Delaware Department of Agriculture

2008 Specialty Crop Block Grant Program

Revised Final Report – February 2013

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CONTACT

Jo-Ann Walston
Marketing Specialist II
Phone: 302-698-4592
E-mail: JoAnn.Walston@state.de.us

Below is the final report for the 6 projects that are funded under this Specialty Crop Block Grant.

**Project Title:** Eat Local Delaware – Restaurant and School Program

**Project Summary:** There are 130 members of the Delaware Restaurant Association (DRA) and 19 school districts with a combined attendance of over 130,000 students. The need addressed by this project was serving this population fresh, local produce grown on over 12,000 acres in Delaware. The push for Buy Local, Buy Fresh has opened the doors to selling to this population and this project helped facilitate that purchase.

**Project Approach:**

- October 2010
  - The MOA Advisory Board met to discuss the current Farm to School purchasing activities, the possibility of a central Delaware produce, and what information to post on the website.
- December 2010
  - Members of the MOA Advisory Board tour the cafeteria of Sunnyside Elementary School in Smyrna, DE. They are gain a greater understanding of how a Child Nutrition Program is organized.
- January 2011
  - Solicitations seeking submissions for the Farm to School logo are sent to all Delaware students
  - *How to Sell to Schools* presentation is made at Ag Week
  - A Grower Survey is distributed at Ag Week and the Women in Ag Conference
- February 2011
  - A Nutrition Supervisor Survey is distributed via Constant Contact – 100% participation.
  - First Rate, First State Summit is held at the Delaware Ag Museum. The event brings together restaurant owners/chefs and growers. The summit, in its third year, is a networking event where farmers and producers, including value-added, can informally meet retailers, buyers, farmer's market managers and restaurant owners & chefs and build new business relationships. The Delaware Restaurant Association was notified of the event and encouraged to email blast their membership an invitation with all details. The DDA also contacted numerous restaurants throughout the state and invited them individually. Approximately five restaurants attended and met with farmers and producers in an informal setting at tables at the Ag Museum in Dover, DE.
- March 2011
  - The Inaugural Farm to School Summit is held at the Delaware Ag Museum. Fifteen of the 19 public school districts and approximately 11 growers are in attendance. This particular summit modeled the success of the First Rate-First State Summit which is open to all retailers/grocers/produce buyers, but in this case targeted specifically Delaware school districts. All other potential competitors for the farmers' crops were excluded. The event was attended by Governor Jack Markell and received a high level of media and press coverage. School district representatives and nutritionists sat at desks and met with farmers

face-to-face, one-on-one, in an effort to commence and build lasting business relationships.

- April 2011
  - Fifteen of the 19 public school districts and 1 charter school tour the Perdue Innovation Center in Salisbury, MD
  - The winners of the Farm to School logo contest are presented at the State School Board Meeting
- May 2011
  - The Second Annual Strawberry Week is held. The Nutrition Supervisors and Growers took the initiative to contact each other on their own.
- July 2011
  - Twelve of the 19 public school districts and 1 charter school participated in a School to Farm Field Trip where they toured five farms.
  - Small Wonder Hydroponic Farm is supplying local produce to The Brick Hotel in Georgetown and Hobo's Restaurant in Rehoboth Beach
  - Andrew Bell, an organic grower, is supplying local produce to Heritage Shores Country Club
  - T.S. Smith & Sons partnered with Heritage Shores for a Farm to Table event
  - Evans Farms did a Farm to Table event at Nage and then again at Abbotts Grill
  - Dogfish Head Restaurant is purchasing produce from Small Wonder and T.S. Smith & Sons
- September 2011
  - Met with the 19 public school Child Nutrition Supervisors to brainstorm ideas for National Farm to School Month. Ideas considered were: Meet your local farmer, have banners printed with the Farm to School logo, and have the Governor visit local schools to promote National Farm to School Month.
- October 2011 – National Farm to School Month
  - The Governor will be visited Colwyck Elementary School in October to promote the Farm to School program and celebrate Farm to School Month.
- January 2012
  - All 19 School Districts participated in a three hour Meet & Greet with Farmers at Ag Week in Harrington, DE, an annual event that brings hundreds of farmers and ag educators together in mid-January. Rain gauges were given to all growers that filled out a survey. The general consensus of the surveys that were completed indicated both a willingness and interest in the school districts participating in the purchasing and serving of local produce at their cafeterias located within their districts. However, the schools also indicated that they were unable to provide pick up of product, that the farms would have to deliver to each individual location.

    Also, laptops were set up and with assistance from FFA students growers were able to fill out the electronic W-9 which is required to be a State of Delaware vendor. Pocket notebooks were given to all that filled out the W-9.
- February 2012
  - Ten school districts are represented at the First Rate from the First State Summit held at the Delaware Ag Museum. For the ease of growers the FTS Summit was combined with the Grower Summit. Growers were able to meet with school

districts and restaurants during one three hour session. They each received a pocket notebook. Surveys were distributed and those that filled them out received a rain gauge. In this fourth year of the event the schools verbally reported their satisfaction with the contacts they made with local growers, one of which is a hydroponic farm.

  - Twenty restaurants are invited to the summit but only four attend. Though the four attending felt it was a beneficial event. Outside of these four restaurants/chefs that did attend and meet with farmers as well as value-added producers, several other invitees (who could not attend) reported that they are partnering with Delaware farms and securing local, fresh produce during the harvest season. Several farms and restaurants, particularly located around the beaches, hold 'farm to table' events and feature the farms' logo and literature in the menu, as well as invite the farm family to attend the evening of the event to meet and greet diners.

- March 2012
  - Local Produce Served Here posters are delivered to all schools. Each school received two for their cafeteria. Posters are 18"x24" and include photos of fresh produce, all photos were taken locally. The background is a listing of all produce grown in Delaware. Purpose is to show students (and other visitors to the cafeteria) what is available in Delaware and to get them excited about eating local produce.
  - Farm to School Banners are distributed to each district. They are used to promote the Farm to School Program in each district. They are rotated to different schools in that district depending on the event they are hosting.
- May 2012
  - The third annual Strawberry Week is held in schools across Delaware. Once again the Nutrition Supervisors and Growers took the initiative to contact each other on their own. Additional produce was purchased at the time which made the trip more worthwhile to the delivering growers.

- July 2012
  - Ten school districts and the Child Nutrition Representatives from the Delaware Department of Education attended the Second Annual School to Farm Field trip. They toured the Laurel Auction Market, a large watermelon producer, and a diverse family farm.
- August 2012
  - The Delaware Farm to School Website goes live. Growers now have the ability to look up contact information for the districts they would like to sell to and Child Nutrition Supervisors now have the ability to find growers contact information and their offerings online.
- September 2012
  - The Inaugural Watermelon Wednesday is held in all 19 school districts. A local watermelon grower presented the idea to the Child Nutrition Supervisors who worked together to make it happen. Media coverage included the Delaware State News, the News Journal, and Gatehouse Media.

- October 2012 – National Farm to School Month
    - Once again all school districts were invited to plan a National Farm to School Month event. Colwyck Elementary (Colonial School District) invited Mr. Celery to their event and received press coverage by WJBR 99.5. Governor Carper also visited their district to promote healthy eating. Seaford Middle School (Seaford School District) invited a local chef to host a cooking demonstration during their lunch period. Students received samples of Watermelon Soup and Two Bean Chili. They have requested the chili become a menu item. Lieutenant Governor Matt Denn and Secretary of Agriculture Ed Kee visited Sunnyside Elementary (Smyrna School District) to each lunch with students. Media coverage included WBOC, the News Journal Health Section, and Gatehouse Media.

**Goals and Outcomes Achieved:**

Performance Goal 1 – Clear Identification on the Menu

The school districts identify the local menus on their menus by either stating local or the name of the farm it was purchased from. For example, Fruit/Vegetable: Fifer Asparagus. Participating restaurants regularly list the source of produce on their menus (particularly when it's 'local') and feature the farms on special nights with posters and even appearances by members of the farm family.

Performance Goal 2 – Approximately 30 restaurants and schools in the program after a two year period

To date every school in every district is buying local produce at least once per year. This includes all 19 public school districts and two known private schools; Sanford School and Salesianum School (a Catholic school in Wilmington, DE). Produce is purchased from local farms, and delivered to the district schools by the farm. Since consistent menus exist for every school within a district, every school (elementary, middle and high) participate in Delaware to varying degrees (depending on availability of product, what's in season, etc.). Additionally, although statistics don't exist, prior to this project only a few known school districts were intermittently buying local produce from Delaware growers. Most districts simply purchased from Sysco or other food distribution companies.

Thanks primarily to the successes of participating in the First Rate-First State Summit, the participation of restaurants buying local produce has increased. Every restaurant that has attended the event has partnered with Delaware growers including two hydroponic operations. Approximately 10 known restaurants, all fine dining establishments, are participating although the number is easily far greater. Several growers cater specifically to the local dining venues, but are reluctant to share their client lists. Most known restaurants that buy local are either at the beaches (Rehoboth, Lewes, Dewey, Bethany) or the more populated hubs of Delaware (Dover and Wilmington).

Performance Goal 3 – Web based information on the program

The Farm to School website was launched in July 2012. It the mission of the program, the timeline with photos and the contact information for both growers and CNS. The national Farm to School website for Delaware (a single dedicated page containing general

info) does not have a counter, nor does the DDA dedicated Farm to School section. The latter page is relatively new.
Web addresses: http://dda.delaware.gov/marketing/FTS/farm_to_school_index.shtml & http://www.farmtoschool.org/DE/
However, growers and schools are encouraged to periodically visit these sites for updates to the Farm to School initiatives in Delaware.

**Beneficiaries:** Economic Impact - We began tracking the Farm to School Sales on a district level in July 2010 which was the start of a fiscal year. From July 2010 to June 2012 there has been a $63,920.28 increase in Farm to School Sales. The products bought were from 11 farms and were apples, asparagus, broccoli, cabbage, cantaloupe, cauliflower, cucumbers, green beans, lettuce, peaches, pears, potatoes, squash, strawberries, sweet corn, tomatoes, and watermelon.

**Lessons Learned:** Grower Participation

- The Grower survey had less than 10% response. There are several farms that are actively participating but the pool is small. One of the challenges is involving the small to middle farmer. Due to the layout of the state it is difficult to have a Sussex County (southern Delaware) grower deliver to a New Castle County (northern Delaware) school district. Especially when the school district requires delivery to individual schools. The solution is to assist with transportation to schools. Although there were several options considered most options were extremely expensive and not feasible at this time.

- Another issue associated with grower participation is the privacy issue. Although business deals are made during the summit the growers are reluctant to broadcast their successes. They value their privacy and feel that DDA asking them to share their business deals is intrusive. This makes it hard for us to determine the success of the program in the area of restaurants. Since schools are considered public information we can gather data from that end.

