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Keynote Address

Status of organic farming research in the Southeast

Kokoasse Kpomblekou-A, Professor, Tuskegee University

Abstract

The Sustainable Agriculture Research and Education (SARE) divides the United States into four regions: Northeast SARE, North Central SARE, Western SARE, and Southern SARE. The Southern Region includes: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, U.S. Virgin Islands, and Virginia. The region has several large land-grant universities with influence beyond the region and want to play a significant role in the well-being of the population.

There is an urgent need for the people of the South to increase their consumption of fresh fruits and vegetables. With the exception of Florida (26.4%), Virginia (27.2%), and North Carolina (29.4%), obesity prevalence in the South is over 30% and ranks number 1 in obesity and diabetes. Mississippi and Virginia reported over 35% of their population, as obese. The current trend nationwide is a decrease in consumption of fresh fruits and vegetables, due partly to an increase in consumption of processed foods. In addition, in the South, most consumers do not know the benefits of organic foods yet the market trends for organic food production and consumption is increasing everywhere but the South. The U.S. organic sales reached $52.5 billion in 2018 and represented 6.3% over the previous year. The organic food sales on the other hand reached $47.9 billion with 5.9% increase over 2017. Producers and market participants in the South should, take therefore advantage of the production and marketing of organic fruits and vegetables in order to increase producers' and market participants' income.

The Southeast United States has favorable rainfall for agriculture and has a suitable climate for food production. The abundant rainfall and long growing seasons of the Southeast, though favorable for crop production, present some unique challenges to organic production. In the South, environmental conditions are favorable for rapid mineralization of organic crop residues, disease outbreaks, weed competition, and insect proliferation. Thus, for a successful organic farming enterprise, a special attention to agro-ecosystem research is required. Such a research must address pest and disease control, soil/soil health, and appropriate crop varieties for the South to include incorporation of cover crops into rotations, improved and sustainable utilization of animal manures to eliminate the need for inorganic agro-chemicals, and development of IPM techniques for important common vegetable crops.

These activities fit well into the land-grant mission of instruction, research, and service. To conduct this research work, however, land-grant institutions in the South must attract federal dollars to develop research programs that address production and consumption needs of constituents in the South. During the past decade (2009 – 2019), the Organic Research and Education Initiative Program funded 183 proposals throughout the four SARE regions; out of this number, only 33 were funded in the Southern SARE region and the vast majority of the proposals dealt with pest issues. In 2009, only two proposals tallying 1.2 million were funded in the Southern SARE region whereas six and eight proposals tallying $7.5 and $7.9 million were

funded in the north central and the northeastern regions, respectively, during the same period. The same trend persisted through 2014 with two proposals funded for a total of $1.5 million for the Southern SARE and seven proposals funded at $9.6 million for the North Central SARE region. In 2015, 2016, and 2017, the Southern SARE region was very competitive in attracting federal research dollars, but in 2019 only two proposals totaling $2.1 million were funded in the Southern SARE region, whereas nine were funded in the North Central SARE region for nearly $12 million. Moreover, state-level support for organic agriculture in the South is not strong compared with state support in Minnesota, Wisconsin, Washington, California, Iowa, and Vermont where states have a strong commitment to organics and offer countless services such as education trainings, informal advice to organic growers, technical assistance, conferences, organic advisory committees, and language access. To strengthen organic farming activities in the South, we must attract more federal research dollars, educate consumers and producers, show commitment to organic farming, enact policies that encourage organic transition, increase state research support for universities, and offer technical trainings for county officers and form specialized organic county personnel to guide organic growers.

Additional Notes:

Southern region soils tend to have lower inherent fertility than soils in cooler climates.

During the discussion following the presentation, it was noted that the Specialty Crop Block Grant awards in the Southern region include few projects that pertain to organic systems.

Strengthening Organic Agriculture through Healthy Soils and Plant Breeding

Soil health principles for resiliency in organic agriculture

Alex Woodley, Assistant Professor, North Carolina State University

Abstract

Dr. Woodley will discuss the concept of soil health, how it relates to soil fertility, crop production and sustainability. An overview of field practices that can be implemented to improve soil health and system resilience in organic agriculture in a Southeastern U.S. context will be presented. These practices, such as cover cropping, crop rotations, and tillage, will be drawn from research conducted in Ontario and North Carolina examining long-term research studies with a focus on soil carbon dynamics, microbial activity, water flow partitioning, greenhouse gas emissions and crop yield stability. Soil organic matter (SOM) is integrated throughout most soil system processes and management of SOM is key to creating a sustaining and functioning soil for food production. The link between soil health, soil carbon and greenhouse gas emissions will be discussed in the broader context of climate change.

Additional Notes

USDA Natural Resources Conservation Service (NRCS) defines soil health as the "continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans." The four NRCS principles of soil health management seek to protect the soil (maintain soil cover, minimize disturbance) and feed the soil life (maintain living roots and biodiversity) to improve and maintain tilth, water storage, drainage, nutrient supply, active microbial biomass, and resilience. Assessing soil health is regionally contextual; for example, a sandy Southeastern coastal plain soil will have lower soil organic matter (SOM) than a loamy soil in a cold, temperate climate.

Converting grassland to cultivation can reduce SOM by 30-50%, but much of this can be restored through improved rotations. Dr. Woodley cited results of long-term farming systems trials at the Harrow Research Center in Ontario, Canada, including a comparison of a four-year corn-oat-alfalfa-alfalfa rotation versus continuous corn, with or without 130 lb N/ac annually (conventional fertilizer). After 50 years, soil under the rotation showed a 42% increase in organic matter and absorbed 80% of incident rainfall, while 93% of rainfall ran off soil under the monoculture treatment without fertilizer. Corn yields in bushels per acre ranged from 166 in the rotation with fertilizer, to 122 in the rotation without fertilizer, 93 for the fertilized monoculture, and just 28 for the unfertilized monoculture.

In a 15-year trial comparing a soybean monoculture with rotations of soy-wheat, soy-soy-wheat, soy-wheat-red clover, and soy-soy-wheat-red clover, both SOM and soybean yields were directly related to amount of residue returned to the soil. Thus, yields and SOM were greatest in rotations with all three crops and least in continuous soybean.

Tillage in organic systems can present a soil health challenge, and Dr. Woodley noted that no-till and minimum-till systems show more yield stability than moldboard-plowed soils. In North Carolina, commercial soil health assessments developed in Texas (Haney test) and Cornell University in upstate New York (the Comprehensive Assessment of Soil Health or CASH) failed to differentiate healthy from degraded (e.g., excessively plowed) soils in North Carolina.

Lessons learned in farmer participatory plant breeding with the Northern Organic Vegetable Improvement Collaborative

Jim Myers, Professor, Oregon State University

Abstract

The Northern Organic Vegetable Improvement Collaborative (NOVIC) is now entering its third round of funding in four year increments by USDA-OREI. NOVIC represents the largest coordinated group of plant breeders focused on improving vegetable cultivars for organic production in the US. The project focuses on improving market extension and making available a wider selection of cultivars grown as certified organic seed. Our approach involves extensive variety evaluation on research and working farms for a suite of vegetable crops.

Breeding objectives are aligned to gaps in the performance of these crops based on stakeholder input. Multistate workshops and publications shared breeding techniques with farmers and seed producers. Breeding efforts have produced breeding lines for late blight resistant tomatoes, long storing butternut squash, early maturing delicata winter squash, heat tolerant snap peas and broccoli, flavorful peppers, productive cabbage, and sweet corn that germinates well in cold spring soils. Several of these breeding lines have been released as cultivars, such as 'Who Gets Kissed' sweet corn.

Variety trial information is curated on eOrganic in the Organic Variety Trial Database. This database allows growers to pick varieties that are proven to excel in their local region and publications and workshops empower many more people with the background to practice seed improvement and adaptation to their environment and goals thus encouraging diversity in our seeds. Small-scale, regionally based breeders have benefited from variety trials. One organic seed company breeder saw income from sales of Italian pepper seed quadruple and his varieties were picked up by national companies. Nearly every grower who has participated in NOVIC has indicated that they have changed varieties based on regional trial results.

Additional notes

NOVIC was launched to meet grower needs for organically produced seed and crop cultivars suited to organic systems. Although the National Organic Program (NOP) currently requires organic seed "if available," that qualifier may sunset in the near future, creating an urgent need for high quality organic seed. Project partners include Cornell University, University of Wisconsin, USDA Agricultural Research Service in Geneva, NY, Colorado State University, Organic Seed Alliance, and Oregon State University. The project has trained eight graduate students in plant breeding for organic systems, and is currently training three more.

Field trials of cultivars and breeding lines use a "mother-daughter" trial design developed by Dr. Sieglinde Snapp of University of Michigan, in which single-replicate on-farm trials supplement a replicated trial at the university research station. NOVIC 1 breeding efforts focused on broccoli, carrot, snap pea, sweet corn, and winter squash, and the project yielded a refereed journal article on outcomes of farmer-participatory breeding. NOVIC 2 prioritized tomato, sweet pepper, delicata, sweet corn, cabbage and crops chosen by farmers. For example, farmers in NY and OR conducted basil trials for downy mildew resistance.

