SCRI-SREP Project CRIS Report

Biodegradable Mulches for Specialty Crops Produced Under Protective Covers

Year 2, October 1, 2010 – November 30, 2011


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PROJ NO: WNP03375 AGENCY: NIFA WN.P
PROJ TYPE: OTHER GRANTS PROJ STATUS: NEW
CONTRACT/GRANT/AGREEMENT NO: 2009-51181-05897
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START: 01 SEP 2009 TERM: 31 AUG 2012 GRANT YR: 2010-2011
GRANT AMT: $1,999,002

OUTPUTS
Activities: Yr 2 of a field experiment under three contrasting agricultural environments in TX, TN and WA, evaluated a modified (based on Yr 1 results) black, experimental spunbond (SB) polyactic acid (PLA) nonwoven fabric (PLA-11) as a biodegradable mulch (BDM) for specialty crops produced in high tunnel (HT) and open field (OF) settings. Comparisons to two leading commercial BDMs (BioBag, BioTelo), and cellulose mulch and conventional black plastic were made. A no mulch treatment was the control, with four replications of HT and OF plots with tomato test crop at all three sites. Three field experiments on adaptability of six cultivars each of lettuce, strawberry and tomato to HT vs. OF production were also done at each location. A two-year mesh bag study investigating biodegradation following mulch incorporation into soil was initiated. Greenhouse tests on soil additives to enhance mulch biodegradation were carried-out in TN and investigations on mulch biodegradability were coordinated with an internationally-renown scientific advisor at Michigan State University. All experiments involved mulch, plant and/or soil sampling with extensive laboratory analyses and/or comprehensive environmental and crop performance monitoring. Focus groups in TN and TX, and crop budget sessions in WA, were held with stakeholders. Widespread extension and scientific reporting took place.

Events: Four focus groups in TX and TN (38 people) on Apr 25-26 and 27-28 identified regional attitudes and knowledge of HTs and BDMs. Two crop enterprise meetings in WA (6 growers) on Nov 21-22 identified costs and returns for HT strawberry, and OF lettuce and strawberry production. Information about BDMs and HTs was delivered to local, regional, national and international audiences via (i) classroom settings; (ii) extension talks, field tours, workshops, radio programs; and, (iii) scientific abstracts, conferences, seminars, and invited presentations. Mesh bag, mulch, plant, and soil sampling completed regularly during 2011 by project working groups (WGs) per revised research protocols. The team and advisors (21 people) met Jun 1-2 in Lubbock, TX where WG presentations, graduate student symposium, video on mulch cleaning, and tours of South Plains Foodbank and SCRI field trials took place. Two team members participated in SCRI Session at ASHS meeting in Waikoloa, HI, Sep 25-28.

Services: Two post-docs, 6 graduate and 9 undergraduate students trained; 1 non-thesis M.S. advised; 2 graduate internships at other labs.

Products: Experimental spunbond (SB) nonwoven for the project (PLA-11) manufactured at Saxony Textile Research Institute, Chemnitz, Germany, based on 2010 project results. Protocols for monitoring crop, environment, mulch degradation and soil quality, refined by WGs based on Yr 1 progress, and
archived on team website. Video on mulch cleaning created for team reference. Web-based tools for defining project terms, improving PPT presentations, making great posters, and the Yr 2 team presentations posted on internal website. Public website (http://mtvernon.wsu.edu/HighTunnels/index.html) re-designed for Pacific Northwest, High Plains, and Southeast regional audiences.

OUTCOMES/IMPACTS
Knowledge: 16 publications; 69 presentations; 13 media interviews; 9,935 people directly educated; 331,766 scientists and 276,666+ people potentially impacted. HTs provide productive growing environments: in WA tomato yields can be 9 times greater with earlier strawberry harvests and fewer culls; in TX strawberry yields can be 880% higher and tomato planting 6 wk earlier; in TN, TX and WA, lettuce can be variably affected depending on climate. The HT model in TX withstood repeated high winds, and can be used in risk management. Spring-retrieved mesh bags of the WA and TX cellulose mulch revealed near complete degradation; WA samples had increased microbial biomass, N mineralization potential and B-glucosaminidase activity relative to no mulch. Only TX samples showed significant degradation of the commercial BDMs. SB-PLA-10 did not break down during cropping or biodegrade in the soil 6 mo post-incorporation. SB-PLA-11 showed improvement over SB-PLA-10 in laboratory-assessed deterioration parameters and on acceptable field levels of weed seed germination and growth. Weather events may be just as important as biodegradation in overall deterioration of BDMs per laboratory, greenhouse, and field assessment results from cooperating institutions. Focus groups revealed stakeholder knowledge of HTs and BDMS as being low, but with strong and growing demand for these technologies.