Contact information: Lisa Falconetti, email – lisa.falconetti@state.de.us, phone – 302-698-4554

**Project Title:** Ethnic Greens Crops for Processing and Fresh Market Sales

**Project Summary:** In discussions with regional processors in 2008, an interest was expressed in sourcing ethnic greens from Delaware. This would provide Delaware processors and growers a new specialty crops market opportunity in processed collard greens, mustard greens, turnip greens and kale for national distribution. In addition, produce buyers expressed an interest in buying more fresh greens demonstrating the potential for expanding fresh market production for local and regional distribution. The potential exists for up to 5,000 acres of new farm enterprise in these crops.

The purpose of this project was to develop a new farm crop system for ethnic greens (including collard green, mustard greens, turnip greens and kale) for processing and fresh market sales and a significant new market opportunity for food processors in Delaware. University of Delaware Cooperative Extension personnel conducted spring and fall greens trials to determine best management practices for ethnic greens production in Delaware. This included trials to determine optimal plant spacing and planting dates, and identify adapted varieties for collard greens, mustard greens, turnip greens, kale. Another aspect of these studies was to identify potential pest problems in these crops and when they impacted production systems.

**Project Approach:** The project included research on production in the spring and fall. Although summer production was possible with Kale and Collards, this would not fit the majority of grower's or processor's production schedules and would conflict with other summer processing crops. Preliminary small plot studies were conducted in 2009. Main trials were conducted in 2010, 2011, and 2012 and results of these trials are presented in this report.

The main goal of these ethnic greens trials was to determine the best planting and growing periods for spring and fall seasons of greens crops and variety adaptation for these periods. Additional trials were conducted to evaluate plant populations and spacing. The overall goal was to determine the best management practices for the best quality crops and yields in Delaware.

The following trials were conducted over the course of the project:

1) 2 Spring planting date, yield and variety trials for processing greens
2) 2 Fall planting date, yield, and variety trials for processing greens
3) 1 fall and 1 spring population and spacing studies for processing greens
4) 1 spring fresh market greens variety trial
5) 2 Fall fresh market greens variety trials

<u>Spring Planting Date, Yield and Variety Trials for Processing Greens</u>

Materials and Methods: Trials were conducted on the University of Delaware Research Farm near Georgetown, DE in 2010 and 2011 on loamy sand soils. Plots were 4 rows with 12 inches between rows and were 20 feet in length. Plots were seeded with a push planter at a seeding rate to give a target spacing of 1 inch between plants. Plots received trifluralin herbicide incorporated at a rate of 0.5 lbs per acre active ingredient prior to planting along with 80 lbs./a nitrogen (N) as urea ammonium nitrate (UAN) solution. After each cutting, an additional 40

lbs/a N were applied using ammonium nitrate fertilizer. Planting dates were March 5, March 19, April 2, and April 16 in 2010 and March 21, April 8, and April 29 in 2011. Plots were cut with a knife or power hedge trimmer and fresh weights were recorded. In 2010 varieties tested included Seven Top and Alamo turnip; Southern Giant Curled, Savannah, and Florida Broadleaf mustard; Georgia Southern and Vates collards; and Vates kale. In 2011 varieties tested included Seven Top and Alamo turnip; Southern Giant Curled, and Savannah mustard; Champion and Top Bunch collards; and Siberian and Vates kale.

Results: Results showed variety by planting date interactions. Yields were higher in 2010 due to more favorable weather. Results for 2010 (Table 1) showed that Georgia Southern and Vates collards had yields around 9 tons per acre in the early April planting. Vates kale yielded similarly in the early April planting. March plantings bolted. Highest yields for mustard were with Savannah in the early April planting with a remarkable 36 tons per acre total Savannah was far superior to Southern Giant Curled or Florida Broadleaf which had bolting problems in the early plantings. Alamo turnip was superior to Seven Top with over 30 ton per acre yields in the early April planting.

In the 2011 planting (Table 2), the only crop that had a satisfactory harvestable yield in the March planting was Siberian kale, all others bolted due to the cold weather. The early April planting most crops performed poorly again due to the cold spring. Only one harvest could be made before bolting. Siberian kale, Southern Giant Curled Mustard and Sevin Top turnip had over 6 tons per acre yield in the second planting. The late April planting gave good yields in a number of the greens tested. Siberian kale and Vates kale performed similarly. Top Bunch collards were superior to Champion collards. Sevin Top and Alamo turnip performed similarly as did Savannah and Southern Giant Curled mustard.

The spring planting trials showed that kale and collards were lower yielding and slower growing than mustards or turnips. For all greens, April planning dates were higher yielding and had less bolting that March planting dates. In general, Alamo turnip and Savannah mustard were best adapted (both are hybrids). Open pollinated mustards could be used but only in later plantings and there still was a risk of bolting. Vates and Siberian kale were adapted for April plantings but only Siberian could be used for March plantings. Georgia Southern, Vates, and Top Bunch collards performed similarly in April planting dates. These results verified recommendations in the Mid Atlantic Vegetable Production Recommendation Guide.

Table 1. Yield of cut greens by planting date and cutting date in spring 2011

| | | Planting | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Tons | Tons | Tons |
| **Sevin Top Turnip** | 30MAY2011 | . | 6.44 | . |
| | 31MAY2011 | . | . | 8.90 |
| | 03JUN2011 | . | . | 2.24 |
| | 07JUN2011 | . | . | 6.13 |
| | 01JUL2011 | . | . | 2.42 |
| **Alamo Turnip** | 30MAY2011 | . | 4.82 | . |
| | 31MAY2011 | . | . | 5.43 |

| | | | | |
|---|---|---|---|---|
| | 03JUN2011 | . | . | 5.90 |
| | 07JUN2011 | . | . | 3.27 |
| | 01JUL2011 | . | . | 4.33 |
| **Champion Collard** | 30MAY2011 | 2.62 | 4.33 | . |
| **Savannah Mustard** | 30MAY2011 | . | 4.89 | . |
| | 31MAY2011 | . | . | 5.42 |
| | 03JUN2011 | . | . | 4.36 |
| | 07JUN2011 | . | . | 5.31 |
| | 01JUL2011 | . | . | 2.21 |
| **Siberian Kale** | 30MAY2011 | 5.63 | 6.08 | . |
| | 31MAY2011 | . | . | 4.39 |
| | 03JUN2011 | . | . | 4.52 |
| | 01JUL2011 | . | . | 2.21 |
| **Southern Giant Curled Mustard** | 30MAY2011 | 0.00 | 6.12 | . |
| | 31MAY2011 | . | . | 6.63 |
| | 03JUN2011 | . | . | 6.45 |
| | 07JUN2011 | . | . | 4.71 |
| | 01JUL2011 | . | . | 3.29 |
| **Top Bunch Collard** | 30MAY2011 | . | 3.18 | . |
| | 07JUN2011 | . | . | 3.58 |
| | 01JUL2011 | . | . | 1.36 |
| **Vates Kale** | 30MAY2011 | 1.43 | 1.95 | . |
| | 03JUN2011 | . | . | 4.38 |
| | 07JUN2011 | . | . | 4.35 |
| | 01JUL2011 | . | . | 3.49 |

Table 2. Yield of cut greens by planting date and harvest date in 2010,

| Variety and Harvest Date | | Planting Date | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| | | Tons | Tons | Tons | Tons |
| **Collard Georgia Southern** | **24JUN2011** | . | . | 9.19 | . |
| | **25JUN2011** | . | . | | 8.68. |
| **Collards Vates** | **24JUN2011** | . | . | 8.41 | . |
| | **25JUN2011** | . | . | | 5.50 |
| **Kale Vates** | **24JUN2011** | . | . | 8.89 | . |
| | **25JUN2011** | . | . | | 9.96. |
| **Mustard Florida Broadleaf** | **07MAY2011** | 0.00 | . | . | . |
| | **24MAY2011** | . | 3.73 | . | . |
| | **01JUN2011** | . | . | 5.12 | . |
| | **08JUN2011** | . | . | . | 5.77 |
| | **09JUN2011** | . | . | 9.91 | |
| | **24JUN2011** | . | . | | . |
| | **25JUN2011** | . | . | | . |
| **Mustard** | **17MAY2011** | 7.14 | . | . | . |

| | | | | | |
|---|---|---|---|---|---|
| Savannah | 24MAY2011 | . | 7.13 | . | . |
| | 01JUN2011 | . | . | 13.69 | . |
| | 08JUN2011 | . | . | . | 6.64 |
| | 09JUN2011 | . | . | 11.17 | |
| | 24JUN2011 | . | . | | 7.49 |
| | 25JUN2011 | . | . | 12.63 | . |
| Mustard Southern Giant Curled | 21MAY2011 | 3.55 | . | . | . |
| | 24MAY2011 | . | 7.09 | . | . |
| | 01JUN2011 | . | . | 5.43 | . |
| | 08JUN2011 | . | . | 5.99 | |
| | 09JUN2011 | . | . | . | 4.96 |
| | 24JUN2011 | . | . | 3.63 | . |
| | 25JUN2011 | . | . | | 2.84. |
| Turnip Alamo | 17MAY2011 | 7.73 | . | . | . |
| | 24MAY2011 | . | 6.00 | . | . |
| | 01JUN2011 | . | . | 10.52 | . |
| | 08JUN2011 | . | . | . | 12.12 |
| | 09JUN2011 | . | . | 13.16 | |
| | 24JUN2011 | . | . | 12.36 | . |
| | 25JUN2011 | . | . | | 9.30 |
| Turnip Seven Top | 21MAY2011 | 5.73 | . | . | . |
| | 24MAY2011 | . | 5.22 | . | . |
| | 01JUN2011 | . | . | 7.64 | . |
| | 08JUN2011 | . | . | 7.83 | |
| | 09JUN2011 | . | . | . | 7.08 |
| | 24JUN2011 | . | . | 6.68 | . |
| | 25JUN2011 | . | . | | 6.86 |

Fall Planting Date, Yield, and Variety Trials for Processing Greens

Materials and Methods: Larger scale fall trials were conducted on the University of Delaware Research Farm near Georgetown, DE in 2010 and 2011 on loamy sand soils. Large commercial size plots were used for fall studies. Plots were 6 rows wide with 9 inches between rows and were 50 feet in length. Plots were seeded with a precision planter (Monosem) at a seeding rate to give a target spacing of 1 inch between plants. Plots received trifluralin herbicide incorporated at a rate of 0.5 lbs per acre active ingredient prior to planting along with 80 lbs./a nitrogen (N) as urea ammonium nitrate (UAN) solution. After each cutting, an additional 40 lbs/a N was applied using ammonium nitrate fertilizer. Planting dates were July 15, July 30, August 16, and August 30 in 2010 and August 1 and August 15 in 2011. Plots were cut with a power hedge trimmer or sickle bar mower and fresh weights were recorded. In 2010 varieties tested included Seven Top turnip; Southern Giant Curled mustard, Champion collard, and Vates and Siberian kale. In 2011 varieties tested included Seven Top turnip; Tendergreen mustard; Champion collards; and Siberian kale. In the fall 2011 trial, the first planting was not harvested due to heavy weed pressure. Low cost open pollinated varieties were tested because that is what the industry is using in other areas of the country.