At the 2018 Organicology conference, NOVIC 2 conducted a needs assessment for Northern states, in which participants reviewed a list of crops and traits and identified priorities.

NOVIC 3 increases the emphasis on regional autonomy and farmer participation in all phases of cultivar development and evaluation. Project co-PI Michael Mazourek (Cornell University) is working with farmers to develop a "fish type" sweet pepper (small, variegated color). Each year, farmers return their best seed to Michael to repeat cross, and the team is close to releasing a finished cultivar. Since its beginning, NOVIC has released eight cultivars representing four different vegetable crops, and a priority goal of NOVIC 3 is to finish and release an additional 12 cultivars now in the pipeline.

During the discussion following the presentation, forum participants asked how to "bring the participatory process to the Southeast where disease challenges are different, and we need different cultivars." NOVIC has held at least one plant breeding workshop in Virginia and is open to doing more workshops in the South under the current funding cycle. Questions about the level of participation and how to provide the needed structure and coordination to make the process optimally farmer-driven were discussed. It was noted that, to date, NOVIC has engaged 30 farms, with multiple individuals participating at some of these farms.

Participatory vegetable crop variety trials in the Southeast: Biomass yields

Desmond Mortley, Professor, Tuskegee University
Delivered by Kokoasse Kpomblekou-A, Professor, Tuskegee University

Abstract

According to the latest United States Department of Agriculture National Agricultural Statistics Service Survey, California has, the highest acreage of farmland under organic farming (688,883 acres) followed by Montana (417,412 acres). With the exception of North Carolina (26,641 acres) and Florida (21,580 acres), the Southeast has the lowest acreage of total land under organic farming. Alabama and Arkansas have the lowest acreage with 1,490 and 1,097 acres, respectively. This uneven distribution of organic acreage around the nation has been attributed to environmental conditions and disease and pest outbreaks in the Southeast.

The objectives of these vegetable variety trials are to give site-specific recommendations to organic growers and explore relationships between crop yields and geographic locations in the Southeast. Forty-one organic and transitioning organic farms in Alabama, Georgia, Mississippi, North Carolina, South Carolina, and Tennessee were selected. The growers must have land space, farming implements, irrigation, and easy road access. The growers must agree to plant two varieties (in parentheses) of one of the following four vegetable crops: Sweetpotato (Garnet, Orleans, or Covington), Squash (Gentry, Zephyr, or Spineless Beauty), Southern pea (Queen Anne, Mississippi Silver, or Pinkeye Purple Hull BVR), or Tomato (Celebrity, Mountain Magic, or Rocky Top). Each grower was also asked to select two varieties of a vegetable crop he/she finds challenging to grow on his/her farm. Once these criteria are met, the grower signs a three-year contract to host the trials for a monetary compensation.

The trials at each farm were run in triplicate on 15 ft.-long rows; spacing within the rows varied with the vegetable crops. The most frequently selected vegetable crops by the growers were squash, tomato, sweetpotato, and southern pea. Among the challenging crops, the growers selected beets and peppers. The highest yield for sweetpotato was in Tennessee for Covington, 26.3 t/acre. However, the yield decreased as one moves south or east. Tomato variety Rocky Top yielded 49.1 t/acre closely followed by Mountain Magic, 34.6 t/acre. These yields were recorded both in North Carolina; however, they tended to decrease as one moves south and west. Growers in Alabama and Georgia reported very high yields for squash; 27.6 and 26.2 t/acre in Alabama for Spineless Beauty and Zephyr, respectively, and 33.9 and 32.6 t/acre in Georgia for Gentry and Spineless Beauty, respectively. For Southern pea, not all yields were reported for 2019 when this report was submitted; however, the yields reported thus far were very low.

As we are collecting data on these on-farm trials, it was obvious that, yield variations depended not only on the crop varieties but also on the grower's ability to collect and report the data accurately. Together with on-going pesticide trials at experiment stations in Alabama, Mississippi, and North Carolina, we will be able to determine the best varieties for each location and near-by farmlands.

Additional Notes

The objectives of this OREI project are to document relationships between yields and geographic location, and develop site-specific recommendations for organic crop production and management of organic residues. Dr. Mortley noted that the growth of organic agriculture in the South is constrained by the "special attention to agro-ecosystems" and labor-intensive efforts required to meet the region's soil, pest, weed, and disease challenges. In addition to Tuskegee University as the lead institution, project partners included Auburn University, Mississippi State University, and the Alabama Sustainable Agriculture Network (ASAN).

A total of 41 organic and transitioning farmers in AL, GA, MS, NC, SC, and TN signed three-year contracts to conduct trials comparing two cultivars of their most challenging crop(s). Squash was chosen by the greatest number of participants (18), followed by tomato (12), sweet potato (11), southern pea (10), and various other crops of farmers' choice. Yields varied widely among site-years, and variation appeared partly related to location, but also to a substantial degree to farmer skills in both crop management and data collection. Weather extremes, such as intense heat in NC one summer also contributed to variable outcomes. More site-years of data are needed to develop variety or management recommendations. Economic analysis to determine net profitability is underway.

Organic cucumber research and breeding for the Southeast

Edmund Frost, Farmer, Common Wealth Seed Growers

Abstract

Common Wealth Seed Growers has been researching and breeding for downy mildew (DM) resistance in cucumbers since 2014, when we received a SARE grant for cucumber, winter squash and melon trials. In 2015 we began crossing standouts from the cucumber trial to create a DM-resistant breeding population.

In 2018 and 2019, with funding from OFRF, we intensified our work with cucumbers. Our 2018 breeding trials focused on DM and bacterial wilt (BW) resistance, productivity, and fruit quality. We also did 2018 variety trials looking at DM and BW. See results at http://commonwealthseeds.com/research.

Downy mildew and bacterial wilt are central concerns for cucumber production in the Eastern U.S., especially for organic farmers, whose control options are limited.

Our breeding population performed well in the 2018 variety trials, so in 2019 we continued with the goals of breeding organic-adapted DM and BW resistant pickler and slicer varieties from this population. Using an approach inspired by Participatory Plant Breeding, we organized DM-focused trials at several other southeast organic farms, and at universities, working with Sanjun Gu at NC A&T, and Susan Scheufele at U-Mass. These trials compared selections from our breeding population to each other and to commercial standards, in high-DM conditions. We also did a 2019 BW-focused variety trial at our farm, and more breeding trials.

Results from the remote 2019 variety trials are not in yet, but have been successfully completed at most locations. The breeding trial is a success in that we gathered data on yield, fruit quality and DM foliage resistance for over 300 plants; and we are close to harvesting hand-pollinated seed of the best selections. The results from the BW trial indicate that our seedstocks have promise for BW resistance/tolerance.

Additional Notes

Common Wealth Seed Growers (CWSG) produces certified organic crop seed and conducts plant breeding and variety trials in organically managed fields in central Virginia. After experiencing severe crop losses to downy mildew (DM, caused by the water mold *Pseudoperonospora cubensis*) in cucumber seed crops in 2010 and variety trials in 2013, CWSG applied for and received a SARE producer grant in 2014 to evaluate 35 cucumber accessions and select parent lines for breeding for DM resistance. CWSG received two research grants from the Organic Farming Research Foundation to continue assessing DM resistance in cucumber seedstocks.

DM resistance trials are planted late (July) to maximize exposure to the DM pathogen, and rated for foliar damage and yield. The pathogen blows in on the wind each summer, but then spreads from plant to plant. The Cornell cucumber varieties DMR 401 and DMR 264 performed well in the 2018-19 trials, but the CWSG breeding line showed the best yield and least foliar damage at the end of the season. Among commercial cultivars, ‘Homemade Pickle’ was above average, while the workhorse ‘Marketmore 76’ suffered severe DM damage.

Bacterial wilt (BW) resistance trials are planted earlier in the season (to minimize confounding DM exposure) without protective row covers (to allow cucumber beetles, the vector for BW, to reach the plants). BW resistance is evaluated by recording the percent of plants lost to the disease, and not by measuring yields. The variety ‘Marketmore 76’ lost no plants in 2018, but showed severe BW damage in 2019, while the CWSG line showed low levels of damage both years.

CWSG continues breeding trials to refine DM resistant pickler (F6 generation in 2019) and slider lines, and plans to release the new cultivars in the near future. Breeding efforts include taste tests and culling of plant with bitter fruit, and hand pollination to both self-pollinate and cross-pollinate the best plants. CWSG has received NOVIC funding for on-farm cucumber variety trials in 2020.

Organic Management of Pests and Diseases

Organic pesticide trials in the Southeast: How to manage pests in the Southeast

Franklin Quarcoo, Assistant Professor, Tuskegee University

Abstract

Organic crop production in the Southeastern United States is low and not reflective of the national trend. Warm temperatures and high rainfall patterns in this region cause rapid decomposition of soil organic matter and high insect pest populations. These conditions do not augur well for vegetable production in this region. Inadequate area-specific and research-based organic pest management information further render organic crop production in this region, particularly difficult. The consequent low production of organic fruits and vegetables does not provide the impetus for the allocating of resources to organic pest management research. This creates a vicious cycle in which the low level of organic production serves as a disincentive for the investment of research efforts in the resolution of production problems and the consequent lack of research-based information contributes to poor performance of crops grown under organic production systems.