Actions: Alternative feedstocks for nonwovens blends are needed to better meet requirements of agriculture. A modified SB-nonwoven (PLA+polyhydroxyalkanoate) manufactured in Germany for testing in 2012 (based on team feedback in 2011) now at Hayes lab in TN. Hayes submitted NSF-IGERT proposal on Customized Energy and Renewable Carbon through Lignocellulosic Engineering as PD for $3.5 M (Jul 1). HTs offer a long-sought, organic alternative for late blight control on tomato in WA and elsewhere, the topic of a new extension effort. Report on Deterioration of Mulches in HT and OF Tomato Culture sent to industry. Hand-out on Biodegradable Alternatives to Plastic Mulch created for field days. Four publications now drafted (BDM fact sheet; manuscripts on HT lettuce and BDM field and gh breakdown). Yr 3 planning underway for (i) colloquium in 2012 on Biodegradable Plastic Mulches for Agriculture at ASHS Ann. Conf., Jul 21-Aug 3, Miami, FL, and (ii) Yr 3 team meeting, Mar 13-14, Knoxville, TN.

Conditions: Miles et al., contributed chapter on BDMs for new book published in The Netherlands; Hayes invited to give research presentations in China; Miles received inquiries from U.S. scientists on project techniques. Team efforts will again benefit stakeholders receiving reimbursement for HTs and/or BDMs via NRCS cost share program in TN and WA; TX growers wish to be eligible as some added HTs to their farms; NRCS stakeholders in MT also interested. WSU field site visits by representatives from BASF Biodegradables Plastics North America and Mirel-Bioplastics by Telles. Project director invited to discuss project management at SCRI Webinar Broadcast, Knoxville, TN (unavailable). Nearly all focus group attendees interested in learning more about HTs and BDMs, and working with project scientists.

Publications:
biodegradable mulches for “Green” agriculture. American Society of Agricultural and Biological Engineering (ASABE) Annual Meeting, Louisville, KY (abstract potentially viewed by 9,000 society members).


Inglis, D., Miles, C., Gundersen, B. and Roozen, J. May 9, 2011. Evaluation of high tunnels in western Washington for growing three specialty potato cultivars. WSPC Potato Progress Vol. XI, No. 4 (newsletter article; readership of 500).


environment—Part 1, cellulosic and melt-spun 100% PLA nonwovens. Journal of Engineered Fibers and Fabrics (reviewed by journal; preparing revisions).

Project participants (during 2010-2011):
Project Director and Co-Project Director: Debra Ann Inglis and Carol Miles, Washington State University (WSU) NWREC at Mount Vernon.
Crops Working Group (WG) members: Annette Wszelaki (Leader), University of Tennessee (UTK) at Knoxville; Russell Wallace, Texas AgriLife Research & Extension Center at Lubbock; Tom Walters at WSU NWREC.
Economics WG members: Tom Marsh (Leader), Suzette Galinato, and Srinivasa Ponnaluru at WSU Pullman; and, Eric Belasco at Montana State University (MSU).
Materials WG members: Douglas Hayes (Leader) and Larry Wadsworth at UTK; Karen Leonas and Hang Liu at WSU Pullman.
Sociology WG members: Robert Jones at UTK (Leader), and Annabel Kirschner, WSU Emeritus Professor.
Soils WG members: Jennifer Moore-Kucera (Leader) at TTU; Marion Brodhagen at USDA ARS Corvallis; Andrew Corbin at WSU Snohomish County Extension; Jaehoon Lee at UTK.