Results: Insect pressure from Harlequin bugs and Lepidoptera larvae was heavy in the July planting causing losses, even with insecticide sprays in 2010. In the 2010 trial (Table 3), collards had the highest yields in the July planting. Mustard and turnip gave the highest yields

from an early August planting date. Siberian Kale performed best from early and mid-August planting dates. Vates kale did not perform well in the fall of 2010 in the large plot trials. In 2011 (Table 4), Collard yields were lower than the other greens tested in large plot trials. Siberian kale, Tendergreen mustard, and Seven Top turnip performed well with Tendergreen yielding over 14 tons per acre. In general, fall yields were lower than April planted greens

Table 3. Yield of cut greens by cutting date in fall 2011

| Crop and Variety | Harvest Date | | | | Total |
|---|---|---|---|---|---|
| | 6-Oct-11 | 27-Oct-11 | 20-Nov-11 | 15-Dec-11 | |
| | Tons | Tons | Tons | Tons | Tons |
| Collards (Champion) | 1.06 | 1.86 | 1.05 | 1.85 | 5.82 |
| Kale (Siberian) | 2.29 | 2.58 | 2.22 | 1.84 | 8.93 |
| Mustard (Tendergreen) | 2.38 | 1.47 | 2.04 | 2.59 | 14.75 |
| Turnips (Seven Top) | 3.1 | 1.63 | 2.78 | 2.26 | 9.77 |

Table 4. Yield of cut greens by planting date and cutting date in fall 2010

| Variety and Harvest Date | | Planting Date | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| | | tons | tons | tons | tons |
| Champion Collards | 16SEP2010 | 4.38 | . | . | . |
| | 22OCT2010 | 4.05 | . | . | . |
| | 26OCT2010 | . | 3.88 | 3.11 | . |
| Southern Giant Curled Mustard | 15SEP2010 | 2.51 | . | . | . |
| | 16SEP2010 | . | 4.30 | . | . |
| | 21SEP2010 | . | 5.68 | . | . |
| | 12OCT2010 | . | . | 4.12 | . |
| | 05NOV2010 | . | . | . | 4.47 |
| | 09NOV2010 | . | . | . | 4.10 |
| Seven Top Turnip | 10SEP2010 | 3.82 | . | . | . |
| | 16SEP2010 | . | 3.73 | . | . |
| | 08OCT2010 | . | . | 4.51 | . |
| | 10OCT2010 | . | 5.29 | . | . |
| Siberian Kale | 16SEP2010 | 3.65 | . | . | . |
| | 12OCT2010 | . | . | 5.22 | . |
| | 26OCT2010 | . | 4.47 | . | . |
| | 09NOV2010 | . | . | . | 3.14 |
| Vates Kale | 12OCT2010 | . | . | 1.69 | . |

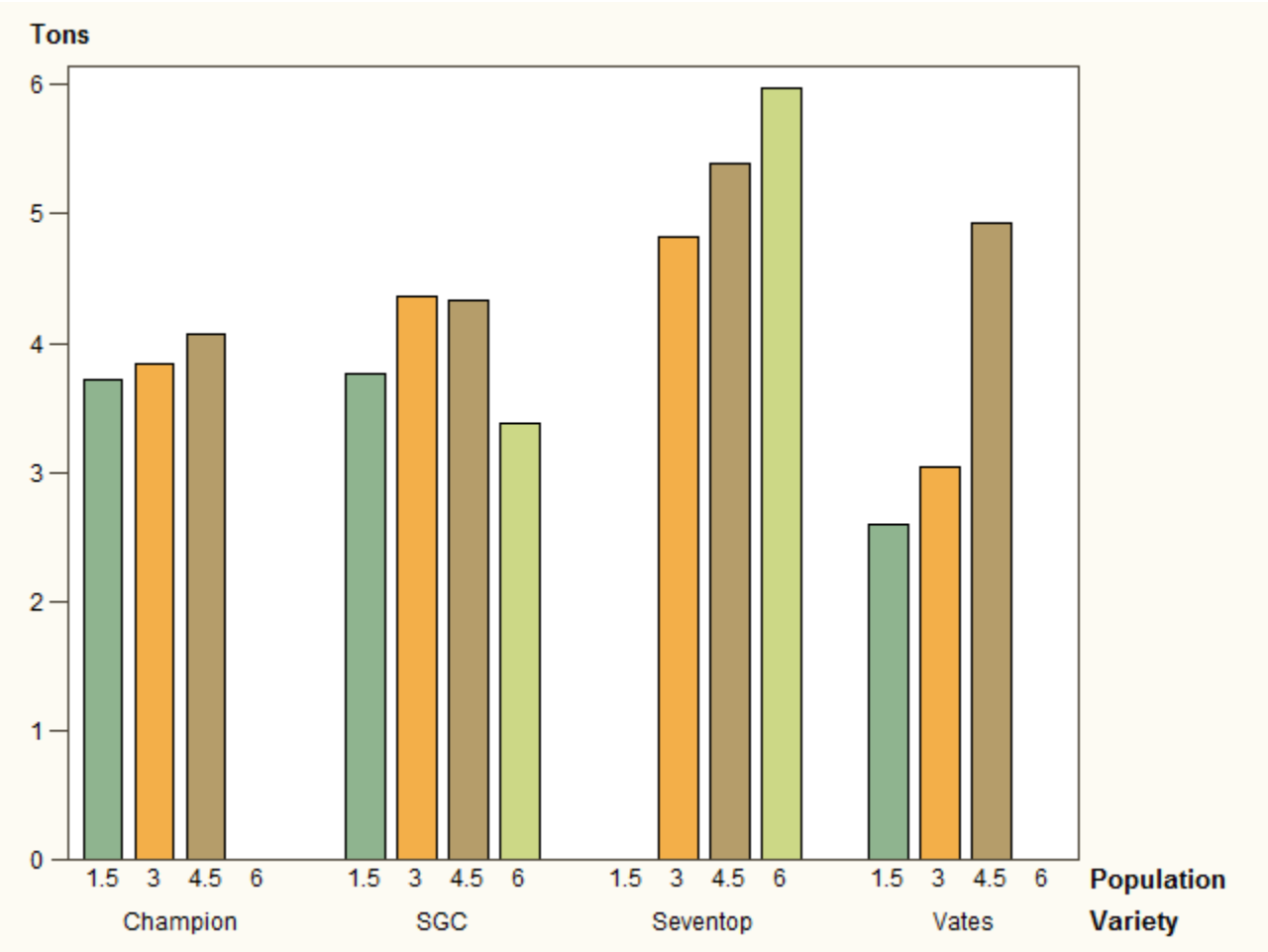
Population and Spacing Studies for Processing Greens

Materials and Methods: A fall trial population trial was conducted on the University of Delaware Research Farm near Georgetown, DE in 2010 on a loamy sand soil. A spring population trial

was planted in 2012 but was not harvested due to poor stand. Large commercial size plots were used for the fall study. Plots were 6 rows wide with 9 inches between rows and were 50 feet in length. Plots were seeded with a precision planter (Monosem) at seeding rates to give target spacing's of 1-2 inches, 2-4 inches, 4-5 inches and 5-6 inches between plants. Plots received trifluralin herbicide incorporated at a rate of 0.5 lbs per acre active ingredient prior to planting along with 80 lbs./a nitrogen (N) as urea ammonium nitrate (UAN) solution. Planting date was August 17. Plots were cut with a power hedge trimmer and fresh weights were recorded. Stand counts were also taken. Varieties tested included Seven Top turnip; Southern Giant Curled mustard, Champion collard, and Vates and Siberian kale.

Results: Champion collard had the highest yields with 4.5 inch spacing between plants as did Vates Kale (Figure 1.). Seven Top Turnip had the highest yields at 6 inches between plants. Southern giant curled mustard had the highest yields at 3 inches between plants. Results show that current recommended planting rates may be too high (giving a spacing of about 1 inch between plants). However, this needs to be balanced against cutting height as closer spacing produces more upright leaves.

Figure 1. Yield of greens as affected by plant spacing.



Fresh Market Greens Variety Trials – spring and fall

Materials and Methods: Fresh market greens trials were conducted on the University of Delaware Research Farm near Georgetown, DE in 2011 and 2012 on loamy sand soils. Plots were one row wide rows with 30 inches between rows and were either 20 feet in length for direct seeded plots and 10 feet in length for transplanted plots. Plots were seeded with a push planter at a seeding rate to give a target spacing of 3 inches between plants except for transplanted plots which were planted at a spacing of 12 inches between plants. Plots received trifluralin herbicide incorporated at a rate of 0.5 lbs per acre active ingredient prior to planting along with 80 lbs./a nitrogen (N) as urea ammonium nitrate (UAN) solution. After each cutting, an additional 40 lbs/a N was applied using ammonium nitrate fertilizer. Spring planting date was April 25 in 2012. Fall planting dates were August 23 in 2011 and August 9 in 2012 for direct seeding and August 15 in 2012 for transplants (kale and collards only). In 2011, plots were cut with a knife and fresh weights were recorded. In 2012 turnip and mustards were cut with a knife and kale and collards were hand stripped leaving 3 leaves at the top of the plant. Varieties tested are listed in the tables or graphs.

Results: In Fall 2011, with the hybrid kales, Reflex was the most productive, with over double the yields of other varieties. However, the open pollinated Siberian was far more productive with over 21,000 lbs. compared to 8223 lbs./a for Reflex. If packaged greens are the market, Siberian would be the best choice. If fancy curled greens for garnish are desired then Reflex would be the best choice. Hi Crop collards out-yielded all other hybrid collards and had over 3 times the yield of the open pollinated Champion. With Turnips, the highest yielding varieties were Southern Green and Alamo with 29900 and 27000 lbs/a respectively. This compared to 22000 lbs/a for Seven Top. Mustard yields were highest with Savannah (28400 lbs/a) but were not significantly different from Tendergree (26100 lbs/a).

- In spring 2012 (Figure 2), there were no differences in yields of mustard or turnips between varieties. Bulldog collards and Blue Ridge kale had the highest yields of those crops (Figure 3). Yields of these crops were reduced in 2012 due to weed pressure.
- Fall 2012 trials with fresh market greens are still being harvested. Initial results are presented in figures 4, 5, 6, and 7. To date, All Top and Southern Green turnips are performing the best and Tendergreen and Savannah mustards have the highest yields. For Kale, Winterbor and Green Curled have the best yields when stripped on green types and Red Russian has the highest yields for a red type. Collard yields were similar across varieties; however, Hi Crop Collard had the highest yields.

Conclusions and Recommendations

For spring, greens plantings should be delayed until mid-April to reduce the chance of bolting and to obtain highest yields. For fall production, the best planting window is the first three weeks in August. With turnips, Alamo is the most reliable for spring processing. For fall processing, Sevin Top performs well. Savannah mustard is the most reliable for spring processing. For fall processing, Southern Giant Curled or Tendergreen are recommended. Siberian kale performed well in spring and fall for processing and Champion collards are recommended for spring and

fall processing. Plant population recommendations are to obtain a final plant population of 4 plants per foot.