Inadequate area-specific research-based pest management information has created a situation in which some organic vegetable producers resort to the use of pest management recommendations that are based on research conducted in regions that have environmental conditions that differ significantly from those that prevail in the southeastern United States. The fact that environmental factors exert significant effects on the efficacy of biopesticides renders some of these recommendations unsuitable for the southeastern region.

In 2018 and 2019, a total of three agricultural research stations located in North Carolina, Mississippi, and Alabama were involved in pest management research to address the afore-stated information gap for producers of organic sweet potatoes, summer squash, southern peas and tomatoes in the southeastern United States. The current report covers the studies conducted on Summer squash and Southern peas in Alabama. The specific objectives of these studies were to (1) conduct insect host-preference assessments using three popular Summer Squash and Southern pea cultivars (2) assess the performance of selected biopesticides against major insect pests of Squash and Southern peas.

Field experiments involving three cultivars of Summer squash: Gentry, Zephyr, and Spineless Beauty; and three cultivars of Southern peas: Mississippi Silver, Pink-eye Purple Hull, and Queen Anne were conducted at the George Washington Carver Experiment station at Tuskegee University in Alabama. The experiments were set up as Completely Randomized Designs (CRD) with a 3x4 factorial arrangement (i.e. 3 crop varieties and 4 treatments made of three biopesticides and a control). Insects were sampled once per week using visual sampling and sticky card techniques. The relative performance and cost-effectiveness of the biopesticides: Azadirachtin, Spinosad, and Pyrethrin were assessed against major insect pests of each crop. Plots were sprayed with assigned treatments when major insect pests attained their respective economic thresholds. Insect numbers were assessed using visual sampling and yellow sticky card techniques. Insect data were analyzed using SAS statistical software. The performance and cost-effectiveness of the

biopesticides: Azadirachtin, Spinosad, and Pyrethrin against the Squash bug (Insecta: Hemiptera: Coreidae) and Thrips (Insecta: Thysanoptera) were evaluated.

In the study conducted in 2018, Gentry recorded significantly higher ($P \leq 0.05$) leafhopper populations than the other summer squash varieties from 36 to 43 Days After Planting (DAP); by 50 DAP, comparable ($P \geq 0.05$) leafhopper populations were recorded on all three summer squash varieties. In the repeat study conducted in 2019, significant differences ($P \leq 0.05$) were recorded in the suitability of the summer squash varieties as hosts for thrips. Zephyr was the least preferred host for thrips from 57 to 64 DAP. The selected biopesticides performed similarly against squash bugs in 2018 but in 2019 Pyrethrin performed significantly better ($P \leq 0.05$) than the other two biopesticides. Pyrethrin was the most cost-effective biopesticide against squash bugs in both years. Spinosad was significantly more effective ($P \leq 0.05$) than Azadirachtin and Pyrethrin in the management of thrips on summer squash.

In the southern pea study, Mississippi silver (MS) was the least preferred ($P \leq 0.05$) host for thrips and aphids and thus offered the best promise for use in the management of these insect pests. Based on the current results, Spinosad is the only candidate biopesticide that performed better than the control study (i.e. plots sprayed with water) in the management of thrips on southern peas. Spinosad was more cost-effective ($P \leq 0.05$) than Pyrethrin and Azadirachtin (which performed similarly) in the management of insect pests on southern peas. Application of biopesticides did not always result in statistically significant pest reductions (i.e. relative to untreated plots). Additional studies involving the use of other Integrated Pest Management (IPM) tactics such as the use of trap crops, biopesticide rotation schedules, and the use of biopesticide mixtures, will provide more information on the performance and cost-effectiveness of a number of commercially available biopesticides.

Keywords: Insect host preference, biopesticides, organic vegetable production

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Additional Notes

Study objectives include evaluating efficacy and cost-efficiency of the NOP-allowed pesticides azadirachtin, spinosad, and pyrethrin; and documenting varietal preferences of pests and pest-beneficial dynamics. The overall goal is crop protection, not necessarily killing pests.

A literature review on summer squash indicated that major pests include squash bug, thrips, aphids, and leafhoppers. Squash bug damage results in part from the insect's saliva disrupting the flow of nutrients and water through the plant's xylem tissue. All three pesticides reduced squash bug populations, but film mulches allowed the pest to escape exposure by hiding beneath the film. In addition to the varietal differences in thrips and leaf hopper noted in the abstract, the study found that 'Spineless beauty' squash had more aphids than 'Zephyr' and 'Gentry.'

Paradoxically, Azadirachtin and pyrethrin actually increased thrips populations on some sampling dates in 2018 and 2019. Leaf hopper showed a similar response to spinosad and azadirachtin. Dr. Quarcoo noted that sometimes "insects multiply faster when you try to kill them," and that the predatory minute pirate bug also increased in a few pesticide treatments.

During the discussion following the presentation, an IPM strategy of rotating among NOP-allowed pesticides was suggested.

Organic solutions to control citrus greening disease and its vector, the Asian citrus psyllid

Amber Sciligo, Manager of Science Programs, The Organic Center

Abstract

Citrus greening disease threatens the citrus industry on a massive scale. The highly destructive disease can spread quickly by its vector, the Asian citrus psyllid, and once a tree is infected it cannot be cured. Currently, the most common method for controlling citrus greening is spraying large amounts of synthetic pesticides such as neonicotinoids to manage psyllid populations. These toxic sprays have only limited success as psyllids continue to develop resistance to all chemical control. Other non-organic research has focused on creating GMO varieties of citrus trees resistant to citrus greening. But these conventional strategies have not yet proven effective and have contributed to policy decisions not compatible with organic management.

Organic citrus growers need ways to control citrus greening through organic practices, without the use of toxic chemicals or genetic engineering, and conventional growers needs strategies outside of the status quo. While research specifically targeted at the control of citrus greening in organic systems is very limited, numerous and diverse studies conducted in conventional systems have included non-chemical methods that potentially could be incorporated into organic protocols. We will present organic strategies to combat citrus greening that we uncovered with an extensive literature review and farmer interviews. These include combining strict disease prevention, diligent scouting, biological control of Asian citrus psyllids, nutritional support of healthy and infected trees, and the planting of cultivars considered tolerant or resistant to citrus greening. Taking a holistic approach may be the only strategy the citrus industry has left to fight against citrus greening disease.

Additional Notes

The Organic Center is a nonprofit organization in DC that conducts research to inform policy with scientific data and leverage research into actionable next steps. The scope of work ranges from environmental and public health, farmworker exposure, soil health, and climate change, to plant health and diseases.

The Organic Center conducted a review of research into citrus greening, a bacterial disease (pathogen *Candidatus Liberibacter asiaticus*) vectored by the Asian citrus psyllid *Diaphorina citri*. The pest is incredibly prolific, with a life cycle of 15 – 45 days with each female laying 800

eggs. Nymphs are the most effective vectors, and are attracted to healthy, young trees. The bacterial pathogen causes starch deposits in vascular tissue that block transport of moisture and nutrients, causing plant tissue to collapse. Fruit remain green, become bitter, and may fall from the tree.

In the U.S., Florida citrus orchards were hit first and hardest, affecting 100,000 acres, causing $4.5 billion in damage, and leading to the loss of 8000 jobs. The disease has begun to arrive in other citrus growing regions across the US. Although hundreds of millions of dollars have been invested in citrus greening research, there is still no cure. Most research to date has focused on IPM programs for conventional farms that include removal of affected trees and neonicotinoid pesticide sprays. However, the psyllid has developed resistance to conventional pesticides; meanwhile the "neonics" continue to harm bees and other beneficials, including a parasitoid wasp that lays eggs inside psyllid nymphs.

The limited research into psyllid and disease management in organic citrus has yielded some promising leads:

- Biological controls—parasitoid wasps, lacewings, and beneficial fungi that kill the psyllid.
- Enhancing plant health and immunity to citrus greening with micronutrients and beneficial microbes to prevent the tree from getting the disease.
- Rootstock genetic disease resistance and induced systemic resistance (ISR).
- Physical barriers (row cover material)—feasibility depends on the size of operation.
- Use organic pesticides— soaps, oils, spinosad—as a last resort, as they harm non-target arthropods.
- Steam treatment against the pest—an experimental last resort, as the steam can also damage the tree.

It is clear that no single tactic will provide sufficient control, and ongoing research aims to develop effective, integrated, "outside the box" strategies. Scientists are focusing especially on plant health and immunity, genetic resistance, and ISR. Dr. Sciligo noted that organic management strategies can help non-organic citrus growers as well.

During the discussion following the presentation, a forum participant asked about the risk of backyard trees harboring the pathogen and its vector. Dr. Sciligo noted that this is an important question, and education of home gardeners in effective management of citrus greening may be vital to help protect the entire citrus industry.

