Making the Choice—Evaluating Two Disparate Strawberry Production Systems

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Executive Summary

Strawberry growers in the Upper Midwest have long relied on the matted-row production system, which involves a minimum of four herbicide and two fungicide applications during the first full year of production. In recent years however, the number of available, approved herbicides for use on strawberries has diminished while the cost of such compounds has increased. Growers are seeking alternatives to traditional methods which would reduce dependence on herbicides and other pesticides in order to create safer working conditions and provide a safe, high quality product to consumers.

We have developed a strawberry production system that plants strawberries in August, using a value-added wool mulch fabric in the row and canola between the rows. We have found in previous studies that this weed control system is highly effective for suppressing weed germination, thus eliminating herbicide applications. As a side benefit, because of the wool mulch, fungicide applications have been eliminated as well. We had three trial sites, two on-farm that compared our late-planting system to the traditional matted-row system. This allowed our grower-cooperators to evaluate the system and suggest ways to advance adoption and implementation.

The typical customers for this research/outreach effort are berry growers in the Upper Midwest whose operations average approximately 5 acres. Through this study, we sought to change the weed management practices used in strawberry production during the establishment year, thus having a ripple effect into the harvest year. Our grower-cooperators provided valuable insight on the effectiveness of the wool mulch system in a commercial operation, and offered suggestions on potential improvements and adjustments that might increase the likelihood of adoption by other growers.

Outreach and education were essential elements of this study. We developed a website that gave educational, virtual tours of the plantings, and allowed all growers to observe the plantings throughout the growing season. The site was updated with photographs and descriptions at each step of the system and outlined the crucial steps of this new production method. We created a manual which offers a step-by-step guide through planting and harvest. This publication can be downloaded from the project website, and offers interested growers all the information required to establish a wool mulch strawberry planting.

Growers were engaged at field days, demonstration events, and grower meetings on the benefits of the wool mulch system. Our grower-cooperators assisted in this effort by participating in panel discussions to share their experiences and offer suggestions on how to incorporate this method into an existing production operation. By the conclusion of the study, knowledge of- and interest in this method had increased among growers through the website and three presentations of the project.

The grower-cooperators have shown an interest in continuing to work with the wool mulch system, and will likewise be excellent advocates for the promotion of this new, sustainable method of strawberry production.
Project Summary

Field Research

The wool mulch strawberry production research/outreach effort began in May 2007 with the establishment of the control group of the experiment. Strawberry transplants were planted in the traditional matted-row system at three sites in Minnesota. These sites included a plot at the University of Minnesota West Central Research and Outreach Center (UM WCROC) in Morris, MN, a farm in Alexandria, MN, and a farm near St. Cloud, MN. Throughout the season detailed records were kept of labor input as well as herbicide and fungicide applications.

At the same time the traditional system was installed, preparations were being made for the wool mulch plots. Canola was sown in the wool mulch plots as a pre-plant treatment against weed seed germination. The end of July 2007, the wool mulch system was installed at the three sites. The plots were prepared, wool mulch fabric rolled out, transplants planted in slits in the wool, and canola planted between the rows as a further weed deterrent. The only herbicide applications were on the canola – one on the cover crop and one on the canola between the rows. (When canola is killed with herbicide, the dying plant tissues release glucosinolates – chemical compounds which are effective at preventing weed seed germination for up to eight weeks.) The use of two herbicide treatments is a reduction from the four treatments used in the matted row system. These plots were monitored for proper growth and weed presence. The wool mulch proved extremely effective at preventing weeds in the rows, and the canola prevented weeds between the rows. In September 2007, floating row covers were installed over the wool mulch plots to allow for late-season growth. In early November, floating row covers were removed and all the trial plots – matted-row and wool mulch – were prepared for winter with the application of straw mulch.