For fresh market greens, Savannah mustard, All Top Turnip, Bulldog Collards, and Blue Ridge kale are good performers in the spring. In the fall Siberian, Reflex, and Winterbor are recommended kales depending on the market. Hi Crop collard is the best fall variety. Fall turnip varieties with the highest yields are Southern Green, Alamo, and All Top. Fall mustard varieties recommended are Tendergreen and Savannah.

Table 5. Yields of fresh market cut greens, fall 2011.

| Variety | Type | Harvest Date | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 21-Sep-11 | 7-Oct-11 | 10-Oct-11 | 2-Nov-11 | 20-Dec-11 | |
| | | lbs/a | lbs/a | lbs/a | lbs/a | lbs/a | lbs/a |
| **Reflex** | **Kale** | . | 6962 | 544 | . | 717 | 8223 |
| **Red Bor** | **Kale** | . | . | 304 | . | 396 | 700 |
| **Blue Ridge** | **Kale** | . | . | 1131 | . | 1355 | 2486 |
| **Blue Knight** | **Kale** | . | . | 1184 | 1191 | 1381 | 3756 |
| **Blue Armor** | **Kale** | . | . | 874 | . | 1134 | 2008 |
| **Starbor F1** | **Kale** | . | . | 954 | . | 1398 | 2352 |
| **Winterbor F1** | **Kale** | . | . | 869 | . | 2834 | 3703 |
| **Ripbor F1** | **Kale** | . | . | . | . | 442 | 442 |
| **Vates** | **Kale** | . | . | 746 | . | 1800 | 2546 |
| **Hi Crop** | **Collard** | . | . | 1310 | 5764 | 1881 | 8955 |
| **Flash** | **Collard** | . | . | 970 | 394 | 1460 | 2824 |
| **Top Bunch** | **Collard** | . | . | 471 | . | 1244 | 1715 |
| **Bulldog** | **Collard** | . | . | 2010 | 1470 | 1640 | 5120 |
| **Southern Green** | **Turnip** | 2434 | 8526 | 5188 | 7375 | 6384 | 29907 |
| **Topper** | **Turnip** | 2459 | 8747 | 5041 | 5116 | 2616 | 23979 |
| **All Top** | **Turnip** | 1864 | 5483 | 4294 | 4736 | 3265 | 19642 |
| **Just Right** | **Turnip** | 1700 | 7724 | 4650 | 6014 | 3411 | 23499 |
| **Alamo** | **Turnip** | 1633 | 8008 | 5063 | 6008 | 6279 | 26991 |
| **Top Star** | **Turnip** | 850 | 7340 | 3550 | 5247 | 4222 | 21209 |
| **Green Wave** | **Mustard** | . | 8001 | 3242 | 4064 | 3953 | 19260 |
| **Hybrid Savannah** | **Mustard** | 2286 | 7900 | 6398 | 6691 | 5117 | 28392 |
| **Southern Giant Curled** | **Mustard** | . | 4871 | 5001 | 5620 | 4438 | 19930 |
| **Champion** | **Collard** | . | . | 1045 | 889 | 689 | 2623 |
| **Seven Top** | **Turnip** | 2213 | 7894 | 3103 | 6307 | 2536 | 22053 |
| **Tendergreen** | **Mustard** | 1774 | 6102 | 3545 | 7394 | 7249 | 26064 |
| **Dwarf Siberian** | **Kale** | . | 6293 | 5313 | 5529 | 3898 | 21033 |

Figure 2. Fresh cut yields of turnip and mustard varieties, spring 2012

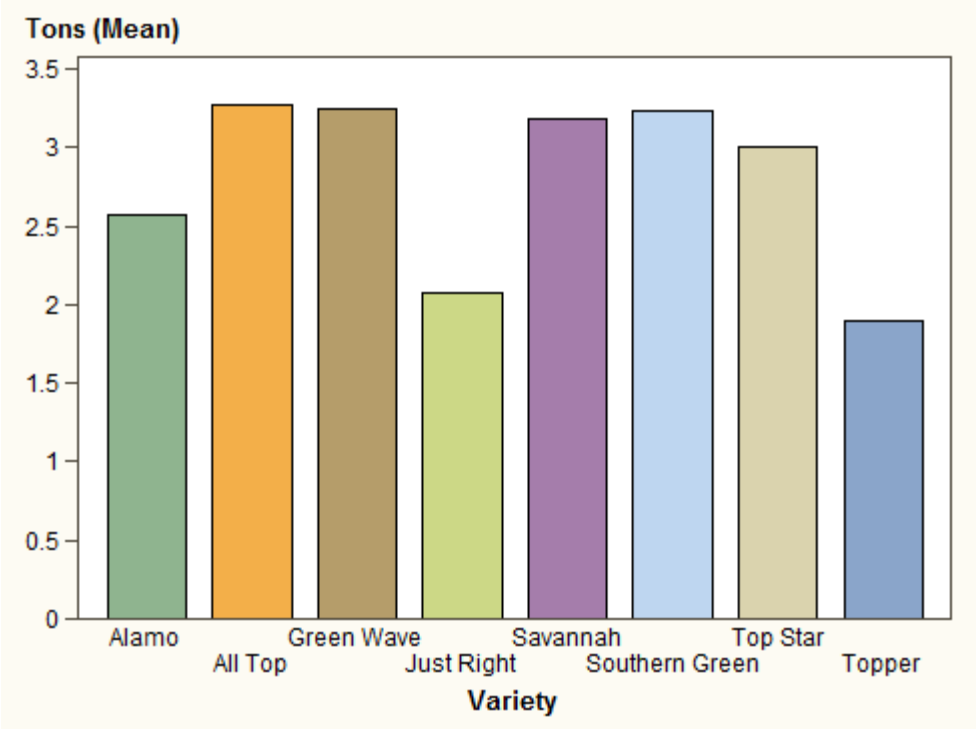



Figure 3. Fresh cut yields of kale and collards, spring 2012

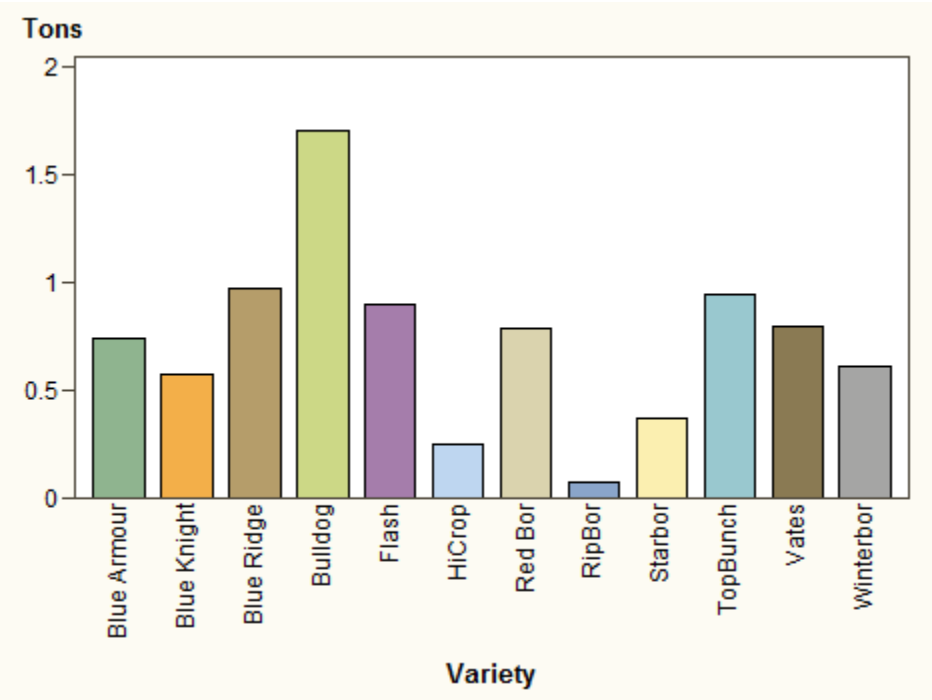


Figure 4. Fresh cut yields of turnips and mustards fall 2012.

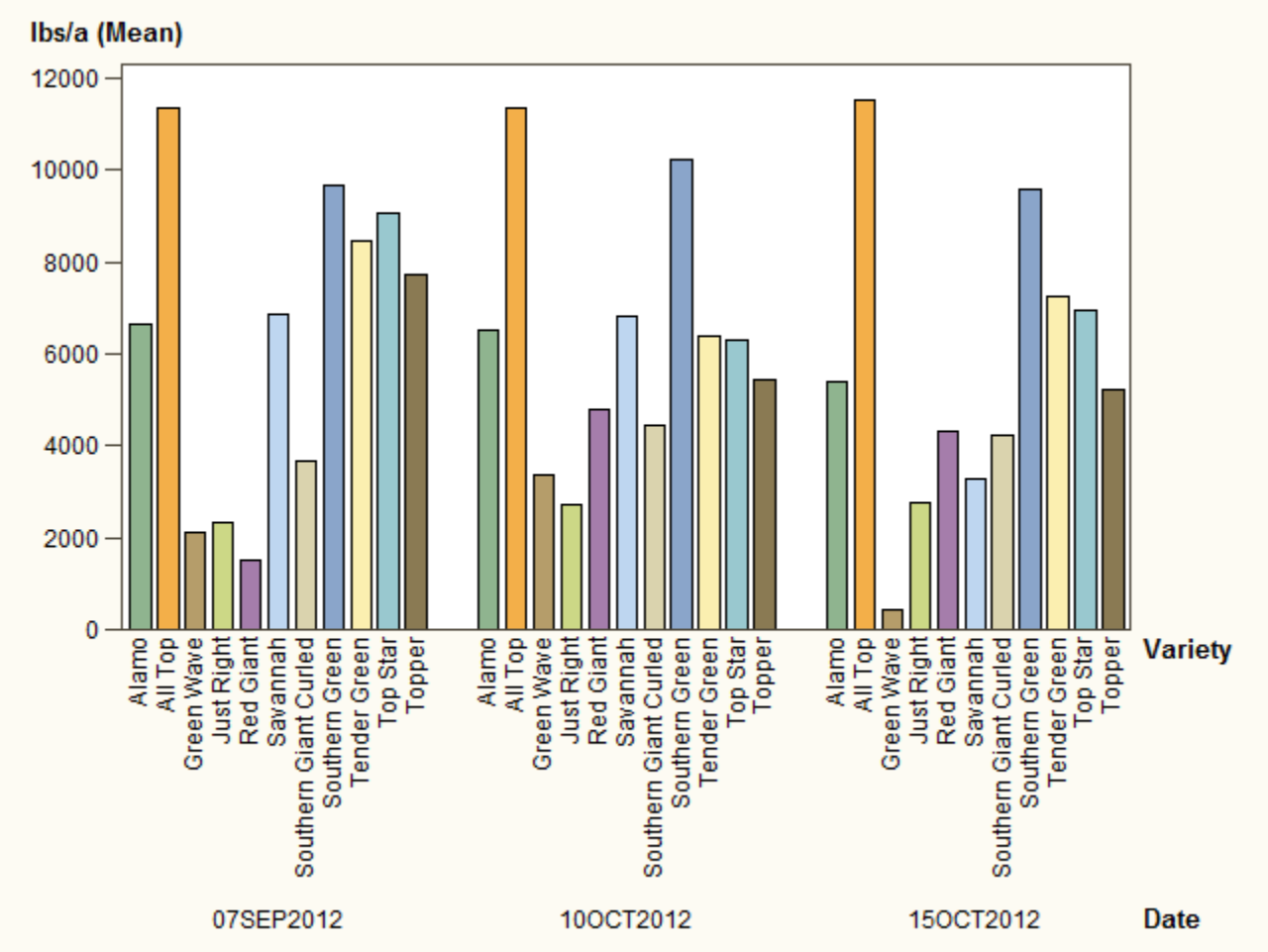


Figure 5. Fresh stripped yields of kale and collards direct seeded, fall 2012.