Other participants (during 2010-2011):
Ad Hoc Interest Groups: Terry Phillips, BIOgroupUSA, Inc., Palm Harbor, FL; Eric Menard, Dubois Agrinovations, Waterford (Ontario) CAN; Dick Mathes, Crown Films, Burlington, WA.
Graduate Students: Sathiskumar Dharmalingam, Jeff Martin and Rob C. Raley at UTK; Chen Chen and Chenhui Li at TTU; Jeremy S. Cowan and Marianne Powell at WSU Mount Vernon NWREC.
Industry Advisors: Robert Green, NatureWorks LLC, Cary, NC; Mark Williams, BioBag USA, Inc., Palm Harbor, FL.
Post-doctoral Associates: Hang Liu and Sasi Ponnoluru at WSU.
Scientific Advisors: John Dorgan at Colorado School of Mines; Lewis Jett at West Virginia University, Ramani Narayan at Michigan State University.
Stakeholder ( grower) Advisors: George (Ben) Craft, Alm Hill Gardens, Everson, WA; Elizabeth Malayter, Farm2School, Rogersville, TN; Ashley Basinger, South Plains Food Bank, Inc., Lubbock, TX; Tom Thornton, Cloud Mountain Farm, Everson, WA.

Professional Development: Altogether, project members involved in nine national and six international scientific meetings. Twenty-one team members and advisory committee members contributed to team meeting in Lubbock, TX where six graduate students presented their research and were critiqued during a symposium, and a mulch cleaning video was shown. Two Materials WG members visited Narayan laboratory Jul 7-17 at Michigan State University to review laboratory techniques for assessing biodegradation according to ASTM D5338, and set-up on-going experiments. One WSU graduate student visited Soils WG PI at USDA-Corvallis Mar-May to help isolate and identify soil microorganisms, potentially capable of biodegradation. Two web-based tools, ‘Improving PowerPoint Presentations for SCRI Outreach’ and ‘Making a Great Poster’ developed by Corbin for the team.

Targeted Audiences: Targeted audiences are local, regional, national and international, and include both conventional and organic specialty crop growers who use high tunnels and mulches, as well as HT and BDM manufacturers. Over 618,364 people have been reached via various publications and a public website, and presentations in classroom settings, at extension meetings, focus group and crop enterprise budget sessions, during workshops and field tours, by radio programs, mass media and on-line articles, during seminars and scientific conferences, and via scientific publications.

Deviations: In personnel: Dr. Marion Brodhagen, soil microbiologist, returned to Western Washington University from USDA ARS in Corvallis, OR. Dr. Eric Belasco, agricultural economist, accepted new
position at Montana State University. Dr. Robert Jones and Dr. Annabel Kirschner, sociologists, completed Yr 2 responsibilities but will not be participating during Yr 3. Dr. Ana Espinola-Arredondo (PI), and Brant Baugh and Mark Radosevich (advisors) also will not be participating during Yr 3. In methods: WSU’s Social and Economic Sciences Research Center will be utilized for Yr 3 project survey to assess the project’s sociological impacts.

Unexpected Outcomes: HT model designed in TX withstood 75 mph winds with minimal damage and the high quality of strawberries in them was unexpected. Also in TX, Southern blight on tomato was problematic in HT although Fusarium crown rot was less severe than in OF. Some growers in TX are concerned about HT costs. In addition, 18 bacterial and 42 fungal isolates with potential biodegradation properties were obtained on minimal media (non-cellulosic BDMs as sole carbon source) from field soils in TN, TX and WA. Because feedstocks for BDMs in our study were not available (as originally expected) in powder form, they could not simply be added to media in suspension. Therefore, Soils WG developed a novel method for UV-sterilizing the mulches themselves and supplying them as a sole, intact C source atop growth media while still supplying non-C nutrients. The isolates grew on the BDMs but not on minimal medium lacking a C source in the original isolations. Isolates have continued to be re-checked, and a third evaluation has revealed some growth without a carbon source for some. To rule out the possibility that some isolates are oligotrophs (efficiently scavenging volatile C sources from laboratory air), rather than true biodegraders, further laboratory studies are underway at WWU. Identification of all strains is ongoing via 18S rDNA analysis.

