within field spatial management concepts.
2. Scout the spatial managed fields by soil types to observe field and crop conditions.
3. Assist with both human and financial resources in funding the resultant information dissemination at grower meetings, mailings, etc.

2009 Results:

1. Foliar fertilizer research was conducted at both the Baker and Stutzman farms with a significant yield increase where foliar fertilizer was applied at the Stutzman farm but not at the Baker farm.
2. Population studies where the planted populations were 120M, 160M, and 200M were conducted at both locations. At the Stutzman location there was no significant difference in yields while at the Baker location the 200M yielded significantly more.
3. Spatial management within a Stutzman field showed no yield trend in the population study when considering different soil types/management zones.
4. A successful August 2009 field day and a January 2010 results luncheon were held with record attendance.

For 2010, the project will continue:

- Research efforts are based on the original premise
- Same project coordinators/cooperators
- Funded at a level up to \$9,500.00

2010 Objectives:

1. Evaluate tillage concepts (turbo disc, strip tillage, both compared to no-till) for economics and yield.
2. Evaluate different planting populations for yield and economics.
3. Evaluate foliar fertilizer applications at the R1 and R3 stage of growth for yield and economics.
4. Conduct both a late-summer field day and winter data report meeting for producers to attend for accessing research results.

Evaluate Early Maturing Soybean Germplasm for SDS Resistance

Dechun Wang (*project leader*), *Bradley Serven, Martin Chilvers,*
Michigan State University

Approved funding level up to \$8,000

Sudden Death Syndrome (SDS), though not documented “early-on” for identification, has been in Michigan for nearly ten years. In both 2008 and 2009, proper culturing has positively identified SDS from Michigan soybean fields. Since it appears to be an annual occurrence, host plant resistance has proven the best control strategy (SDS has been a serious challenge in southern states who now utilize resistant varieties). Since host plant resistance screening of early maturing germplasm (Group II and earlier) is rare, this is our initial effort.

2010 Objectives:

1. Evaluate early maturing soybean germplasm for SDS resistance at two SDS nurseries in central Michigan.
2. Evaluate germplasm with the most virulent SDS strain from Michigan and compare the results with an Illinois virulent strain.

Improve Michigan Soybean for Rust Resistance

Dechun Wang (*project leader*), *Ray Hammerschmidt, Michigan State University*
Hiraigu Chen, Jiangsu Academy of Agricultural Science

Ying Luo, Sanming Institute of Agricultural Science

Approved funding level up to \$24,000

Since host plant resistance to SBR has not yet been employed as a major control method, probably due to a lack of known source for stable and strong resistance, this project is long term in nature. With the, now established, two rust screening nurseries in China, previously identified possible resistant PI's along with lines from different crosses material can now be screened effectively at both the China SBR nursery as well as in cooperation with the University of Georgia.

2009 Objectives:

1. Further evaluate the possibility of SBR timely reaching Michigan for infection of soybean to determine future SBR research needs.
2. Since we have completed PI evaluations in our China SBR nursery, efforts will be to introgress and evaluate in China our confirmed resistant sources into elite Michigan soybean germplasm.

2009 Results:

1. One line continued to show partial resistance to SBR at multiple tests both in China and Georgia.
2. The partial resistant line was used as a “resistant” source in our breeding program. 12 lines out of over 600 showed a good level of SBR resistance in our 2009 evaluations.

For 2010, this project will continue:

- Research efforts are based on the original premise
- Same involved researchers
- Approved funding level up to \$24,500.00

2010 Objectives:

1. Re-evaluation of the SBR resistance will be conducted and agronomic selections will be made.
2. Confirmed SBR resistant lines will be crossed/back-crossed with elite germplasm.

Introgress Aphid Resistance from Exotic Germplasm to Elite Michigan Soybean Germplasm

Dechun Wang (project leader), Christine DiFonzo, Michigan State University

Approved funding level up to \$20,000

In addition to yield losses of up to 50% from physical damage of the SBA, they also transmit several viruses. In the long term, host plant resistance is the solution rather than risk the cost of spray timing while having environmental consequences of killing beneficial insects. The successful evaluation of over 2,000 plant introductions that resulted in identifying two PI's with antibiosis resistance has resulted in our antibiosis SBA resistant trait release. This release requires greater informational needs as questions arise from possible commercial partners as well as updated commercial SBA resistant germplasm.

2009 Objectives:

1. In an effort to address the possibility of regionally different SBA biotypes, diverse SBA resistant source research will continue.
2. Continue DNA genetic marker work relative to interested resistant sources.
3. Allocate human and financial resources to assisting commercial companies using SPARTA™ to validate SBA resistant genes by marker assisted breeding and actual grow-outs.