Impacts of Organic Agriculture on Food Safety and Human Nutrition

Nutritional quality of selected organic vegetables: A review

Adelia Bovell-Benjamin, Professor, Tuskegee University

Abstract

Consumer perception of organic food is associated with the assumption that organic foods differ from those produced conventionally. The value associated with this difference includes premium retail price, whether or not it is produced with or without the use of antibiotics, added hormones, synthetic chemicals, or genetic modification; and the belief that organic farming is kinder to the environment, animals, and people. This review describes the nutritional quality of selected organic vegetables comparatively with that of conventional ones.

Crude protein content is lower in organic compared to conventional crops; however, the protein quality is better in organic produce. Conventionally grown vegetables and fruits have lower amounts of certain essential amino acids such as lysine. Organic leafy, root vegetables and tubers have higher dry matter contents than those conventionally grown. For example, the dry matter content in tomatoes has been reported as 5.9% versus 5.8% in organically and conventionally grown, respectively.

The most studied minerals in organic foods include calcium, magnesium, potassium, iron, zinc, copper, manganese, selenium and iodine. The mean percent difference for vitamin C, iron, magnesium and phosphorus in lettuce, spinach, carrot, potato and cabbage has been studied. Organic lettuce had significantly ($P<0.05$) higher amounts of vitamin C, iron, magnesium, and phosphorus than conventional ones. Similarly, organic spinach had higher amounts of vitamin C, iron, and phosphorus but significantly ($P<0.05$) lower amounts of magnesium than conventional. Organic carrots had significantly ($P<0.05$) less vitamin C than conventional. Antioxidant activity in organic foods has been reported as 17% higher than conventional.

The amount of extra antioxidants one would consume daily by eating the recommended five servings of organic instead of conventional fruits and vegetables is equal to one to two whole servings of conventional. Organic produce tend to contain 10-50% higher phytonutrients than non-organic. More research is needed to verify and quantify the differences in nutritional content, and the link between organic food consumption and human health.

Additional Notes

Based on limited research thus far, some studies show differences in favor of organic while others do not. Great variation among organic and non-organic production systems makes it hard to do a controlled comparison. However, one meta-analysis of 300 studies conducted in the United Kingdom found that organic produce contains significantly higher antioxidant levels than conventional produce. Other studies indicate higher levels of Vitamin C and some minerals, and lower toxic heavy metal concentrations in organic compared to conventional produce.

Recent studies have begun to explore the role of the soil microbiome in plant nutritional quality. One such study is Jacob et al., 2017. Frontiers in Plant Science 8: 1617. *Role of soil microorganisms in plant mineral nutrition—current knowledge and future directions*.

In the discussion following the presentation, participants asked how organic methods might be enhancing nutritional quality. Possible factors include: higher stress levels promote antioxidant and vitamin C synthesis in plants, beneficial microbes promote mineral nutrient uptake, and the shorter time interval between harvest and consumption preserves nutritional quality. Researchers attempt to correct for the last factor by not comparing freshly picked organic farmers market produce with conventionally grown supermarket produce with a longer harvest-to-consumption interval. It was also noted that produce was generally more nutrient-dense 50 years ago than it is today, possibly because of soil degradation or demineralization, and/or cultivar differences.

Another question, not yet researched, is how the nutritional value of hydroponic produce compares with that of soil-grown organic produce.

Implementing conservation practices while improving produce safety and quality

Kristin Woods, Statewide Extension Agent, Auburn University

Abstract

Balancing food safety concerns with farm financial viability and environmental stewardship goals is of paramount importance to growers across the region. Over the last few decades, the Centers for Disease Control has reported that foodborne illness traced back to produce is a significant source of all foodborne illness in the United States (Painter et al., 2013). Forty-six percent of foodborne illnesses from 1998-2008 were traced back to produce and the single highest number of illnesses were attributed to leafy greens (Painter et al., 2013). A 2018 report shows that this trend continues with produce being indicated as a source of foodborne illness from *Salmonella, E. coli* 0157:H7, *Listeria monocytogenes,* and *Campylobacter* (GA and D.C.: U.S. Department of Health and Human Services, CDC, FDA, USDA-FSIS., 2018).

While produce safety and shelf life are important, many growers have found it difficult to implement newly suggested practices that conflict with environmental stewardship. In this session, we will discuss pathogen movement on the farm and focus on common sense strategies to enhance the safety of produce while preserving the farm environment. The topics for this session will include the use of riparian areas, OMNI approved sanitizers, and irrigation methods that minimize water use, all of which support the goals of both conservation and food safety. The session will include time for group discussion of common conservation practices and challenges; the effect of these practices on wildlife; and the sharing of ideas to uphold produce safety and quality while continuing to protect the environment and maintain financial stability.

Additional Notes

The presenter has served in Extension for 17 years, utilizes Produce Safety Alliance training materials to help small food businesses and farms meet food safety criteria, and operates a small diversified farm with goats, chickens, woodlot, and produce.

Food safety risks related to fruits and vegetables eaten raw include the capacity of small numbers of foodborne pathogens to cause illness, the ability of pathogens to bind to produce surfaces or enter leaf tissue via stomata so that they cannot be washed off, and the growing number of immune-compromised individuals in the human population. Proximity to livestock operations adds risk. For example, produce fields adjacent to pasture show higher food safety risk than fields in close proximity to cropland, riparian buffers, or other natural areas. A serious *E coli* outbreak in 2018 was traced to a Yuma, AZ produce farm located directly across an irrigation canal from a large confined animal feeding operation (CAFO) which apparently contaminated surface water used for irrigation. This risk factor has led to increased use of groundwater and/or chemical treatment of irrigation water, both of which entail environmental costs.

Casual contact with wildlife was cited as another potential source of risk. Examples include rodents, wild swine, flocks of birds that visit a nearby CAFO and then the produce field, or a nearby wildlife refuge for birds such as sandhill crane that may defecate on the crop. Falconry or raptor habitat near produce fields can scare-off other birds and reduce contamination by bird droppings. However, tradeoffs can arise; for example, strawberries located near wild bird habitat can be protected from pests by insectivorous birds (Gonthier et al., 2019. Journal of Applied Ecology).

Dung beetles in biodiverse agro-ecosystems can lower food safety risks. At least one study showed that higher dung beetle populations in organic farms enhance fecal processing and integration into soil, thereby attenuating foodborne pathogen populations and reducing food safety risks (M. S. Jones et al. Journal of Applied Ecology 2019).

One question is whether this research, most of which has been conducted in the western U.S., applies to the humid southern U.S., where soils, environmental conditions, wildlife biology and bird migration patterns, and crop and livestock production practices are different.

Research conducted in the Southeast is needed to inform a step by step, adaptive management approach to reducing risk. Dr. Woods offered the following example of adaptive management: Plant legume cover → monitor wildlife pressure → assess risk → assess cash crop (change it?) → adjust cover crop rotation based on new information.

During the discussion following the presentation, Dr. Sciligo noted that recent research testing wild bird feces generally found very low levels of human foodborne pathogens. Risks of contamination via wild birds increase around agriculturally intensive areas, and are lower in regions with small, diversified farms, or wild areas. Other participants cautioned against expecting farmers to single-handedly solve society-wide problems, including hazardous CAFO operations that develop more virulent pathogens, as well as compromised human immune

systems. Instead, we need to look into restoring healthy soil, plant, animal, and human microbiomes.

Compositional differences in organic and conventional alternatives: Nutrients and bioactive compounds

Alberta N. A. Aryee, Assistant Professor, Delaware State University
Delivered by Adelia Bovell-Benjamin, Professor, Tuskegee University

Abstract

The rapidly growing market for organic foods has mostly been spurred by consumer perceptions. Organic foods are perceived to be nutritious compared to their conventional/non-organic counterparts. While the methods used in cultivation may affect the content of nutrient and bioactive compounds, there have been relative few studies to substantiate this. Additionally, there is divided scientific opinion on whether differences even exist. What have a somewhat consensus is that, there is reduction in frequency of occurrence and content of pesticide residues and thus exposure. Some studies have shown statistically significant and substantial differences in the composition of organic and conventional/non-organic food products, while others have not. Other studies have reported significantly higher amounts of antioxidant (phenolic acids, flavanones, flavones, flavanols and anthocyanins) content in organic than non-organic crops and food products.

The main focus of this presentation is to demystify what is currently available and discuss potential impact of the differences in nutrients and bioactive compounds on product formulation and health.

Additional Notes

Consumer perception that organic foods are more healthful because of subtle effects of synthetic inputs on conventionally grown food crops have led to studies of effects of mineral versus organic fertilizers on gene expression, protein patterns, and secondary metabolite profiles. Variability in region, farming practices, and experimental and lab assay methods complicate efforts to identify trends across multiple studies. Some studies have actually shown lower levels of protein and amino acid nitrogen in organic compared to conventionally grown vegetables, fruit, and grains. On the other hand, organically produced meat and milk show higher levels of biologically active fatty acids (conjugated linoleic acid and omega-3 fatty acids) than their conventional counterparts.