In April, straw was removed from the wool mulch plots and floating row covers reinstalled to promote early season growth. The matted row plots remained covered with straw for two additional weeks. At 10 percent bloom, the floating row covers were removed from the wool mulch plots to allow insect access to the plants for pollination. Weed presence was negligible in the wool mulch plots throughout the first harvest season, while it was high in the matted row plots. Because of the long, cold spring Minnesota experienced in 2008, harvest in both systems was delayed by approximately two weeks. However, as expected the plants in the wool mulch plots were ready for harvest one week before the matted row plots, and produced somewhat larger fruit throughout the season.

Outreach

Extension and outreach to growers were primary goals of this study. Numerous events, extension materials and publications produced throughout the year brought information about the research out to growers. One of the significant milestones for this study was the development of a website dedicated to the project. Development began in June 2007, and the site was updated, maintained and monitored throughout the study to ensure all information was current and accessible. The site was intended to make the research accessible to growers who could monitor the progress of field trials as the season progressed. The site includes several pages which provide the following information: background on the research and links to related, published articles; a timeline/calendar with photographs that chronicles the steps of implementing the wool mulch system; nutritional information and published health benefits of strawberry consumption; yield, cost, and labor data from the field trials; and links to related websites. The site has received moderate traffic, and growers have expressed satisfaction in regards to information on the site and ease of navigation. The wool mulch strawberry production website can be accessed at http://fruit.cfans.umn.edu/strawbsite/index.htm.

Researchers presented this project at several regional events throughout the year, and with each event came increased interest in wool mulch and its use in strawberry production. In July 2007, Emily Hoover presented the project at Horticulture Night at the University of Minnesota West Central Research and Outreach Center (WCRQC) in Morris, MN. The presentation was attended by local growers and interested residents. This was the first time many had heard of wool mulch. Researchers had designed a 3” x 5” color postcard to distribute at the event which included strawberry nutritional information and a list of strawberry varieties suited for production in Central Minnesota. This postcard was a popular take-away for attendees.

In August, 2007 the Minnesota Fruit and Vegetable Growers Association (MFVGA) held a field day at one of the field trial sites at Fairhaven Farm near St. Cloud, MN. Approximately 30 growers from the region attended the event at which Emily Hoover, Steve Poppe, and grower-cooperator David Macgregor gave a detailed
presentation of the project. Attendees were able to see both systems in progress and discussions followed. The overall response was very positive and there was expressed interest in the system’s potential to reduce labor inputs (primarily hand-weeding) as well as herbicide and fungicide use.

In February, Emily Hoover and graduate student Emily Tepe presented the project at the MFVGA annual meeting in St. Cloud, MN. The session included a Powerpoint presentation on the details and benefits of the wool mulch system and how it compares to the matted row system in terms of schedule, labor, chemical inputs, materials, and cost. An electronic audience response system was used throughout to add audience participation and to provide researchers with general grower demographics. Attendees showed interest and appreciation for the use of the audience response system which brought vitality and interaction to the session. The presentation was followed by a panel discussion that included Steve Poppe, Ron Branch – a grower-cooperator from Berry Ridge Farm, and Sherry Stringfield of the Minnesota Lamb and Wool Producers (MLWP), which is the organization marketing the wool mulch (product name is Woolch™) used in the project. The panel fielded many questions about the product, process, and cost of the system. The response to the session was very positive, and growers expressed a heightened interest in this product.

**Manual Development**

Emily Tepe, graduate research assistant, compiled a manual for growers interested in implementing the wool mulch strawberry production system. This 30-page document details the research on the production system and all its elements. The bulk of the manual consists of step-by-step instructions of the system from establishment year through the first harvest. The manual includes many color photographs of the various steps, system-specific diagrams, a production calendar, literature references, online resources, cost comparisons, and yield data. Researchers expect this publication to increase adoption of the wool mulch system, since it provides all the information a grower would need to successfully transition from the traditional matted-row system to this improved system. The manual is available for download on the project website, [http://fruit.cfans.umn.edu/strawbsite/index.htm](http://fruit.cfans.umn.edu/strawbsite/index.htm).