2009 Results:

1. The second antibiosis SBA germplasm identified as E07906-2 was released for commercial evaluation.
2. Two SBA lines containing the E07906-2 were tested in the Michigan advanced yield trials with promising results.
3. Over 6,000 lines (resulting from crosses with SBA resistance) were evaluated in greenhouses during the 2009-2010 Winter.
4. Genetic markers were identified for both of the MSU germplasm released SBA resistant material.

For 2010, this project will continue:

- Research efforts are based on the original premise
- Same involved researchers
- Approved funding level up to \$20,000

2010 Objectives:

1. Continue to diversify SBA resistance into elite germplasm for assurance of overcoming any diverse SBA resistant biotypes.
2. Refine any DNA markers to allow germplasm selection of "stacked traits".
3. Prepare needed marketing demonstrations and/or facilitation for creating the SPARTA™ awareness program.

Specialty Soybean Breeding and Soybean Germplasm Enhancement for Michigan Environment

Dechun Wang (project leader), John Boyse, Michigan State University

Approved funding level up to \$74,300

This is a long term project with crosses made yearly with subsequent evaluation for desired quality traits. Crosses are made, grow outs are implemented, selections are made, and those with desirable traits are advanced.

2009 Objectives:

1. Develop specialty varieties exhibiting characteristics for tofu, low-lin, low-sat, disease/insect resistance, etc. suitable for Michigan production.
2. Develop vegetable soybean (edamame and out-of-pod green soybean) varieties.
3. Continue the fatty acid composition analysis of Michigan adapted germplasm for specialty soy oil applications.
4. Enhance soybean germplasm by incorporating desired traits into germplasm adaptable to Michigan.

2009 Results:

1. Testing of advanced genetic material for agronomic evaluations.
 - Michigan performance trial (6 tofu lines, 1 edamame, 1 conventional)
 - USDA uniform soybean test data
 - Quantity traits (5 lines tested here)
 - SCN preliminary test (3 lines – 1, 2 and 6 – in yield ranking and 3 lines tested well in non-infected locations).
2. Edamame testing
 - One line tested for agronomics in MI Performance Trials
3. Progress of low-lin, low-sat germplasm
 - 42 lines were tested as either low-lin, low-sat, or combination of two with advancement of 6 lines to 2010 quality trait tests.
4. Fatty acid content/composition continued with the testing of over 7,000 lines.

For 2010, this project will continue:

- Research efforts are based on the original premise (this is a continuing effort)
- Same involved researchers
- Approved funding level up to \$75,000

2010 Objectives:

1. Develop soybean varieties/germplasm adaptable to Michigan environments with resistance to prevalent Michigan soybean disease.
2. Develop vegetable soybean (Edamame/out-of-the-pod green) varieties/germplasm.
3. Develop soybean varieties/germplasm with special fatty acid composition.

Soyfoam for Automotive Applications

Alan Argento (*project leader*), *W. Kim, University of Michigan-Dearborn,*
United Soybean Board (project coordinator), Co-funder
MSPC Approved funding level up to \$35,000

“Plugs” as manufactured foams are used as fillers in the automobile industry for applications such as reducing noise producing vibrations (drive shafts) and dissipate impact energy to prevent cracking of the plastic fascia between metal and plastic structures (bumpers). The traditional “plug” material is usually a petroleum-based polyurethane foam of low density. Preliminary research has shown that soy based foams can have similar properties if they can be manufactured to have similar densities and suitable stiffness to the existing petro based products.

2009 Objective:

Further investigate parameters surrounding past successes for process refinement to obtain our ultimate goal.

2009 Results:

1. Flexible soy based foam samples were tested and determined to have damping characteristics similar to the traditional NVH foam.
2. Testing of rigid foams (possible bumper reinforcement) is now being conducted.
3. A full size flexible foam drive shaft plug is being manufactured for testing.

This project will end on September 30, 2010.

Soy Oils and Polyols in High Performance Elastomeric Compounds

Cynthia Flanigan (*project leader*), *Ford Motor Company;*
United Soybean Board (project coordinator) and Co-funder
Approved funding level up to \$47,500

As a result of prior development work, the team within Ford's Research and Innovation Center has significant experience in compounding, processing and testing soy-based elastomeric compounds. Interest exists in using their established rubber processing facility to research high performance silica and carbon black reinforced rubber compounds typically used in tires by the incorporation of soy products to expand Ford's interest in sustainable material options.

2010 Objectives:

To develop and test high performance elastomeric compounds containing soy oils and soy polyols.

Use of Soymeal as a Filler in Plastics for Automotive Applications

Cynthia Flanigan (*project leader*), *Ford Motor Company*,
United Soybean Board (*project coordinator*) and *Co-funder*
Approved funding level up to \$60,000

With the strong corporate philosophy of using environmentally responsible materials and processes as evidenced by the recent implementation of soy based, flexible foam for automotive applications, Ford Motor Company intends to research the use of soymeal as a filler for automotive plastics.