A meta-analysis of multiple studies indicates that organic foods contain higher levels of many antioxidants than conventional, though there were no differences in levels of vitamins C and E.

During the discussion, participants asked about the lower protein levels in organic food, and about the impact of “organic by input substitution” versus regenerative organic systems that emphasize soil and ecosystem health and seek to minimize reliance on inputs from off farm sources. In addition, experienced farmers take a site- and season-specific approach to address

production problems as they arise. Thus, conclusions regarding nutritional quality under different farming systems that are based on results from a single location or a single growing season can be misleading.

Attributes of organically grown squash (*Cucurbita pepo* L.) and tomato (*Lycopersicon esculentum*)

Julian Jones, Graduate Student, Tuskegee University

Abstract

Organic food is of essential importance to both human health and the environment. Squash (*Cucurbita* spp.) is a vegetable, native to Mexico. Tomato (*Lycopersicum escullentum*) belongs to the Solanaceae family and is made up of many antioxidants, such as carotenoids, vitamin E, vitamin C and phenolics. Three squash cultivars (Gentry, Spineless beauty, and Zephyr) treated with three organic pesticides (Azadirachtin, Pyrethrin, Spinosad) were evaluated for nutritional (fiber, vitamin C, protein, ash, antioxidant activity) and qualitative characteristics (moisture, color, texture, sugar profile, percent alcohol insoluble solids (AIS), degrees brix [°Bx], titratable acidity). Additionally, three tomato cultivars (Celebrity, Mountain magic, and Rocky Top), treated with the same three organic pesticides were also evaluated for lycopene, total phenols, tannins, vitamin C, ash, fiber, protein, antioxidant activity, and moisture, color, texture, sugar profile, percent alcohol insoluble solids (AIS), °Bx, and titratable acidity. Spineless Beauty cultivar treated with Spinosad pesticide had the highest mean vitamin C content of 2.1±0.2 mg/100 g, which was significantly ($P<0.05$) higher than Spineless Beauty cultivar treated with Azadirachtin pesticide, Spineless Beauty cultivar treated with Spinosad pesticide and Gentry cultivar untreated (control). Gentry cultivar treated with Pyrethrin pesticide had the highest protein content of 2.2±0.1 mg/g which was significantly ($P<0.05$) higher than Gentry cultivar untreated (control) and Gentry cultivar treated with Pyrethrin pesticide. The highest mean °Brix content of 5.4±0.0 was observed in Zephyr cultivar treated with Pyrethrin pesticide. For the tomatoes, Mountain magic had the highest vitamin C content of 11.5±0.3 mg/100 g, which was significantly ($P<0.05$) higher than the Celebrity and Rocky top cultivars. The highest mean protein content of 2.0±0.1 mg/g was observed in the Mountain magic cultivar. The Rock top was the least acid of the tomatoes, having had the highest mean °Brix of 4.5±0.05, which was significantly ($P<0.05$) higher than Celebrity and Mountain magic cultivars. The three organic pesticides influenced the vitamin C, protein and °Brix contents of the squash and tomato cultivars.

Additional Notes

In ‘Spineless Beauty’ squash, spinosad doubled Vitamin C content compared to other treatments, while Azadirachtin increased ash content. Two squash cultivars showed increased acidity with spinosad treatment. Pesticide treated ‘Gentry’ had slightly more ash than untreated.

In all three squash cultivars, pyrethrin treatment appeared to enhance degrees Brix over untreated crop. The pesticide may have enhanced this quality parameter by reducing pest stresses on the crop, a hypothesis that would require additional research to verify.

Leafy green quinoa: A potential nutrient-rich new vegetable for organic farming

Safiullah Pathan, Assistant Professor, Lincoln University of Missouri

Abstract

Quinoa (*Chenopodium quinoa* Willd.) grain is well known worldwide as a healthy food, sometimes even referred to as a 'super food', but consumption of the nutrient-rich green leaves of quinoa as a leafy vegetable is atypical. The nutrient content and health benefits of quinoa leaves were mostly unknown till recently. A group of scientists at the Lincoln University of Missouri have investigated the nutrient composition in dry, green leaves of quinoa and compared it with the dry, green leaves of amaranth and spinach. Preliminary results showed that dry quinoa leaves contain a higher amount of protein (37%) and lower amount of carbohydrate (34%) compared to amaranth (protein 27%; carbohydrate 48%) and spinach (protein 30%; carbohydrate 40%). Quinoa leaves also contain higher amounts of all essential amino acids necessary for humans compared to the other two tested vegetables. Mineral composition analysis showed that quinoa leaves contain higher levels of potassium, manganese, and copper than spinach and amaranth, with moderate levels of calcium, phosphorus, sodium, and zinc. The green leaves of quinoa contained lower amounts of heavy metals like arsenic, cadmium, cobalt, mercury, and lead compared to spinach leaves.

Quinoa is an abiotic stress-tolerant (cold, drought and salinity) summer crop, requiring less water and fertilizer compared to most traditional vegetables. In addition, quinoa grows well in high tunnels from March to April, when fewer fresh vegetables are available on the market. Vegetable quinoa is ready to harvest in 4-5 weeks and a second harvest can be made from the ratoon of the first harvest. Small and socially disadvantaged vegetable growers can increase farm profitability by growing this new vegetable several times in the fields and in high tunnels, thereby extending the growing season. As such, green leafy quinoa appears to be an ideal choice for both organic and conventional farming. This new vegetable may provide easier access to Americans with lower incomes, minorities, the elderly, and rural residents who face food insecurity or lack access to reasonably priced produce. Green leafy vegetable quinoa appears to be a sustainable vegetable crop for a climate-changing environment. Additional research and extension work is in progress.

Additional Notes

Cultivation of quinoa began about 5,000 years ago in Peru and Bolivia. Its gluten-free grain contains 12 – 18% protein, and provides all essential amino acids, B vitamins, and higher concentrations of the essential mineral nutrients calcium, magnesium, phosphorus, iron, manganese, and zinc than other staple grains such as corn, wheat, and rice. In 2017, the United States imported 78 million pounds of this increasingly popular grain, but grew very little domestically, and almost none in the Midwest.

U.S. nutritional professionals recommend 5 vegetable servings, including at least one leafy green, each day. However, low-income populations often cannot afford to meet these guidelines. Leafy greens from a quinoa crop offer good flavor and high nutritional value similar to the edible

weed lambsquarters (*Chenopodium album*), and may offer an affordable leafy green alternative. The greens can be used in a salad or stir-fry, and the seeds can be used to grow edible sprouts.

Quinoa for grain is planted in rows 10 inches apart, whereas the crop grown for greens is sown in rows 5 inches apart, and can be grown in high tunnels during the winter and outdoors in the growing season. Current research into quinoa greens includes optimizing organic production in high tunnels, greenhouses, and the field; nutritional analysis; and extension efforts in production and marketing.

Consumer Preferences, Markets, and Knowledge Transfer in Organic Systems

Consumers hedonic liking of organic squash (*Cucurbita pepo* L.)

Keniya Davis, Graduate Student, Tuskegee University

Abstract

Organic food consumption is on the rise, and its prevalence in grocery stores and supermarkets nationally is continually growing. However, consumers in the Alabama Black Belt region have very little access, limited availability, knowledge, exposure to and affordability challenges regarding organic foods. This study is part of a larger one (Tuskegee University and partners in the Southeast), of which one of the objectives is to conduct consumer education and marketing research on organic produce focusing on Alabama. Therefore, the objective of the current study was to evaluate consumers' preference/acceptance of three cultivars (Gentry, Spineless Beauty, Zephyr) of organically grown squash (*Cucurbita Pepo* L.).

All the squash samples were grown on the Tuskegee University Certified Organic Farm. Six squash samples were steamed, three were seasoned with fresh onion and garlic, and three were unseasoned. The consumer testing with untrained judges was done at a local grocery store in Tuskegee, Alabama. A random sample (as they came to shop in the store) with the condition that they normally consume squash was chosen. A nine-point Hedonic scale was used to assess their levels of likes and dislikes for the samples. The squash samples were labeled with three-digit random codes; judges were asked to taste six samples from left to right, rinsing their mouths with water (22+/-2°F) between samples. A total of 79 untrained judges/consumers participated, of whom 54 (68.4%) were females and 25 (31.6%) males.

The study findings revealed that consumer hedonic liking for the squash samples varied significantly by age in some instances. Among the females and males in the 18 to 25 and the 45 to 70 year-old age group, there were differences in the level of likeness for the three cultivars of squash, seasoned or unseasoned. However, for the 25 to 45-year-old age group, the judges liked the Spineless Beauty, Gentry and Zephyr squash, seasoned or unseasoned, equally well (6.0±0.01), with no variation in the degree of liking. Overall, the three cultivars of squash were acceptable to the consumers.

Additional Notes

Samples of cooked squash from the three cultivars with and without seasoning were taste-tested by 100 customers at Family Foods, 67 at Piggly Wiggly, and 46 at Krogers. The three cultivars received similar ratings for taste, texture, color, and appearance, though 'Spineless Beauty' had the best taste overall, a difference which was statistically significant.