**Technical Content**

There are many in the public health community that would like to encourage Americans to consume strawberries regularly as part of a healthy diet, rather than as an occasional “healthy indulgence”. Over the last two decades, strawberries have experienced one of the highest rates of consumption growth of all fruits and vegetables. Strawberries are the fifth highest consumed fresh fruit in the United States, behind bananas, apples, oranges and grapes. Per capita consumption of strawberries has increased steadily since 1970 from 2.9 pounds to 6.1 pounds in 2003. New information on health benefits of strawberries has helped increase consumption.

Strawberries are recognized as a source of important nutrients including Vitamin C, folate, potassium, flavonoids, quercetin, kaempferol and ellagic acid for humans. Preliminary evidence suggests that strawberries may have a role in cardiovascular disease prevention, due to their rich nutrient content and corresponding antioxidant potential.

A typical grower of conventional strawberries may use any of the 371 labeled pesticides to bring strawberries to market. On occasion, residues are found to exceed current legally allowable tolerances, the safety of which has been called into question by consumers Union. Of particular note is the fungicide Captan (phthalimide). Captan is estimated to be applied to 89% of the strawberry crop in the U.S., with many growers in the Upper Midwest using it for control of gray mold and anthracnose on the fruit. In toxicology studies, Captan has proven highly toxic to freshwater fish but is generally not persistent in the environment. Captan exposure of the population is high due to its heavy use in fruit production. Reduction of risk from pesticides is a goal of the Food Quality Protection Act. Determining exposure to such compounds is important. In the wool mulch strawberry production system described here, Captan is eliminated, thus reducing overall population exposure.

Even though there are many compounds labeled for use, there is limited availability of herbicides to control weeds in traditional matted-row production systems. Diminishing availability and increasing costs of herbicides used for weed control in strawberries is causing growers to seek non-chemical methods. Adopting a new way of producing strawberries may be very desirable as growers are looking towards eliminating use of synthetic chemicals in their production systems. Non-chemical replacements will not only substitute for herbicides, but will also curtail ill-advised use of off-label chemicals, and, ultimately will provide an even safer
product for human consumption. There is strong demand for domestically produced specialty crops that are pesticide free.

The typical customer for this research/outreach effort is berry growers in the Upper Midwest. The majority of growers produce an array of vegetables and fruits sold directly to the consumer. The size of the operations varies from 0.25 acre to over 30 acres, with the average size being around 5 acres. Many of them grow strawberries because the fruit is harvested early giving them income before vegetable harvest begins. There is a growing interest within this group of growers in organic production as the consumer is interested in pesticide-free products. This group of growers has shown great interest in this research, and has in the past proven to change production practices after being convinced research results will work in their situation. Of the 90 MFVGA members who currently use the matted-row strawberry production system, at least 50% were educated about the new wool mulch system throughout the year. We are continuing our efforts to educate growers about wool mulch and its benefits in small fruit production.

**Key Personnel**

Dr. Emily Hoover – Grant coordinator, professor, UM Dept. of Horticultural Science. Dr. Hoover coordinated all members of the research team, arranged participation of the grower-cooperators, took part in field work, traveled to all trial sites to observe progress, and presented the research at the UM WCROC Horticulture Night in July 2007, an MFVGA field day and at the MFVGA annual meeting. Dr. Hoover continues to study the use of wool mulch in commercial fruit production systems, currently with high tunnel-grown raspberries. She believes the wool mulch product has potential in home garden and landscaping applications, and will continue to work with producers to lower the cost and increase availability. From the success of this study and its outreach efforts, she is confident that growers will begin to adopt such improved methods of production in order to create safer working conditions, offer pesticide-free food to consumers, and advance the overarching goals of sustainability.