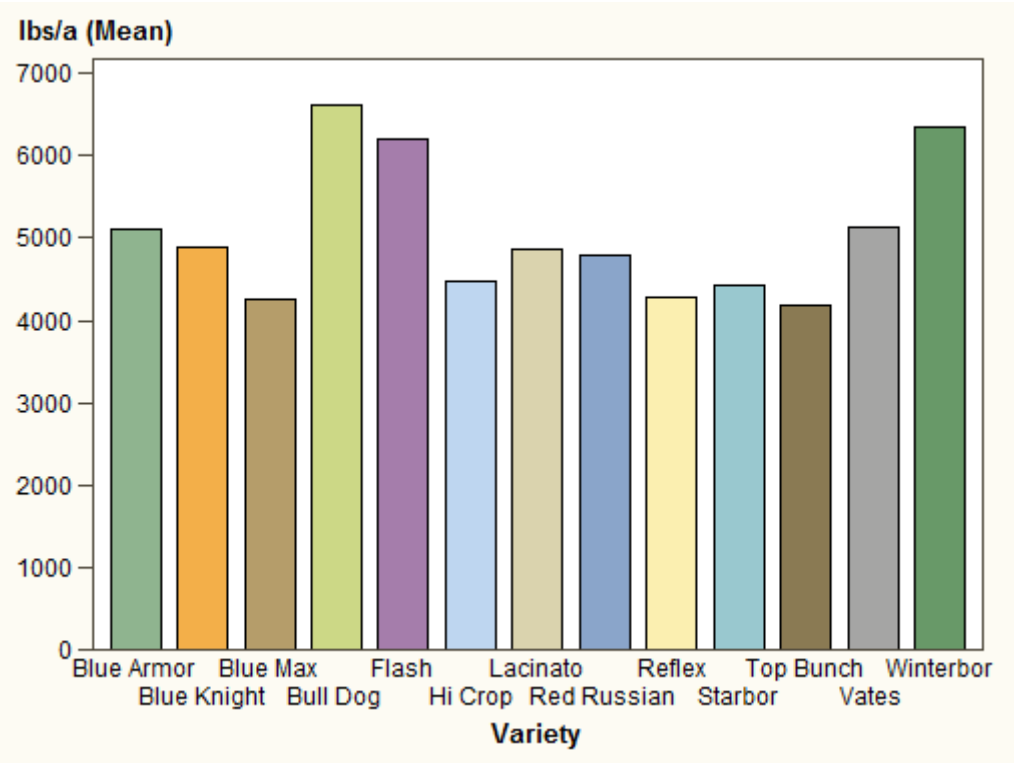



Figure 6. Fresh stripped yields of transplanted collards fall 2012.

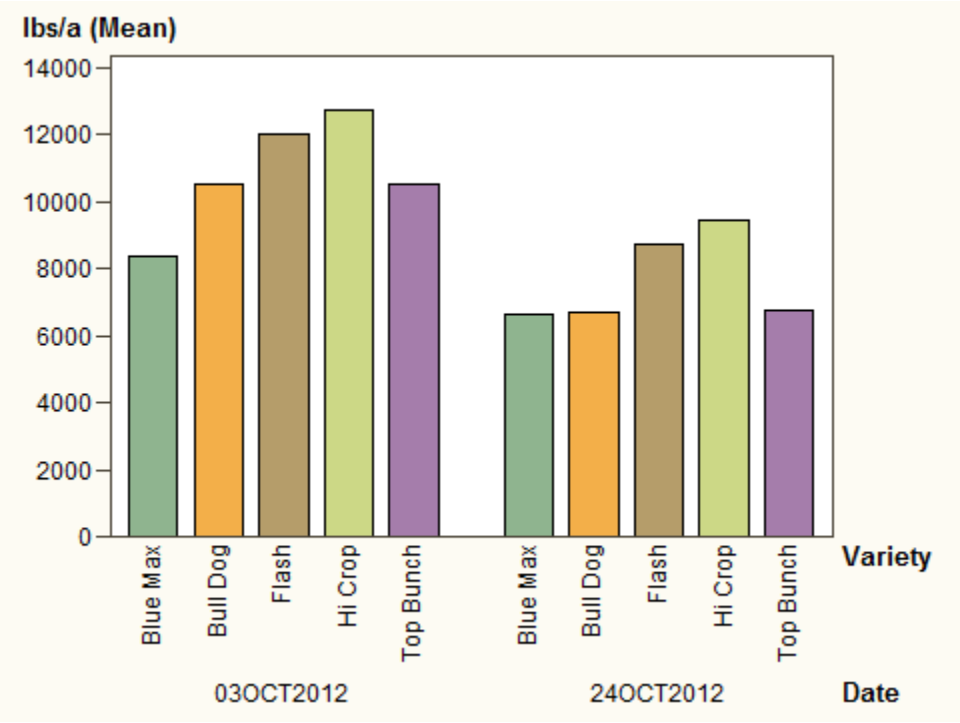
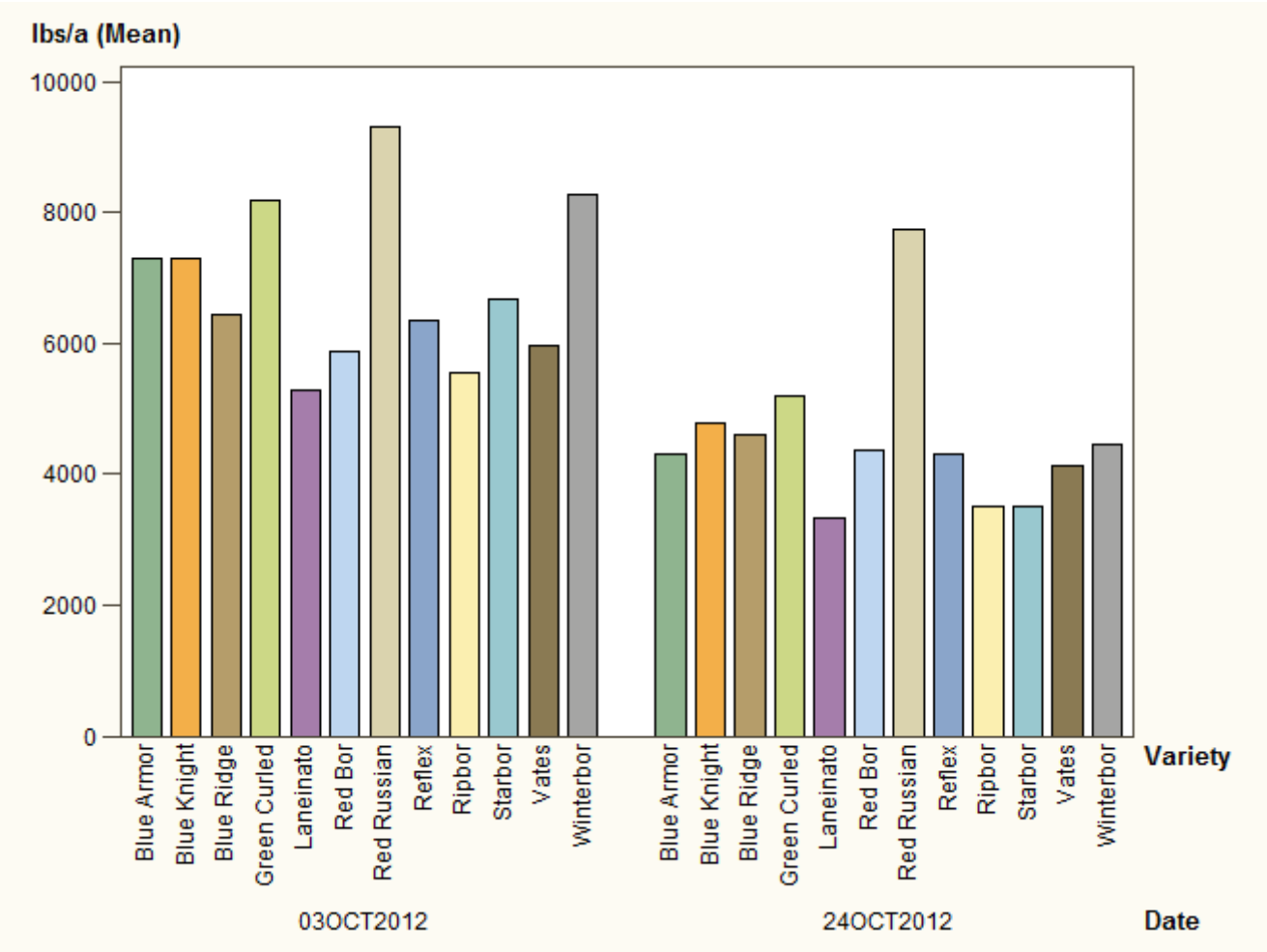


Figure 7. Fresh stripped yields of transplanted kale fall 2012.




**Goals and Outcomes Achieved:** The purpose of this project was to develop a research base for ethnic greens (including collard green, mustard greens, turnip greens and kale) for processing and fresh market sales in Delaware. Spring and fall greens trials were conducted to determine best management practices for ethnic greens production in Delaware. This included trials to determine optimal plant spacing and planting dates, and identify adapted varieties for collard greens, mustard greens, turnip greens, kale. Another aspect of these studies was to identify potential pest problems in these crops and when they impacted production systems.

The following trials were conducted over the course of the project:

1) 2 Spring planting date, yield and variety trials for processing greens
2) 2 Fall planting date, yield, and variety trials for processing greens
3) 1 fall population and spacing studies for processing greens
4) 1 spring fresh market greens variety trial
5) 2 Fall fresh market greens variety trials

Results from these trials are presented in the Project Approach section above.

From these trials were able to identify the optimum spring and fall planting dates for kale, collard, mustard, and turnip; the highest yielding varieties for those time periods; and optimum planting density for processing greens. For fresh market greens we were able to identify superior varieties for use in spring and fall.

For spring, greens plantings should be delayed until mid-April to reduce the chance of bolting and to obtain highest yields. For fall production, the best planting window is the first three weeks in August. With turnips, Alamo is the most reliable for spring processing. For fall processing, Sevin Top performs well. Savannah mustard is the most reliable for spring processing. For fall processing, Southern Giant Curled or Tendergreen are recommended. Siberian kale performed well in spring and fall for processing and Champion collards are recommended for spring and fall processing. Plant population recommendations are to obtain a final plant population of 4 plants per foot.