Market development for organic squash, tomatoes, and southern peas in the Southeastern United States

Nicole Nunoo, Graduate Student, Tuskegee University

Abstract

In recent years, an increasing number of health conscious, knowledgeable, and more demanding consumers has led to an increase in demand for healthy and safe food products. In response, there is an increased interest in production of organic produce; however, there is an overtiring task locating available marketing channels for these produce. Organic farmers have traditionally relied on a variety of marketing channels which suggests that earned organic income will depend on the farmer's production, bargaining and marketing expertise. This project sought to identify alternative marketing opportunities available to small-scale/ limited resource organic producers in the Southeast. Three varieties each of squash, tomatoes, and southern peas were grown organically at Tuskegee University organic farming site. We identified local restaurants, stores, and entities within the Auburn-Montgomery-Tuskegee-Georgia areas that buy organic produce. Although all our buyers were enthusiastic about buying the produce, none of them was willing to purchase the produce at an organic price. The potential exists for limited resource farmers to compete by adopting niche market strategies, on-farm sales, and selling at retail prices to other farmers who already have existing markets. The study revealed the willingness to purchase organic produce but high resistance to pay a premium price for the organic produce.

Keywords: Organic produce, Southeast, marketing channels

Additional notes

Nicole Nunoo explained, "We Millennials want to know what is in our food, how it is grown (environmental impact) and are willing to pay for organic." This marketing study put this hypothesis to the test in Georgia and Alabama, and found that people are interested in organic, but are not always willing to pay the premiums. Nicole also encountered some racism in doing this work, and expressed concern about its impact on farmers of color. She experienced what farmers must cope with day in and day out. Farmers have to wear different hats—marketer and producer—to make a living, and face very long days with many logistical problems. Her work illustrated a need for consumer education for organic enterprises to be successful.

During the discussion, participants explored ways to meet these challenges. Possible strategies include making value added products from seconds, and electronic marketing via informational e-mails and social media. Nicole noted that farmers in the study used social media

to some extent, and it drew some customers. For older people and people of color, communicating via text messages is often the most effective social media outreach.

Willingness to pay for organic food was related to the degree of social connection, connection with the land, and sense of place. Customers may be more willing to pay if they know it goes back to the farmer to provide fair compensation for their products.

Consumer perspectives on fruit bagging: A small grower horticultural practice for southern organic tree orchards

Katie Kule, Graduate Student, Clemson University

Abstract

Fruit bagging is a simple method used to protect fruit from pests and diseases. It is very popular among backyard gardeners in Asia and there is an increasing interest in the United States, especially in regions with warm and humid climates where pests and diseases thrive. A survey was conducted in person using Survey Monkey at farmers markets in South Carolina, Georgia and Florida. Consumers were questioned on how often they buy conventional and organic peaches, whether or not they knew that organic pesticides may be used to produce organic peaches, and were asked which they would most likely buy with options being conventional, organic, or a bagged peach when in a market situation. Consumers were also asked to rate how important recycling the bags would be, as well as how much more cents per pound they would spend on an organic peach, and then a bagged peach. The demographics of age and ethnicity were the last two questions.

Results showed that consumer preferences at farmers markets throughout the southeastern U.S. are diverse, with some consumers answering they always or sometimes buy conventional peaches, organic peaches, or both. The majority of consumers across the states did know that organic pesticides were used to produce organic peaches. In a market situation, respondents at farmers markets in SC and FL mostly preferred organic peaches (either grown in a bag or not), but consumers in GA preferred conventional. Consumers in all three states reported being willing to spend slightly more cents per pound for an organic peach, as well as for a bagged peach. The age groups and ethnicity varied by state, although the majority was white or Caucasian and age group over fifty overall.

Additional Notes

Bagging protects fruit from both insect pests and fungal pathogens, thereby reducing the need for pesticide applications. Made from biodegradable materials (paper, wax, and a tiny iron clip), the bags decompose slowly and can be unsightly if left in the orchard after harvest. They can be composted, and begin to undergo decomposition in about 12 weeks with visible white mold growth. They degrade faster in an aerated static pile than in a windrow composting system. Surveys of farmers' market customers indicated that they would be willing to buy peaches that had been bagged for pest and disease control, especially if they know that used bags will be composted.

During the discussion, a forum participant asked if the bags would control brown rot. However, it appears a copper fungicide is still needed to control brown rot in the southeastern U.S. Another participant suggested that bags could be left on the orchard floor and flail-mowed to decompose in place to save labor and other costs of composting.

Bags are imported from China, and cost about one penny each when purchased in bulk. Bags are installed when the developing peaches reach golf ball size, after early drop of "buttons" that trees naturally abort. This timing works well, since pests are not attracted to the small green peach. Researchers found that the bag has no impact on color, flavor, or degrees Brix (a measure of sugar content) of the peach at harvest.

Larger-scale conventional growers are not interested in this labor-intensive method, so bags are marketed to smaller-scale, especially organic, producers.

Innovative approaches to transferring knowledge to beginning and transitioning farmers and ranchers

Tim Miller, Farmer, Millberg Farm

Abstract

Our master planned permaculture farm has fostered innovation utilizing resources provided by facebook in the many farmer related facebook groups. Being a member of some has provided me to answering many farmers related questions. From being selected as one of ten growers in a SARE Risk Management grant offered back in 2000. Those 10 farmers were the beginning of the online resources as we know it now.

To further my dissemination of knowledge I have offered a yearly workshop at our farm on fig growing with each participant getting a rare Haupt fig. The past 3 years with over 180 workshop attendees consisting of small-scale farmers, backyard gardeners and permaculture enthusiasts have all helped to save this fig which I found the last one in Texas. A farm tour of my 140-fruit tree orchard along with innovative planting demos along with how to propagate this and other figs.

For several years with the help of an intern from Texas State Nutrition Department they have helped me put together several power point presentations and posters. Growing Heirloom Alliums has been presented at the Mother Earth Fair for 3 years along with having a co booth with Southern Exposure Seed Exchange selling these alliums, at Texas Organic Farmers and Growers Association (TOFGA) and Austin Organic Gardening Club meeting and a Water Conservation power point that has been presented at the SSAWG conference years ago.
As the years have passed, area farmers have come and gone but still the alliums that I have given away by the thousands to new young farmers and gardeners as start packets keep showing up at the farmers markets. With my power point presentation on how to grow these southern, drought hardy, perennial alliums a secure income source is so needed, a reason why I'm expanding my

certified organic allium field by 4 more acres this year. We need more farmers and having a resource like mine that helps and supports new and old farmers has been very fulfilling.

Additional Notes

Tim organized his presentation around the word "JOURNEY," which he used as an acronym to describe his permacultural farming principles. (Unfortunately, the note taker did not catch what the "J" represents.). He spoke from his 31 years' experience with dryland organic farming in Kyle, TX, and additional experience teaching at school gardens and Austin Community Gardens. He noted that increasing numbers of students want to establish certified organic farms at universities.

O = opportunity. In 1993, Tim took two cuttings from a rare Haupt fig to start his planting stock of this line. He also propagates Haupt peach, blackberry, and heirloom onions. He now has enough Haupt fig stock to give a free cutting to each participant in on-farm permaculture workshops that can draw 200 people at a time. In addition, he has established a local network of 50 producers and launched one of the first garden discussion groups on Facebook.

U = understanding one's surroundings, including cultural factors, cropping styles, different soils, and climate. He grows only certified organic, southern heirloom vegetables.

R = responsibility to pass knowledge on to the next generation, and to maintain organic integrity.

N = new innovation. In utilizing wood chips on the farm, he found that as they decompose, they release a form of phosphorus that soil tests do not track. Most types of wood work fine, but he added, "watch out for mesquite and China berry which are full of thorns."

E = ethics and evolution.

Y = years. Over the years during which he has developed his permaculture farming system, Tim has collected roofwater to supplement direct rainfall. He uses about 6000 gal/ac-yr for 10 acres, watered manually onto crops.

Posters: Organic Crop Production, Soil Health, and Pest Management

Physico-chemical parameters of determinant at the level of the Laboko and Kokoro varieties of Dioscorea rotundata in Benin

Fiacre Adifon, University of Abomey-Calavi

Abstract

Yam production system in tropical Africa in general and Benin in particular has not changed significantly, farmers are still practicing slash-and-burn agriculture with high consumption of area to meet the growing yam demand. The present study aimed to determine the soil physico-chemical properties affecting the productivity of yam (*Dioscorea rotundata)* varieties Laboko and Kokoro in the perspective of development of an optimization model for yam production in Benin. In the farmers' field growing the two yam varieties, 48 composite soil samples were collected (at 0-20 cm and 20-40 cm depth) with eight at the Center, eight in the North-East and eight in the North-West of Benin before the beginning of the growing season and yam plantation. After the harvest, yields were subsequently weighed in 10 m x 10 m plots. The samples were analyzed for particle size, pH(water), pH(KCl), organic carbon, total nitrogen, exchangeable cations and available phosphorus. An analysis of variance followed by Student Newman-Keuls test was performed. Soil characteristics were subjected to multiple regression to assess soil characteristics determining yam yields.