In similar progression to the soyoil based foam products, Ford has completed positive initial assessments of soymeal use as a filler in plastics. The logical progression is to investigate processing conditions, properties and complete prototype molding of soymeal modified plastics.

2009 Objectives:

1. Continue to define optimum compounding formulas while performing performance testing.
2. Share preliminary data results with Ford supplier companies for product design/development/testing partnerships.

2009 Results:

1. The incorporation of soy filler in rigid polyurethane foam was possible without sacrificing performance.
2. Specific ranges of soy filler content were instrumental in product performance.

This research project is now complete.

OEM Technology Development 2010 and Beyond

Steve Howell (project leader), National Biodiesel Board (project coordinator)
A \$500,000 project with the Michigan funding level up to \$100,000

Through the soybean checkoff, soybean farmers funded most of the earlier research and market development efforts for soy biodiesel. Continuing efforts are now being leveraged with both private and government funding to address the many issues being faced in this burgeoning biodiesel industry. Since the year 2000, biodiesel production has grown from thousands to millions of gallons. It is estimated 700 million gallons were produced in 2008 and is estimated to be available nationwide at nearly 1,600 distributors and about 1,300 retailers.

Original Equipment Manufacturers (OEM) have diligently researched biodiesel use in their equipment which has resulted in a low biodiesel blend level endorsement by most OEM. With more restrictive emission requirements being implemented, newer challenges now face the biodiesel effort. As an example, diesel engine manufacturers that address emission with a Diesel Particulate Filter (DPF) in conjunction with In-Cylinder Post Injection of fuel to regenerate the trap (burn off accumulated particular matter) believe biodiesel blends of greater than B5 will cause engine oil dilution. If true, this phenomenon could lead to premature engine wear if oil changes are not more frequent.

2009 Objective:

With newer EPA emission mandates, diesel engine manufacturers are developing newer technologies that must be tested with B20 for compatibility to assure the continued use of biodiesel, such testing is the objective of this research.

2009 Results:

1. Significant in-kind funding via donation of engines, after-treatment components and engineering time was secured.
2. The baseline test with ULSD has been completed while biodiesel testing of B20 is nearing completion for the Diesel Particulate Filter (DPF). Operational issues with the CAT engine necessitated a pause in the testing.
3. Emissions testing of final fuels with the International engine is now complete. Data analysis is currently underway. Testing with this engine now shifts to determining biodiesel's impact on DPF regeneration.
4. Break-in work for the Cummins engine is now complete. Testing of emissions will be coordinated with the same set of fuels as other engine manufacturer tested.
5. Performance testing and durability in advanced light-duty diesel engines is complete with data analysis being done.

For 2010, this project will continue:

- Research efforts are based on the original premise.
- Researchers and research coordination remain the same.
- Approved Michigan with funding level up to \$100,000.00.

2010 Objectives:

1. With newer EPA emission mandates, diesel engine manufacturers are developing newer technologies that must be tested with B20 for compatibility to assure the continued use of biodiesel, such testing is the objective of this research.
2. Use the final year of the project to publish data.

Developing Glycerin in Oil Emulsions for Heating Fuel Supplements

Dave Karpovich (*project leader*), *Christopher Schilling, Saginaw Valley State University; Lanny Robbins, Larco Technologies*

Approved funding level up to \$19,975

This research effort is intended to build upon earlier research of testing the co-firing of glycerin with fuel oil in a dual fired furnace system. With the production of biodiesel fuel through the transesterification process using soybean oil, a valuable by-product is crude glycerine. Crude glycerine has been successfully refined for multiple uses; however, with more being produced because of the use of soy biodiesel additional uses need to be developed. Any development into a burnable fuel needs to recognize costs. The overall goal of this project is to develop glycerin/oil emulsions in the laboratory to facilitate an over-supply of crude glycerin.

2009 Objective:

Develop glycerin/oil emulsions in order to facilitate the use of glycerin as fuel in commonly available fuel oil burners.

2009 Results:

1. Stable emulsions were difficult to obtain; therefore, an extension of the project was granted through June of 2010.
2. An unstable emulsion was obtained from crude glycerin and fuel which is being investigated for the creation of a water-free stable product.

For 2010:

- Research efforts are based on an amended original premise
- Same research coordinator(s)
- Continued funding of original grant since an extension was granted

2010 Objective:

Further stabilize the emulsion to use greater amounts of crude glycerin while using a naturally derived fatty acid surfactant.