For fresh market greens, Savannah mustard, All Top Turnip, Bulldog Collards, and Blue Ridge kale are good performers in the spring. In the fall Siberian, Reflex, and Winterbor are recommended kales depending on the market. Hi Crop collard is the best fall variety. Fall turnip varieties with the highest yields are Southern Green, Alamo, and All Top. Fall mustard varieties recommended are Tendergreen and Savannah.

Preliminary results from these trials have been presented at the Processing Vegetable Sessions at Delaware Agriculture Week which was attended by 116 growers and processors. Final results will be presented again in 2013. Fresh market greens results will be presented at the 2013 Fresh Market Vegetable Session at Delaware Agriculture Week, the 2013 Mid-Atlantic Vegetable Conference, the 2013 Southern Maryland Vegetable Meeting, and the 2012 Loveville Produce Auction meeting. Total grower attendance at these meetings was 387. This report will be distributed to all processors in the region and to potential greens growers. It will also be posted for access on the internet.

**Beneficiaries:** Beneficiaries of this project will include Delaware vegetable processors and growers by providing them information on new specialty crops market opportunities in processed collard greens, mustard greens, turnip greens and kale for national distribution. In addition, this project will provide produce buyers and fresh market growers information on the potential for expanding fresh market production of greens for local and regional distribution. The potential exists for up to 5,000 acres of new farm enterprise in these crops.

Information from this project will reach 3 regional food processors that distribute throughout the eastern half of the US, over 200 processing crop growers in the region, and over 400 fresh market growers in the region.

Information from this project has been incorporated into the 2012 and 2013 Commercial Vegetable Production Recommendations for the Mid-Atlantic which is distributed to over 1500 growers, processors, fieldsmen, and consultants in the region.

**Lessons Learned:** This project was able to confirm current greens production recommendations and add new recommendations that will benefit processors and growers.
Several challenges affected this project. First, no spring population study was carried to completion because the trial that was planted had stand issue problems. One fall processing planting date and the 2011 spring fresh market trials had weed problems; the July planting in the 2010 fall processing trial had insect problems; and one section of the spring 2011 processing trial had water damage. Cold, wet conditions limited spring processing trials to 3 planting dates.

It was found that timely irrigation in the first week after planting was critical for greens establishment in direct seeding.

Despite these challenges, quality information was obtained and we were able to achieve the goals set in the project.

**Contact Person:** Dr. Gordon C. Johnson, Extension Vegetable and Fruit Specialist, Assistant Professor
University of Delaware - Department of Plant and Soil Sciences
General Phone: (302) 856-7303
Direct Phone: (302) 856-2585 ext. 590
Cell Phone: (302) 545-2397
Email: gcjohn@udel.ed

**Project Title:** Processing Sweet Corn Variety Trials

**Project Summary:** Approximately 6,000 acres of processing sweet corn are grown in Delaware each year. Three vegetable processors contract sweet corn acres in the state and the value of the crop averaged $3.7 million per year for 2009-2011. Regional vegetable processors are looking for sweet corn varieties that are better adapted to Delaware's climate and produce consistently high yields. Average processing sweet corn yields for Delaware are lower than those of other production regions; the average yield in Delaware for 2005 through 2007 was 6.5 tons/acre, while yields average 7 tons/acre in the Midwest and 10 tons/acre in the Pacific Northwest. During the optimum part of the growing season Delaware's processing sweet corn yields approach or match the higher yields obtained in other regions. However, yields tend to be lower in early April plantings, which experience colder than optimal temperatures at planting, and in June plantings, which are exposed to high temperatures during pollination. Higher yielding and better adapted varieties will increase the competitiveness of Delaware processing sweet corn growers and regional sweet corn processors.

**Project Approach:** The main activity of this project was to conduct processing sweet corn variety trials in multiple locations, both in grower fields and at the University of Delaware Research Farm in Georgetown, DE.

The 2010 trial planting dates and locations were:
Early-Season Sugary Enhanced Variety Trial on April13 (grower field in Laurel, DE)
Early-Season Supersweet Variety Trial on April 12 (UD Research Farm, Georgetown, DE)
Mid-Season Sugary Enhanced Variety Trial on May 25 (UD Research Farm, Georgetown, DE)
Mid-Season Supersweet Variety Trial on May 21 (grower field near Felton, DE)

The original plan for the second year of this grant had been to plant four trials in 2011 – two in early May and two in early June. After talking with fieldsmen from the three processing companies that contract sweet corn in Delaware it seemed that it would be more useful to repeat the early season variety trials and plant a mid-season supersweet variety trial. The early part of the planting season is when growers seem to have the most inconsistent yields and so we wanted more data on how varieties performed at the earliest planting dates. The processing companies are almost exclusively planting supersweet varieties except during the first week or so of planting, so the later planted sugary-enhanced trial was dropped.

The 2011 trial planting dates and locations were:
Early-Season Sugary Enhanced Variety Trial on April15 (grower field near Sandtown, DE)
Early-Season Supersweet Variety Trial on April 12 (UD Research Farm, Georgetown, DE)
Mid-Season Supersweet Variety Trial on May 10 (grower field near Bethlehem, MD)

Data was collected on stand establishment, plant and ear characteristics and various yield components. Trial results from each year were analyzed using statistical methods and compiled into two reports, which is available online at http://extension.udel.edu/ag/files/2012/03/cornpro2011.pdf and http://extension.udel.edu/ag/files/2012/03/cornpro2010.pdf. The results from the trials were

presented to growers during the Fruit and Vegetable Growers' Association of Delaware Annual Meetings in 2011 and 2012, held as a part of Delaware Agriculture Week. The reports were distributed to growers, processors and seed industry personnel, through the website and as paper copies.

The main goal of this project is to identify new sweet corn varieties that are well suited to Delaware growing conditions. Through these trials we have identified several varieties that perform well in Delaware, and have other desirable characteristics, such as fewer days to harvest than the standard varieties.

In addition to the variety trials, two experiments were added to the project to look into the differences between supersweet varieties in terms of germination in cold soils and early stand establishment. All 18 of the supersweet varieties that were entered in the 2011 variety trial were planted in a field emergence study on April 7, 2011. Data was taken on the emergence and final stand of each of the varieties but this trial was not taken to yield. Additionally, two growth chamber germination tests were performed for each of the varieties; a cold vigor test and a germination test under ideal conditions. This data is being used to develop variety recommendations for early supersweet sweet corn plantings.

One of the regional sweet corn processors, S.E.W. Friel, contributed significantly to this project by making arrangements with their contracted growers for the on-farm field trials and by allowing us to use their corn cutter to facilitate evaluation of varieties for yield of cut corn. Fieldsmen from the other processors provided information regarding appropriate standard varieties to include in the trial as well as seed of some of the standards. As previously noted, the timing of the 2011 trials was changed based on input from the processor fieldsmen.

**Goals and Outcomes Achieved:** Seven processing sweet corn variety trials were completed and the results of the trials were presented during the Processing Crops Session of the Fruit and Vegetable Growers Association of Delaware Annual Meeting in January 2011 and 2012. There were over 100 individuals in attendance of both these sessions including growers, consultants and processor fieldsmen. Results of the trials were distributed in hard copy and electronically to growers, consultants, processors and seed company representatives in 2011 and 2012. The results are archived at: http://extension.udel.edu/ag/vegetable-fruit-resources/vegetable-small-fruits-program/variety-trial-results/.

Processor fieldsmen have reported that the results of these trials have been useful in helping them decide with new varieties to plant on a trial basis. They are particularly interested in some of the varieties that yielded well and matured earlier than the standard variety Overland.

**Beneficiaries :** Processing vegetables are an important part of Delaware's agricultural economy and provide opportunity for crop diversification for Delaware's larger farms. At the time of the 2007 Census of Agriculture, 35 Delaware farms were growing processing sweet corn. An additional 49 farms on Maryland's eastern shore were growing processing sweet corn according to the 2007 Census of Agriculture, and the information from this project is also applicable to their operations. The three regional vegetable processors that contract sweet corn in Delaware are also beneficiaries of this project. Although the results of this project have been presented to

growers, the main focus of the extension of research results from this project has been to processing companies, because they make the variety selections and supply seed to the growers.

The continued viability of Delaware's three main processing vegetable crops (lima beans, sweet corn and peas) is vital to maintaining the state's $18 million per year processing vegetable industry.

**Lessons Learned:** In the process of interacting with the processor fieldsmen, it became clear that the sweet corn variety needs and desires of each of the processors are somewhat different. Processors differ in their planting timing, use of supersweet versus sugary varieties, and requirements regarding quality characteristics (i.e. kernel color, size and shape). Given these differences, my goal is not to make variety recommendations, but to provide detailed yield information through the reports, that will allow the processors to identify new varieties they would find useful to plant on a trial basis.

The seven trials were performed in different locations with different levels of heat and drought stress. Taken together, the yield data from the trials indicate several varieties which have produced high yields, even under stressful conditions. The results of the 2010 Late Supersweet Trial would indicate that with the right varieties and ample irrigation, yields of 10+ tons per acre are achievable, even if temperatures are very high.

These trials were performed at a time when processors were switching from growing sugary varieties to almost exclusively supersweet varieties. As a result, more supersweet trials were performed and these trials were expanded to include as many varieties as possible. In the two years we trialed twenty-seven distinct supersweet varieties, which provides processors with yield data for many varieties available from five different seed companies.

Through our interaction with growers and processors during this project, we became aware of several other processing sweet corn production issues, two of which are being addressed through Specialty Crop Block Grant funded projects presently in progress: assessment of supersweet variety response to stand reduction, and nitrogen fertilization requirements of processing sweet corn.

**Contact Person:** Emmalea Ernest, (302) 856-2585 ext. 587, Emmalea@udel.edu

**Project Title:** Insect Trapping Systems for IPM Decision Making in Processing and Fresh Market Vegetables

**Project Summary:** In Delaware, European corn borer and corn earworm are important pests of major fresh market and processing vegetable crops including lima beans, peppers, snap beans and sweet corn. Tolerance for damage from these pests is extremely low and once larvae are found in the fruit economic loss has generally already occurred. In sweet corn and snap beans, there is virtually no tolerance for larval damage so local moth trap catch information is needed to time insecticide applications. Each year economic infestations of corn earworm occur and in at least one year out of four we experience outbreak situations. Both overwintering and migratory populations occur each year so it hard to predict when we will see an economic outbreak. Trapping information is needed to track seasonal occurrence and effectively time insecticide applications. Without proper timing of insecticide applications and knowledge of pest levels, yield losses ranging from 30-100% would occur in these crops, especially in high pest pressure years.

A trend towards lower European corn borer (ECB) moth trap catches has been observed in some locations of the country but we continue to see spikes in moth activity especially in the Bridgeville, Georgetown and Laurel areas. Maintenance of a statewide trapping network is needed to document when these spikes occur to prevent economic losses from ECB.

With the first detection of the Brown Marmorated Stink Bug in New Castle County in 2009, the maintenance of a statewide trapping network is also be used to monitor for BMSB and is being used to develop monitoring systems for this important new insect pest in vegetables.