Emily Tepe – Graduate research assistant, UM Dept. of Horticultural Science. Emily developed and maintained the project website, created postcards and other outreach materials, organized collection of photographs at each trial site, presented the research along with Emily Hoover at the MFVGA annual meeting, wrote the interim and final reports for this grant, and wrote the manual for implementation of the wool mulch system of strawberry production. Her participation in the field research component included all field work at the Fairhaven Farm trial site, from planting to harvest. She saw first-hand the benefits of wool mulch used in strawberry production, and carried this over to use in a garden setting. Emily utilized wool mulch in raised bed garden plots on the UM campus and found it offered significant benefits of weed prevention and moisture retention. She is enthusiastic about promoting use of wool mulch in the home garden and other applications as well as in strawberry production.

Steve Poppe – Research scientist, UM WCROC in Morris, MN. Steve oversaw planting at each site, and maintained the planting at the WCROC. Steve believes the wool mulch system is an improvement over the traditional method of strawberry production. The reduction of herbicide use is a significant improvement over conventional methods. He believes that the wool mulch system would be adopted by more growers if the wool mulch could be laid mechanically. This issue would be a good next step for research into this system. For growers interested in becoming organic, the wool mulch system would be an effective step in that direction, especially on smaller acreage (½ to ¾ acre). At this size, the wool could easily be laid by hand. Steve feels that total elimination of synthetic herbicides should be a goal of future research so the wool mulch system could be certified organic.

Ron Branch – Owner/operator of Berry Ridge Farm, 1201 Fireman’s Lodge Road SW, Alexandria, MN 56308 (320) 763-6893. Ron has a diversified specialty crop farming operation growing multiple fruit and vegetable crops. He markets his produce through a farmers’ market and is a member of the Minnesota Farmers’ Market Association. Berry Ridge Farm was one of the experimental sites, and Ron assisted with the efforts on his farm.

The wool mulch system performed very well at Berry Ridge Farm. Plants yielded larger fruit approximately one week earlier than the matted row plots, both of which are goals of the production system. The
system fit well into Ron’s existing operation, and the year progressed smoothly. The combination of wool and canola effectively reduced weeds in the experimental plot, and thus reduced hand weeding labor.

Ron would be willing to adopt this system if the wool mulch were a bit less expensive and more suited to mechanized production. Ron is currently participating in a study using wool mulch with raspberries in high tunnels. He feels the product is not as effective with raspberry plants because it can obstruct the growth of new canes. But with strawberries, and perhaps other crops including vegetables it is very valuable for preventing weeds and thus eliminating herbicide use on fruit and vegetable plants.

David Macgregor and Marsha Anklam – Owners/operators of Fairhaven Farm, 13835 51st Avenue, South Haven, MN 55382 (320) 236-7685. David and Marsha grow apples, strawberries, blueberries, and brambles. They have accomplished sustainable agricultural practices and are helping to fulfill the growing demand for responsibly-grown foods. Fairhaven Farm was one of the experimental sites, and David and Marsha assisted with efforts on their farm.

The planting at Fairhaven Farm experienced some challenges that were not present at other sites. Drip irrigation was not installed here. Rather overhead irrigation is employed on this farm. These plants did not grow as large as those at other sites, nor did they yield as much fruit as those at the two other sites that utilized drip irrigation. Despite this, it was good for the researchers to see how differences in irrigation methods affect the success of the wool mulch system.

Perennial weeds were a major stressor at Fairhaven Farm. This affected both the matted-row and wool mulch plantings, and resulted in lower yields than the two other sites. Perennial weeds such as quackgrass are undeterred by wool mulch. David and Marsha agreed that if perennial weeds were eliminated, the wool mulch system would be extremely effective in their operation. They expressed an interest in working with wool mulch on a different area of their farm that does not suffer from the same weed problems, and where strawberries have not been planted in recent years. Their commitment to sustainable production techniques makes them advocates of this and other systems that rely on improved practices over dependence on pesticides.