Significant yam yield variations ($P < 0,001$) among the areas were noticed. Silt, N, exchangeable K^+, Mg^{2+} and organic matter contents significantly affected the yield level of Laboko variety while organic matter, exchangeable Ca^{2+} and K^+ content affected the yield of the Kokoro variety. These soil characteristics will be used for the optimization model of yam production in the agro ecosystems of Benin.

Key-words: Slash-and-burn agriculture, soil quality, optimization of yam cultivation, ecosystem degradation

Storage root yield and elemental leaf concentration of three sweet potato varieties in response to organic fertilizer

Andreka Wills, Tuskegee University

Abstract

Nutrient management in organic agriculture is critical to optimal yield since sources of fertilizers are biological and availability of nutrients to plants is often delayed. In contrast, inorganic fertilizers are readily available to plants soon after application. Because of the speed of nutrient availability to plants from organic fertilizers optimum application rates need to be determined. An experiment was conducted to determine the effects of organic fertilizer rates on growth, storage root yield and elemental leaf concentration of Orleans, Garnet and Covington sweetpotatoes. Plants of each cultivar were planted in a randomized complete block design with a 4x3 factorial treatment arrangement and three replications in rows 1.8 x 0.3 m. Mighty Grow

organic fertilizer (4-3-4 NPK) was applied at four levels (control, one-half, recommended, and 2X the recommended rate). Plots were drip irrigated as needed and grown for 100 days. Nine weeks after planting samples comprising the fourth fully expanded leaf from the tip of the vines from six plants were collected to determine leaf elemental concentration.

Results show that neither total foliage weight, storage root, nor marketable yields were impacted by Mighty Grow fertilizer. There was a trend towards greater yield of US#1 storage roots in Covington compared to the other two varieties, while the yield of canners was significantly greater for 2X the application rate with respect to the control plants only. N, K, B and Mn levels were significantly higher among plants receiving the 2X rate. These results show that fertilizer treatments exerted a greater influence on varietal responses and the plants that received the higher rates of fertilizers had elemental leaf concentrations equal to or higher than the standard values associated with optimum production.

Effects of thermal pretreatment on anaerobic methane production from a belowground cocktail of cover crops

Caitlin Skinner, Tuskegee University

Abstract

Organic growers incorporate into crop rotations cover crops that protect soils against wind and water erosion and reduce weed pressure. There are important distinctions between legume and non-legume cover crops and they play specific role in crop rotations. Above and/or belowground cover crop biomass could be used to produce biogas (methane) through anaerobic digestion for value-addition. Anaerobic digestion is a biochemical process in which complex biological materials are biodegraded by anaerobic microorganisms. However, not all biomass of cover crops are efficient in biogas production. The final products of such biodegradation are primarily carbon dioxide and methane gas. A thermal pretreatment of feedstock to anaerobic digestion serves to increase solubilization of organic compounds and increase biogas production efficiency. The objective of the study was to investigate effects of a thermal pretreatment on Biochemical Methane Potential of a belowground cover crop cocktail. The cocktail was composed of abruzzi rye (Secale cereal L.), bell bean (Vicia faba L.), black oat (Avena strigose Schreb), crimson clover (Trifolium incarnatum L.), hairy vetch (Vicia villosa Roth), taproot radish (Raphanus raphanistrum L.), and winter barley (Hordem vulgare L.). The pretreatment was carried out in an oven at 70, 80, 90, and 100 ºC for 1 hour with a non-pretreated control. The substrate loading rate was calculated by using the total solid (TS) and the volatile solid (VS) obtained through drying. The feedstock in a 500-mL glass bottle fitted with a septum and a screw cap was inoculated with a secondary sludge obtained from a municipal wastewater treatment plant in Alabama. Contents of the triplicated bottles were digested using an anaerobic respirator (PF-8000A) connected to a recirculating water bath unit set at 37°C for 30 days. The PF-8000A unit was connected to a computer that recorded every second the biogas released after CO2 removal. Results will be presented.

Keywords: Thermal pretreatment, anaerobic digestion, biogas, cover crops, BMP

Tomato hornworm (*Manduca quinquemaculata*) management in organic tomato production in Alabama: Performance of selected biopesticides and host preference of the insect pest

Sonu Koirala BK, Tuskegee University

Abstract

Organic farming largely excludes the use of chemical fertilizers, synthetic pesticides, genetically modified organisms, antibiotics, and growth hormones. Organic food production in the Southeastern United States is low and not reflective of the national trend. Warm temperatures and high rainfall patterns in this region cause a rapid decomposition of soil organic matter and high insect pest populations; both conditions do not augur well for vegetable production. The specific objectives of this study were to (1) conduct insect host-preference assessments using three popular tomato cultivars 2) assess the performance and cost-effectiveness of selected biopesticides against tomato hornworm. Field experiments involving three tomato cultivars: Celebrity, Mountain Magic, and Rocky Top were conducted at Tuskegee University in Alabama in 2018 and 2019. A field experiment involving three tomato varieties and four treatments (made up of three biopesticides and water for the control experiment) was set up. Hornworm populations were assessed once a week using the visual sampling technique. The relative performance and cost-effectiveness of the biopesticidal active ingredients: Azadirachtin, Spinosad, and Pyrethrin were assessed against the tomato hornworm. An economic threshold (ET) of 1 hornworm per 10 foot row of tomato plants was used for biopesticide applications. Hornworm counts recorded on different sampling dates were analyzed using SAS statistical software. The criteria for assessing cost-effectiveness of biopesticides included: biopesticide application cost, hornworm management performance, and the marketable yield of tomatoes.

Tomato hornworms showed equal preference for the tomato varieties in both years. Plots treated with the candidate biopesticides recorded hornworm populations that were comparable to the untreated plots in 2018. Plots treated with Spinosad and Azadirachtin recorded hornworm populations that were significantly lower than those recorded on untreated and Pyrethrin-treated plots in 2019. In the 2019 study, spinosad was the most cost-effective biopesticide for the management of the hornworm.

Keywords: Organic farming, Tomato hornworm, Economic threshold, biopesticides, Spinosad, Azadirachtin, Pyrethrin

Organic pesticides influence the nutritional and physical properties of organically grown sweet potato (*Ipomoea batatas* [L.] Lam)

Keniya Davis and Julian Jones, Tuskegee University

Organic food production has several essential health benefits. Previous research showed that organic crops contained significantly higher vitamin C, iron, magnesium, and phosphorus and significantly less nitrates than conventional crops. Organic farming entails using pesticides derived from natural sources, not synthetic. Pesticides increase food production, profit for farmers, protect crops from pest and diseases, and improve food quality. Research on organic products shows structurally fewer pesticide residues than conventional products. Three organic orange-fleshed sweet potato cultivars (Covington, Orleans, and Garnet), treated with three organic pesticides

(Azadirachtin, Pyrethrin, Spinosad) were evaluated. Protein, vitamin C, crude fiber, β-carotene, and moisture were analyzed using the Bradford method, 2,6- Dichlorophenol indophenol dye, AOAC procedure, spectrophotometric and conventional oven procedures, respectively. Color and texture were analyzed using Minolta chroma-meter and Instron procedures, respectively.

Covington, Orleans and Garnet had mean protein contents of 11.8±0.9, 10.2±0.3 and 8.3±0.3 mg/g, respectively. Covington cultivar untreated (control) and Covington cultivar treated with Spinosad pesticide had similar protein contents (11.1±0.1 versus 10.8±0.1 mg/g). Covington cultivar treated with Pyrethrin pesticide had the highest mean protein content of 12.9±0.1 mg/g, which was significantly ($P<0.05$) higher than all the other Covington cultivars treated with organic pesticides. Garnet cultivar treated with Spinosad pesticide had significantly ($P<0.05$) higher β-carotene content than Garnet cultivar untreated (control) (62.6±2.7 versus 45.5±2.7 mg/100g). In terms of flesh color, Orleans cultivar treated with Spinosad pesticide and Orleans cultivar treated with Azadirachtin pesticide had similar b values (blue-yellow components) (43±1.1 vs 42.1±1.1). Orleans cultivar untreated (control) had the highest mean b value of 47.8±1.1, which was significantly ($P<0.05$) higher than all the other Orleans cultivars, as well as the Garnet and Covington cultivars treated with the three organic pesticides. Orleans also had the lowest L value 75.34±0.8, which was significantly ($P<0.05$) lower than all the other cultivars treated with organic pesticides, indicating that it was darkest in color with the most orange-colored flesh. The three organic pesticides influenced the protein, β-carotene, and color contents of the three sweet potato cultivars.