**Project Approach:** Thirteen black light traps and eleven corn earworm pheromone traps were placed on vegetable farms throughout Kent and Sussex counties in late April. A University of Delaware trap technician drove to each location twice a week from early May through mid-September and counted the number of corn borer and corn earworm moths in black light and pheromone traps. Starting in 2011, we also began counting the number of all stink bug species (green, brown and brown marmorated). A survey of producers, consultants, field men and agribusiness was also conducted in the fall of 2012 by Extension IPM personnel to evaluate the value of this trapping network.

**Goals and Outcomes Achieved:** Information collected in the trapping program was sent to the University of Delaware's Extension IPM Associate (Bill Cissel) and Extension IPM Specialist (Joanne Whalen) on each trapping day to ensure that clientele received timely information. The information was decimated by four methods: (a) twice a week posting on the University of Delaware's IPM Website (http://extension.udel.edu/ag/insect-management/insect-trapping-program/); (b) twice a week recorded telephone message on the Crop Pest Hotline (1-800-345-7544 - instate); (c) links provided in our electronic newsletter Weekly Crop Update (http://agdev.anr.udel.edu/weeklycropupdate/); and (d) entering information into Pest Watch (run at Penn State) which is a regional trapping program providing information to a larger group of clientele in the entire United States (http://www.pestwatch.psu.edu/). The use of multiple methods of dissemination of trap information allowed users to access the information 24 hours a day. The hotline received approximately 30 -70 calls weekly, mainly from consultants and field

men who then use this information for a larger group of clientele. Links in the Weekly Crop Update provided information on a weekly basis to 300 subscribers.

Survey results indicate that trapping information was used to make management decisions on the following crop acres: (a) Processing Lima Beans: 15,800; (b) Fresh Market Peppers: 180; (c) Fresh Market Snap Beans: 1350; (d) Processing Snap Beans: 1550 (includes some VA acres); (e) Fresh Market Sweet Corn: 4,000; and (f) Processing Sweet Corn: 12,500 (includes MD acres in adjacent counties to Delaware). Respondents indicated that the trapping program helped to prevent yield loss on over 35,000 acres of vegetables. They reported savings in terms of yield loss for fresh market and processing snaps beans and fresh market sweet corn averaging $44 per acre. Producers and consultants using trapping information to make spray decisions also reported improved quality of fresh market snap beans and sweet corn valued at an average of $50 per acre.

**Beneficiaries:** At the sites were traps were located, those individual producers receive direct benefit from the trapping network. The advantage of a statewide program is the benefit to the larger group. In particular, processors, agribusiness and private consultants use this information to extend this information to a larger group of clientele. Producers also stressed the importance of a statewide program to alert them to issues that may be occurring in one area that could move to their part of the state – i.e. an early warning system within the state.

**Lessons Learned:** Although clientele described this network as an extremely valuable service, it is clear that we will need to find new revenue sources to fund the program. Our survey results indicate that while some clientele (producers and consultants) are willing to pay a fee for this service, others feel that this is a program that should be supported by state and federal dollars. The challenge will be to find appropriate funding sources for the long term. If this service is not provided, some survey respondents indicated that they would return to calendar based sprays which would be a step backwards for IPM programs in vegetable crops.

**Contact Person:** Joanne Whalen 302-831-1303 jwhalen@udel.edu

**Project Title:** Third party Audits for Good Agricultural Practice/Good Handling Practices for Delaware Vegetable Growers

**Project Summary:** There has been a growing number of food borne disease outbreaks attributable to contaminated fresh fruits and vegetables, emphasizing the need for growers, packers, and shippers to reduce potential exposure of fruits and vegetables to pathogenic microorganisms and to other contaminates. At the same time, many factors [1] are converging to create a growing demand by consumers for fruit and vegetables grown locally, and the estimated 150 Delaware farmers are being asked to meet demands with safe produce.

In 1998, FDA and USDA recommended[2] that the risk from fruits and vegetables could be reduced or prevented by the application of Good Agricultural Practices and Good Handling Practices. Based on this guidance, USDA developed a voluntary third party audit program to assure the effective implementation of GAP's and GHP's. Since 2009, when the original grant was written, there have been significant changes in government policy and oversight of on-farm food safety, and this situation continues to evolve with the implementation of the FDA Food Safety Modernization act signed into law on January 4, 2011 by President Obama. This granted FDA new authorities to regulate and oversee the growing and production of food. FSMA is considered the first major piece of federal legislation related to food safety since 1938.

As a part of the increasing interest in fruits and vegetables, grocery chains, institutional buyers and food service companies are requiring farmers have independent (third party) audits of their farming operations and food handling practices. Currently, third party audits are only available through the federal government based in Frederick, Maryland or from private third party companies. Private third party audit companies are prohibitively expensive for relatively small farms in Delaware. DDA is working with USDA to train a Delaware auditor who could provide reviews at a more reasonable cost within the state of Delaware. Although private auditing companies exist, they are prohibitively expensive for the relatively small farms in Delaware.

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[1] (a)CDC recognition of an epidemic of obesity in the US, (b) First Lady's program to combat obesity in children, including White House vegetable garden, (c) US Dietary Guidelines 2010, recommending an increase in the servings of FFV, (d) Growing "Locavore" movement, with smart phone apps to direct travelers to farmers markets, etc.

[2] Guides to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables: Guide for Industry, October, 1998. Based on "Microbial Safety Evaluations and Recommendations on Fresh Produce, "report by the National Advisory Committee on Microbial Criteria for Foods, March 5, 1998.

**Project Approach:** 2010 - DDA selected an auditor who was licensed for shipping point commodity inspections and terminal market inspections. This employee met the minimum auditor criteria for Federal and Federal-State Auditors (Fresh Product Branch Directive- FPB 701).

2011 -April – Harmonized Audit Course

May – Licensed as a GAP/GHP Auditor

May - GAP/GHP Audit Performed Asparagus/Strawberries

June thru August – Farmer's Market Survey conducted. The survey was developed to evaluate sanitation and food safety knowledge and practices of vendors in Delaware Farmers Markets. Determine food safety training and certification including third party GAP/GHP audits. Future food safety needs from farmers, vendors and regulators perspective. The findings were analyzed to determine future food safety training and audit needs

August – GAP/GHP Audit Performed Corn

September – GAP/GHP Audit Performed Corn

October – GAP/GHP Audit Performed Distribution Warehouse

December – GAP/GHP Refresher Course

2012 -January - Auditor presented a GAP/GHP power point presentation for approximately 63 farmers, packers, shippers, government agency representatives and educators. Envelopes of third party audit information where distributed. The forum was Delaware Agriculture Week.

February - DDA hosted a Third Party GAP/GHP certification training. Farmers, Farm Market vendors and Farm Market Managers participated. In attendance were approximately 10 participants.

July – GAP/GHP Audit Performed Sweet Corn/Watermelons/Cantaloupes

July – Harmonized Audit Performed Sweet Corn/Cantaloupes/Nectarines/Peaches

August – Harmonized Audit Performed Sweet Corn

March thru September - Prepare professional educational programs/displays and workshops for producers, packers and shippers. Planned, designed and purchased educational supplies /materials needed to provide ongoing GAP/GHP presentations and outreach to farmers who produce, pack and ship fruits and vegetables. The folders include the GAP/GHP Audit Verification Program User's Guide, Guidance for Industry (Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables) and Guidance for Industry: Evaluating the Safety of Flood-affected Food Crops for Human Consumption. The folder includes a cover letter and contact information for the auditor.

**Goals and Outcomes Achieved:** The DDA auditor completed all necessary training and has maintained credentials for conducting GAP/GHP third party audits. These audits are priced at a more affordable rate to the farming community than third party services. Over the past three

years a total of 13 third party audits were completed. Products included asparagus, strawberries, peaches, sweet corn, nectarines, cantaloupes and apples. The process based auditor is licensed to perform GAP/GHP and Harmonized GAP audits.

The Farm Market summary results provided insight into the need for additional GAP/GHP training and outreach. Results show 55% vendors are the owner, 11% received GAP/GHP training, 1% is considering participating in an audit and 24% have taken food safety training.

The outreach materials will allow DDA to promote the Third Party Food Safety Program in the future which needs are sited in the survey. With the onset of the FSMA, increased need for audits is forecasted. The first presentation including GAP/GHP education materials scheduled for Delaware Agriculture Week - 2013. Other outreach forums will include the Delaware State Fair, farmer market venues, and GAP/GHP hosted DDA training. The Food Safety Audit folder with educational materials will be made available on a permanent basis in the Food Products Inspection section at DDA and will also be made available to marketing representatives.

**Beneficiaries :** The approximately 150 growers of fresh market vegetables in Delaware will be increasingly required to have independent (third party) audits conducted of their farming operations and food handling as prerequisites to selling to grocery chains, intuitional buyers and food service companies. From a public health perspective, improvements in the safety of our food system are invaluable.

**Lessons Learned:** The auditor became aware that the Food Safety Plan development task was over whelming to several participants. DDA was able to provide newly purchased materials such as Food Safety Begins on the Farm – A Grower Self-Assessment of Food Safety Risks which helped them immensely.

**Contact Person:** Andrea Jackson, 302-698-4545, Andrea.Jackson@state.de.us

**Project Title:** Evaluation of New Generation Biodegradable Plastic Mulches for Watermelon Production on Delmarva

**Project summary:** Watermelons are the main plasticulture crop on Delmarva with over 95% of this production grown on standard black plastic mulch with drip irrigation. Currently plastic mulch and drip tape is removed by hand at the end of the growing season and that plastic currently goes into landfills at a cost. Methods to collect and recycle the plastic have been studied. Baling mulch is feasible but recycling of baled mulch has been limited to date by the lack of recyclers willing to accept the mulch and the economics of recycling. An alternative to standard plastic mulches is degradable mulches that can be left in the field to disintegrate. This would reduce the need for recycling or for disposal in landfills and would leave only the drip tape to dispose of (tape collection is also more easily mechanized with tape winders). Degradable mulches need to have similar physical properties to current plastic mulches to be accepted by growers. Degradable mulches have the potential to reduce waste going into landfills and reduce labor needs.

Degradable mulches have been studied since the 1980's. Photodegradable mulches left too much plastic residue in the soil (especially where soil covered bed edges) and were not adopted in the region. Paper mulches were difficult to lay and were prone to tearing so they have received limited use. Biodegradable plastics based on plant starches have been studied starting in the 1970's. Oxo-biodegradable mulches use additives to plastic resins to start degradation also have been tested for several decades. However, biodegradable mulch films with acceptable longevity and physical properties were not available until the last decade. Advances have been made to improve the performance of these mulches and field performance has been shown to be acceptable in a number of studies in the US. However, the cost of these mulches is higher.

The purpose of this project was to test biodegradable plastic mulches for use in watermelon production, the predominant plasticulture crop in our region. Factors to be studied include physical properties (laying qualities), longevity, and factors affecting longevity, crop performance, weed control, and residue. Another part of this project was to evaluate the economics of biodegradable mulch use versus standard mulch for watermelon production. This included crop revenue, mulch costs, and costs of mulch and drip tape removal and disposal.