Alpha Olefins from Soyoil

Ramani Narayan (*project leader*), *Dan Graiver, Michigan State University*

Funded at a level up to \$10,000

Alpha olefins are not an end product but are building block hydrocarbon chemicals used in plastic copolymers, synthetic detergents, lube oil additives, metal working fluids, personal care products, and surfactants presently derived from petroleum based feedstocks. The hypothesis is that these new derivatives would have unique properties, be very price competitive and have a certain degree of biodegradability. The reasonable amount of funding requested is adequate to perform a limited amount of exploratory synthesis work and for analytical characterization of the product.

2009 Objectives:

1. Substituting a different alcohol for methanol in the soyoil transesterification process will be researched in hopes the reaction and end product, ally fatty acid esters (AFAE) can be readily made in the laboratory.
2. Even though the AFAE are not a completely new product, they have not been investigated in some of the current applications for alpha olefins which is a second objective.

2009 Results:

1. Since this was only a proof of concept, the laboratory success involving the transesterification of methyl soyate with an unsaturated alcohol was successful on a small scale basis.
2. A partner firm has agreed to use the alpha olefins made and will polymerize these to a high molecule weight olefin under a high pressure reactor.

This successful project funding is now complete.

Moisture Activated Cure of Modified Soyoil for Sealants, Paints and Varnishes – Phase II

Ramani Narayan (project leader), Dan Graiver, Michigan State University
Approved funding level up to \$20,000

Limited laboratory testing by this research group has shown that the silylated soybean oil can be used as a coating for wood, paper, glass and metal with good adhesion. The commercial target is to replace silicone coatings and sealants and polyurethane adhesive and coatings with a more cost effective system that has less environmental hazards and has the silylated soybean oil as the feedstock. Increased effectiveness should be realized because of the low viscosity of the modified soyoil allowing greater penetration into porous surfaces for providing a waterproof coating. Based on a recent patent application allowing intellectual property protection, additional work can be done to effectuate commercialization.

2009 Objectives:

1. To develop additional data on this novel coating polymer based on “grafting” a poly-functional vinyl silicone onto the fatty acid backbone of soybean oil through an extensive product development and testing program.
2. Present the resultant test data to companies involved in commercial coatings and sealants.

2009 Results:

1. The soy oil based coating which is modified with an alkoxy silane that reacts with the atmospheric moisture to effect a cured coating for (potentially) room temperature cure, adhesion to wood and metal surfaces and anti corrosion protection of metals.
2. Collaboration agreement following patent protection filing has been established with three companies as well as a grant application submitted to UNSF.

This successfully funded research is now complete.

Preparation of Soy Based Isocyanates from Soymeal

Ramani Narayan (project leader), Dan Graiver, Michigan State University;
United Soybean Board (project coordinator), co-funded MSPC
Approved funding level up to \$50,000

This is “proof of concept” project which will determine if the chemistry hypothesized can result in a soy isocyanate that can be used with soy polyols to produce high bio-based content polyurethanes. If soy isocyanate can be produced from soy protein, there will need to be a more involved project to investigate how to develop a cost effective process. With limited chemical experience to support the concept, success may be risky; however, if successful further research would be intriguing.

The overall objective of this project is to use soymeal in the process to make soy based isocyanates. Isocyanates are common industrial raw products used in the production of polyurethanes and polyureas. By building upon earlier “proof of concept” research, plans are to prepare soy based isocyanates with similar properties to traditional isocyanates to interest the polyurethane manufacturers.

2009 Objectives:

1. Further investigation of the chemical treatment of soy meal (protein) for a more efficient process.
2. Using any success in goal #1 to efficiently process the resultant treated soy protein to soy based isocyanates.

2009 Results:

1. The process used has produced soy protein with functionality; however, this has yielded a polymer that would not be commercially acceptable.
2. Alternative approaches are being researched with the remaining grant funds with success here determining further direction.

As proposed, this project is now complete.

Steel-Corrosion Inhibitors and Biocides Against Sulfate Inducing Bacteria

Ramani Narayan (*project leader*), Dan Graiver, Michigan State University

Approved funding level up to \$20,000

Prior research funded by the Michigan Soybean Promotion Committee had yielded a soy oil derivative that may have some functionality in the microbial induced corrosion of buried pipes. The cost of microbial induced corrosion on buried pipes alone is estimated to be in the millions of dollars and that at least one half of this corrosion is of microbial origin. The product from earlier research may be used to make Schiff bases which have been evaluated for their biocidal activities against sulfate inducing bacteria. Knowing these properties will allow the use of this grant to be used as seed money for more comprehensive research as the need/acceptance for “green” products increases.

2010 Objectives:

1. To explore the manufacturing of these Schiff bases from soy oil derivatives and to investigate their effect against the sulfate inducing bacteria that causes steel-corrosion.
2. To use these funds as “seed money” for securing larger grants which need data showing a “proof of concept” research effort.