PRESENTATIONS – TENNESSEE SENIOR AUTHORS
(Local, Regional, National and International Audiences)

Jones, R. Jun 7, 2011. Identifying the barriers and bridges to high tunnel/BDM production systems among specialty crop producers and other stakeholders. 17th International Symposium for Society and Natural Resource Management, Madison, WI (oral presentation; 40 people).
Jones, R. Jun 14, 2011. Identifying the barriers and bridges to high tunnel/BDM production systems among specialty crop producers and other stakeholders. 18th International Symposium for Society and Natural Resource Management, Koto, Kinabalu, Malaysia (oral presentation; 40 people).
Hayes, D.G. Nov 7, 2011. Seminar on biodegradable mulches at Nanjing Agricultural University in China (invited research presentation; 30 people).
Wszelaki, A. Mar 3, 2011. Eastern Region Agricultural Extension Agent In-service Training, Knoxville,
PRESENTATIONS – TEXAS SENIOR AUTHORS
(Local, Regional, National and International Audiences)
Wallace, R.W. Apr 9, 2011. LDS Preparedness Fair, Lubbock, TX (oral presentations; 520 people).
Wallace, R.W. Apr 25, 2011. SCRI HT & BDM Focus Group, Lubbock, TX (oral presentation; 23 people).
Wallace, R.W. Sep 15, 2011. Presentation on High Tunnels to Texas AgriLife Faculty. Lubbock, TX (oral presentation; 20 people).
Wallace, R.W. Sep 17, 2011. High/Low Tunnel Workshop, Lubbock, TX (oral presentation; 30 people).

PRESENTATIONS -- WASHINGTON SENIOR AUTHORS
(Local, Regional, National and International Audiences)
Cowan, J. Oct 27, 2011. SCRI Project. Agriculture and Northwestern Ecosystems Graduate Student
Symposium, WSU Mount Vernon NWREC (45 people).
Inglis, D. Mar 23, 2011. Managing a large-scale SCRI project. Presentation to WSU Plant Pathology Graduate Students (oral presentation; 40 people).
Marsh, T., Sep-Nov, 2011. Weekly discussion of BDMs and high tunnels in a Managerial Economics Course (WSU EconS 452), Pullman, WA (four classroom presentations; 55 students each time).
Miles, C. Mar 8, 2011. Extended season vegetable production. WSU King County Hmong Farmers (oral presentation; 15 people).
Miles, C. Apr 16, 2011. Extended season vegetable production. Inland Northwest Small Farm Conference, Spokane, WA (oral presentation; 60 people).
Miles, C. Apr 27, 2011. Sustainable vegetable production, WSU San Juan County Master Gardeners (oral presentation; 25 people).
Miles, C. Jun 30, 2011. High tunnels and biodegradable mulch field tour for South Seattle Community College culinary students. WSU Mount Vernon NWREC (oral presentation; 60 people).
Miles, C., Inglis, D., Walters, T., Cowan, J. and Powell, M. Jul 14, 2011. WSU NWREC Field Day, Mount Vernon, WA (oral presentations by each; 100 people).
Miles, C. Sep 14, 2011. High tunnels and biodegradable mulch field tour for Charlie’s Produce buyers. WSU Mount Vernon NWREC (oral presentation; 60 people).
Powell, M. Jan 16, 2011. Disease issues in high tunnel tomato production.’ Island County Master Gardeners, Coupeville, WA (oral presentation; 100 people).
Powell, M. Mar 7, 2011. Disease issues in high tunnel tomato production.’ WSU Department of Plant Pathology graduate students (oral presentation; 25 people).
Powell, M. Oct 27, 2011. SCRI Project. Agriculture and Northwestern Ecosystems Graduate Student Symposium, WSU Mount Vernon NWREC (oral presentation; 45 people).

**MEDIA INTERVIEWS**
*(Local, Regional, National and International Audiences)*


Miles and Inglis (WSU) interviewed by WSU CAHNR NEWS for Jul 29, 2011 newsletter article, Biodegradable mulches for specialty crops produced under protective covers project team meeting. (1,255 readership)

Miles and Inglis (WSU) interviewed on Sep 16, 2011, by Eric Sorensen, Washington Magazine, for upcoming article on SCRI project, ‘Biodegradable mulches for specialty crops produced under protective covers.’


Wallace, R. W. (Texas AgriLife), Oct 22, 2011. (Texas AgriLife). Using Biodegradable Mulches (Radio Interview with Tom Nicolette; distributed to 30 radio stations as part of the Texas Farm Bureau Network), Waco, TX (35,000 listeners).