Posters: Organic Livestock Production

Organic compared with conventional systems for lamb production yield differences in performance in Southeastern U.S. pastures

Joan Burke, USDA

Abstract

Little is known about U.S. organic production of ruminant livestock. Objective was to determine differences in production between conventional (CON) and certified organic (ORG) Katahdin ewes between 2014 and 2018 in Booneville, AR. Organic sheep and pastures were certified by NICS. ORG (n = 14-54 ewes/breeding; n = 344 total) and CON (n = 62-164 ewes/breeding; n = 1112 total) were exposed to same rams in organic pastures, but otherwise separated, and exposed to rams for spring (Apr-May) or fall (Aug-Sep) breeding for ≤35 days. Ewes were ≥32 kg or 12 months of age at lambing, and up to 9.5 years of age. Pregnancy was determined by ultrasound 30 days after ram removal. Sheep grazed tall fescue and/or mixed forages, and were supplemented when forage quality/mass became limiting. Ewes lambed on respective pastures and were only moved to a jug if needed. Body weight and BCS of ewes was determined on day of ram introduction and ~60 days post-lambing. Lambs were weighed at birth and ~60 days of age. Data were analyzed by Proc GLM (SAS) and included group, age, season, year, and interactions; age of lamb was included as covariate if needed.

Year and season effects were significant for all traits, and group x year for most traits. Pregnancy rate was higher in ORG than CON ewes in 2014 and 2017, lower in 2016, and similar in 2018 ($P < 0.001$), likely reflective of differences in forage quality. Litter birth weight was heavier in CON than ORG ewes in 2014 but similar in other years. ORG ewes were more efficient (lamb/ewe weights) in 2018, but mostly similar to CON otherwise ($P < 0.001$). Comparisons between farming systems are complex and should consider several economic traits and genetic selection over time and will be discussed.

Posters: Organic Certification, Organic Transition, and Public Policy

Obstacles in transitioning to a certified organic production system in farmers from the central-northern region of Sinaloa Mexico

Carlos Alonso Maldonado Rocha, Universidad Autónoma de Sinaloa

Abstract

Nowadays, some of the most developed economies worldwide have become involved in strengthening farming sectors that produce within the sidelines of a system with greater ecologic and sustainable conscience, such as organic agriculture. Their participation is so committed that, in fact, international production and commerce of organic food is expected to overcome the US$100 billion-dollar milestone by 2019. However, it is known that little has been tried by the farming sector in Sinaloa Mexico to take advantage of specific niches in organic market. For that reason, from the approach of Strategic Administration and International Marketing and the purpose of identifying obstacles in transition, research was conducted in a region that holds only 4% of Mexico's total certified operations. The objective was to determine if economic or financial factors were identified by farmers as the main obstacles in the transition to a production system that offers prime prices, given that local media has suggested these were among the main worries for local farmers. In order to objectively portray the farmer perspective, a statistical analysis was made over the answers of 39 surveyed producers from the central-northern region of the state, techniques of crossed tabulation and Pearson´s chi-squared test, linear correlation analysis, and analysis of main components were used. Among the findings, some planning aspects outstand with greater significance than economic or financial aspects. It can be concluded that local stakeholders must provide farmers with solutions in the fields of planning in crop rotation, low yields contingency plan, commercial channels and retail industry.

Key Words: Challenges, economic, planning, transition, organic agriculture.

Public policies to facilitate the transition to organic farming (Tunisian experience)

Chehidi Hatem, CTAB.

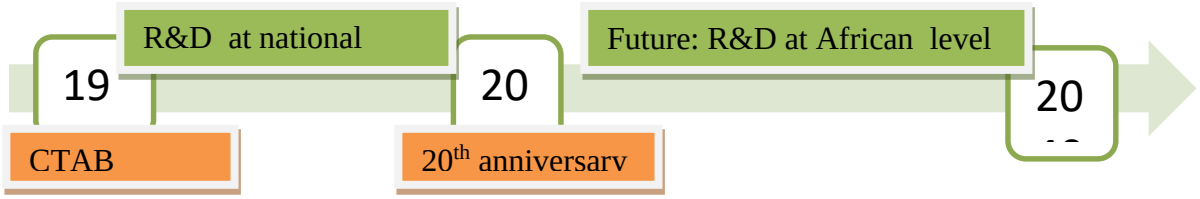
Abstract

Tunisia was recognised by EU on June 2009 as a country having an equivalent organic regulation (1999). The sector started by private initiatives and work of EU certification bodies and

companies exporting to EU. However, the last years were characterized by a high increase in area of production and number of producers after fruitful support of policies implemented by decision-makers. It was a responsibility and a support of the state to promote the image of the country and their products in the European market. Many support policies to Organic Agriculture sector were done in Tunisia in these last few years. As example, a Technical Centre of Organic Agriculture (CTAB) was created in 1999 within the Ministry of Agriculture and Hydraulic Resources. It is a member in National Bureau of Organic Agriculture and provides applied research; training & building capacities and technical advice to farmers, researchers and the regional network of provinces. It will celebrate nearly its 20th anniversary. During these twenty years many works has been done at National and International level before and after the creation also of DGAB (2010) within the Ministry of Agriculture and Hydraulic Resources and making actualization of the national strategy to have a Tunisian model for Organic Agriculture sector.

At International level, Two ISOFAR-MOAN-CTAB symposiums were organized in Sousse, Tunisia when CTAB was directed by Professor Dr. Mohamed Ben Kheder. The first was about "Soil Fertility and Crop Nutrition Management in Mediterranean Organic Agriculture" (March, 2010) and the second treated the subject of "Plant Protection Management in Mediterranean Organic Agriculture" (May, 2013) In addition, A Technical Cooperation Program (TCP) was achieved between FAO and Tunisia on organic agriculture. Furthermore, in collaboration with CIHEAM-MAIB 7 Mediterranean Training weekly sessions were also organized. Participants came from Mediterranean countries and Tunisian Regional Organic Networks, and were supervised by European and Mediterranean experts. Many technical visits were done to KSA (2010-2013), Yamane (2009), Libby (2009), Oman (2011-2012), Jordan (2008) Kuwait (2016), and Algeria (2017). Several technical visit and weekly sessions of training were also organized for Arab and Afrcan Delegations in CTAB .

In this paper we will present, not only the missions of CTAB, but also its contributions in the development of Organic Agriculture sector in Tunisia and some prospective ideas to empower the transition to organic Agriculture at Mediterranean and African level.



Posters: Forestry, Wildlife Conservation, and Global Change

Image data acquisition for estimating individual trees metrics: Closer is better

Hospice Akpo, University of Ibadan

Abstract

The recent uses of Structure-from-Motion with Multi-View Stereo photogrammetry (SfM-MVS) in forestry have underscored the robustness of this technique in tree mensuration. This study evaluated the differences in tree metrics resulting from various related SfM-MVS photogrammetric image acquisition schemes. Scaled tri-dimensional models of 30 savanna trees belonging to five species were built from photographs acquired in a design consisting of two factors: shooting distance (d = 1, 2, 3, 4 and 5 m away from tree) and angular displacement (α = 15°, 30°, 45° et 60° nested in d). Tree stem girth at 1.3 m and volume were estimated using models resulting from each of the 250 schemes/tree. Relative mean absolute error (RMA) was computed for both metrics and used to compare the performance of each image acquisition scheme in relation to reference data collected manually with a graduated tape. Effects of species (s), distance (d) and angular displacement (α) were examined. Results showed that the best 3-D models were obtained with 15° and 30°. RMAs calculated from stem girth and volume varied widely ($1.6 \pm 0.4 - 20.8 \pm 23.7$ % and $2.0 \pm 0.6 - 36.5 \pm 48.7$ % respectively) and were consistently lower for smaller values of d and α. Stem girth and volume significantly differed with d and α respectively, with a significant interaction between α and s for both metrics. Shooting distances and angular displacements below 2 m and 30° respectively are recommended photogrammetric data collection settings for basic tree mensuration.

Key words: Photogrammetry, SfM-MVS, Relative mean absolute error, tree stem girth, tree volume, Benin

Ecological niche modeling of the stone partridge (*Ptilopachus petrosus* Gmelin, 1789) in Benin republic center

Christelle Codjia, University of Nigeria

Abstract

In a context of global changes caused directly or indirectly by human activity, the preservation of biodiversity has become an irrefutable issue. The changes in climate lead to changes in the reproductive phenology of some species, unbalancing ecosystems. Stone partridge, *Ptilopachus petrosus* is a mountain species. It has a large distribution area in tropical climates and it's not unfortunately spared the magnitude of the effects of these climate changes. The present study aims to analyze the potential impact of climate change on the geographic distribution of favorable habitats to *Ptilopachus petrosus*. The maximum entropy principle (MAXENT) associated with a Geographical Information System (GIS) was used to model favorable habitats to *Ptilopachus petrosus* and the conservation of the species, under current and future climatic conditions (horizon 2055). Presence data of the species were collected and

combined with bioclimatic data derived from the Worldclim database and soil data. In total, 13 environmental variables were selected for the prediction.

It turns out that the nature of the soil is the environmental variable that contributed the most to the prediction of models *soil* (AUC = 0.867). This means that edaphic factor could have the most useful information for modeling the ecological niche of the species. The environmental variable that most decreases the gain when it is isolated is the *number of dry months* (AUC = 0.845). Studies of this magnitude must be carried out as the predictive powers of climate models are improved, for greater relevance of conservation of *Ptilopachus petrosus* against climate variability effects.

Key words: Stone partridge, climate change, MAXENT, ecological niche, Benin republic center.