Continuation of research

There are several elements in the wool mulch system that warrant further exploration. The first is the possibility of eliminating the two herbicide applications on the canola, or determining a non-synthetic, environmentally benign method that is as effective as the glyphosate. Several non-chemical methods of killing the canola were trialed in previous studies, including mowing and undercutting. Neither of these methods were as effective as herbicide treatment. Other methods that may prove effective at killing the canola, but have not yet been studied include flaming, in which a propane torch is directed at the canola; and various non-synthetic herbicides such as citric acid- or vinegar-based compounds.

Further funding would also make possible the extension of the field trials beyond the first harvest year. Renovation is an integral part of strawberry production and this has not been attempted with the wool mulch system. Renovation occurs at the end of the first harvest year, and involves tilling and mowing. With the wool mulch in place, tilling between the rows may be detrimental because, 1) it may tear the wool and reduce its effectiveness against weeds the following season, and 2) the wool may tangle in the tiller and damage the equipment. Mowing could also be problematic for similar reasons if the mower is set too low. In studies to this point, funding has never allowed continuation of the research beyond the first harvest year. Therefore researchers have not had the opportunity to address these issues.

Continuation of research may also provide the chance for researchers to explore various methods of mechanizing the wool mulch system. Most of the labor in establishing the trial plots has been done by hand with student labor because of the small size of the plots. These methods would not be as effective for a grower installing an acre or more of the wool mulch system. Further research and cooperation with growers would likely reveal methods to mechanize the laying of wool and planting through the wool.

Other related research includes the use of wool mulch in other production systems. The mulch is currently being used in a study on producing raspberries in high tunnels. Wool mulch is used in the rows of raspberry plants with the purpose of preventing weeds, stabilizing soil temperature, and retaining soil moisture. It is hoped that continuing research will prove the benefits of this locally-produced, renewable and biodegradable product in various fruit and vegetable production applications over the use of plastic mulches, which themselves pose
environmental problems due to the need for annual disposal. Furthermore, researchers hope to reach home growers with this information to promote use of the product over herbicides in their gardens.

**References and Resources**

**References**


Hartnett, M. 2006. Natural growth: Natural food stores, large and small, are growing in number all across the country, with frozen food departments and refrigerated programs helping to drive that growth. Frozen Food Age. March 2006:22-23.


**Online Resources**

**General Information**

Minnesota Department of Agriculture

http://www.mda.state.mn.us/

University of Minnesota

Department of Horticultural Science

http://horticulture.cfans.umn.edu/

Extension Service

http://www.extension.umn.edu/

Commercial Fruit

http://fruit.cfans.umn.edu/

Minnesota Fruit and Vegetable Growers Assn.

http://www.mfvga.org/

North American Strawberry Growers Assn.

http://www.nasga.org/

Minnesota Lamb and Wool Producers Assn.

http://www.mlwp.org/

Woolch Supplier

http://www.mlwp.org/woolch.htm

Cornell University Berries

http://www.fruit.cornell.edu/berry.html

**Production Guidelines and Pest Management**

Many sites offer information on suppliers

Commercial Strawberry Production in Minnesota

http://fruit.cfans.umn.edu/strawbs/commercialproduction.htm


http://www.mda.state.mn.us/plants/pestmanagement/berrymanual.htm

Midwest Small Fruit Pest Management Handbook

http://ohioline.osu.edu/b861/pdf/ch02_51-54.pdf

Minnesota High Tunnel Production Manual for Commercial Growers – includes drip irrigation information and suppliers

http://www.extension.umn.edu/distribution/horticulture/M1218.html

National Sustainable Agriculture Information Service – production and pest management information, suppliers

http://attra.ncat.org/
Links to Articles on Wool-Canola Mulch Research


Renewing the Countryside  http://renewingthecountryside.org/index.php?option=&mode=region&task=view&category=3&Itemid=43&limit=1&limitstart=4

Renewing the Countryside 2002 – Pine Tree Orchards  http://renewingthecountryside.org/component/option,com_smartpages/task,view/category,10/id,148/Itemid,43/