There were 2,700 acres of watermelons grown in Delaware in 2010 and an additional 2100 acres grown nearby Eastern Shore of Maryland. Over 95% of this production was grown on standard black plastic mulch with drip irrigation. This represents over 200 tons of plastic mulch that currently goes into landfills. Removal and disposal costs for farmers are estimated at >$400,000. Adoption of biodegradable plastic mulch for watermelon production in the region could reduce or eliminate this waste stream.

**Project Approach:** The funds that were allocated for this grant were originally to be used by James Adkins, Extension Agricultural Engineer to survey growers on plastic mulch use and disposal. Information had already been collected from growers on use and disposal so it was determined that the funds should be used elsewhere and degradable mulch research was seen to compliment the original goals. However, by the time this work was approved, there were only 15 months left on the grant to conduct the research and research goals had to be limited.

Study 1 - The first portion of the project was devoted to a one year study of biodegradable mulch physical properties and longevity using commercially available products under different laying regimes (amount of stretch) without a crop being grown on the mulch.

Materials and Methods - The two most commonly available biodegradable mulches, BioTelo and Eco-one, were laid under low, medium and normal (high) tensions with a standard plastic layer that formed a 4 inch high bed on a loamy sand soil. No drip tape was used. Strips were 50' long and plastic was laid on July 20, 2011 at the University of Delaware research farm near Georgetown, DE. Treatments were replicated 4 times. Visual ratings of percent cover were done at 30 and 90 days. Plastic was then lightly disked into the soil and a rating of percent remaining was done on several meter square areas in the strips by excavating soil to a 6 inch depth and screening out plastic remnants.

Results

| Mulch Parameters | | Plastic Type | | |
|---|---|---|---|---|
| | | BioTelo | Eco-one | Control |
| Tension | Measurement | % | % | % |
| Low | 30 day cover | 75 b | 99 a | 100 a |
| Low | 90 day cover | 45 b | 97 a | 100 a |
| Low | 6 month residual | 2 b | 33 a | NA |
| Medium | 30 day cover | 65 b | 99 a | 100 a |
| Medium | 90 day cover | 25 b | 98 a | 100 a |
| Medium | 6 month residual | 1 b | 30 b | NA |
| High | 30 day cover | 67 b | 97 a | 100 a |
| High | 90 day cover | 8 b | 95 a | 100 a |
| High | 6 month residual | 1 b | 35 a | NA |

Values in the same row are not significantly different if followed by the same letter.

In the table above, it was found that tension did affect initial breakdown of the BioTelo mulch. At 90 days and high tension, the BioTelo only had 8 % cover compared to 25% and 45% for medium and low tensions respectively. Tension had little effect on Eco-one breakdown. Eco one was shown to biodegrade at a much slower rate than BioTelo independent of the tension laid at. Low tension was undesirable for standard plastic mulch as it was very loose and prone to movement in the wind.

Study 2 - A one year study of biodegradable plastic mulch was conducted in 2012 under watermelon cropping systems. Only one site was used for the study.

Materials and Methods - The two most commonly available biodegradable mulches, BioTelo and Eco-one, were laid under medium tensions with a standard plastic layer that formed a 4 inch high bed on a loamy sand soil. Drip tape was applied under the plastic mulch at the same time. Strips were 300' long and plastic was laid on June 10, 2012 at the University of Delaware research farm near Georgetown, DE. Treatments were replicated 4 times. Seedless watermelons were transplanted on June 11 on 200 ft. of the plastic; the remaining 100 ft. was left unplanted. The variety used was SS7187 and the pollinizer was Accomplice. Seedless plants were placed 3 feet apart and a pollinizer was placed between every 3rd and 4th plant. Prefar and Sandea herbicides were applied prior to laying the plastic. Standard fertility, disease, insect, and mite control programs were used and plants were irrigated via the drip irrigation system as needed. A once-over harvest was done on September 4, 2012 (85 days after transplanting) on two, 30 foot sections on each strip and the number and weight of each melon was recorded. After harvest, on September 6 (88 days after laying plastic) ratings were done on each strip in planted and unplanted areas on the percent plastic cover, plastic integrity was measured by the percent of pieces less than 2 inches in diameter (broken) and the number of weeds were counted.
Residual ratings will continue into the spring of 2013

| Location | BioTelo | | | Eco-one | | | Control | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cover | Broken | Weeds | Cover | Broken | Weeds | Cover | Broken | Weeds |
| | % | % | # | % | % | # | % | % | # |
| East | 18.75 b | 72.50 b | 112.50 b | 97.50 a | 1.25 a | 0 a | 100.00 a | 0 a | 0 a |
| West | 25.00 b | 75.00 b | 57.25 b | 96.25 a | 0 a | 0 a | 100.00 a | 0 a | 0 a |
| Blank | 7.50 b | 61.25 b | 99.50 b | 93.75 a | 1.25 a | 0 a | 98.75 a | 0 a | 0 a |

Values for a parameter in the same row followed by the same letter are not significantly different.

In the table above, the BioTelo mulch had significantly reduced longevity when compared to Eco-one and where there was no plant cover (blank), the percent cover at the end of the trial was much lower than where watermelons had been grown. Eco-one performed very similar to the control (standard black plastic mulch). Weed pressure in the beds was only found with the BioTelo but came in late in the season.

| **Yield Parameter** | | **Plastic Type** | | | |
|---|---|---|---|---|---|
| | | **BioTelo** | **Eco-one** | **Control** | |
| **> 22 lbs** | **No./plot** | 1.13 | 1.25 | 0.50 | NS |
| **18-22 lbs** | **No./plot** | 4.25 | 4.75 | 4.25 | NS |
| **14-18 lbs** | **No./plot** | 9.00 | 9.38 | 8.88 | NS |
| **7-14 lbs** | **No./plot** | 12.50 | 13.63 | 11.50 | NS |
| **Total** | **No./plot** | 26.88 | 29.00 | 25.13 | NS |

| | | | | | |
|---|---|---|---|---|---|
| **Yield** | **Lbs/a** | 84,042 | 90,770 | 78,039 | NS |

NS No significant difference at the 0.05 level

There were no significant differences in yield between the plastic mulch treatments. Both biodegradable mulches performed similarly to the standard plastic mulch.

On-Farm Demonstrations - Degradable plastic mulches were trailed by 4 growers using their plastic layers and growing systems. Observations were made and growers were surveyed as to their opinion on the performance of the material.

Across all growers, there was dissatisfaction with the BioTelo. It tended to tear during laying at their existing settings for mulch tension and even when tension was reduced. While we were able to apply the mulch without tearing for our research trials, growers had a hard time. Growers were very satisfied with the performance of the Eco-one mulch but were concerned whether or not residue would remain in the soil in future years. Growers were dissatisfied with watermelon performance on BioTelo, but were very satisfied with Eco-one.

Cost Analysis - A cost analysis of different biodegradable plastic mulches in comparison to standard mulches was made based on current prices.

| **Type** | **Plastic Cost/A ($)** | **Labor & Disposal Cost Per Acre** | | | | | |
|---|---|---|---|---|---|---|---|
| | | 40 | 60 | 80 | 100 | 120 | 160 |
| **Standard** | 100 | 140 | 160 | 180 | 200 | 220 | 260 |
| **Standard** | 120 | 160 | 180 | 200 | 220 | 240 | 280 |
| **Standard** | 140 | 180 | 200 | 220 | 240 | 260 | 300 |
| **Eco-one** | 180 | | | | | | |
| **Eco-one** | 200 | | | | | | |
| **Eco-one** | 220 | | | | | | |
| **BioTelo** | 300 | | | | | | |
| **BioTelo** | 325 | | | | | | |
| **BioTelo** | 350 | | | | | | |
| | | | | | | | |

The table above gives costs for each type of mulch. Included in the standard mulch cost is the cost of labor to remove the mulch and the cost of disposal at a landfill. The highlighted are considered the standard costs. Eco-one was shown to be competitive with standard black plastic mulch. BioTelo was competitive only when disposal costs were high for standard mulch. These results are based on 48 inch wide mulch. However, the watermelon industry uses a narrower mulch commonly so costs will be approximately 12% lower for the mulch to do the comparison.

**Goals and Outcomes Achieved:** The goals of this project were to provide a research base on the potential of biodegradable mulches in watermelon production systems in the region and to trial these materials on-farm.

One longevity study, one performance study, 4 on-farm demonstrations, and a cost analysis were done in the project. See results and discussion above.

Research showed that biodegradable mulch could be used successfully in watermelon production. The BioTelo biodegradable mulch, a corn starch plastic, gave similar yields to standard plastic. However, it was shown to be more difficult to lay, started to tear and breakdown quickly, and was not favored by growers. The Eco-one oxo-biodegradable mulch gave similar performance as standard plastic mulch in application and in crop response. Growers viewed the product favorably. The main concern is longevity of plastic in the soil.

Results from this work will be presented to growers at the Fruit and Vegetable Growers Association of Delaware annual meeting at Delaware Agriculture Week, the Mar-Del Watermelon Association Convention annual educational meeting, and the Laurel produce auction meeting in 2013. Results will also be made available through publication of findings by the University of Delaware Cooperative Extension in The short-term success of this project will be measured by attendance at sessions where research results are disseminated, the numbers of reports requested by or provided to growers and advisors and the number of downloads from the UD vegetable program website.

Longer-term success of the project will be measured by the adoption of suitable biodegradable plastic mulches by growers in their production systems and the replacement of standard plastic mulch with biodegradable mulch on significant acreage.

**Beneficiaries:** The major beneficiaries of this project will be watermelon growers on Delmarva. There are over 80 farms in Delaware that grow watermelons and 75 farms on the Eastern Shore of Maryland that grow watermelons. We expect to reach 200 growers, consultants, suppliers, extension personnel, and agency personnel with information from this project.

If biodegradable mulch performs acceptably for watermelon production, growers could eliminate 200 tons of mulch going into landfills and associated landfill tipping fees, and labor for mulch removal ($400,000 cost).

A second beneficiary will be landfills such as the state of Delaware Solid Waste Authority. The elimination of plastic mulch from the waste stream will result in a potential 200 tons less of waste that needs to be landfilled.

**Lessons Learned:** Newer generation biodegradable plastic mulches were found to have promise for use in watermelon production. Potential problems encountered were similar to those with past products: difficulty in laying the mulch in one product, (BioTelo), short longevity and tearing in that same product, and long residual in the soil for the Eco-one product. Costs were high for BioTelo which was not fully offset when taking into account labor and disposal costs for standard plastic mulch in comparisons.

To fully understand these biodegradable products in watermelons, at least one more year of research will be necessary.

**Contact Person:** Dr. Gordon C. Johnson, Extension Vegetable and Fruit Specialist, Assistant Professor
University of Delaware - Department of Plant and Soil Sciences
General Phone: (302) 856-7303
Direct Phone: (302) 856-2585 ext. 590
Cell Phone: (302) 545-2397
Email: gcjohn@udel.edu