Project Title: "A Comprehensive Approach To Control Weeds in Organic Peanut Systems in the Southeast"

Organization: Georgia Organic Peanut Association, Inc.

Project Summary

This OFRF project examined the effectiveness of an integrated weed control system in Certified Organic peanut production utilizing regular mechanical cultivation and Eugenol, a broad spectrum herbicide derived from cloves and approved for Certified Organic production in a commercial formulation as *Weed Slayer*. The project was conducted primarily on three Certified Organic farms in Southwest Georgia, with other Certified Organic producers adopting components of the system in their fields. Each primary farm attempted to begin use of a tine weeder within 5-7 days after planting, with 5-7 total passes, followed by 2-3 passes with sweeps until the peanut plants' canopies extended across the rows. As applications of Eugenol become necessary, farmers tested its efficacy in combination with mechanical production in the real environment of working farms. Data for all weed control activities was collected throughout the year, and weed populations were measured after approximately eight weeks of control and again before harvest. Unfortunately, Weed Slayer did not prove to be an effective herbicide. More importantly, 2020 peanut seed was compromised, and poor germination and vigor negatively impacted project activities.

Introduction

Since the first attempts to develop a rational and comprehensive Certified Organic system for peanut production in the South, overcoming weeds has always been the primary limiting factor to yield. The vining habit of peanut plants enable them to outcompete weeds with proper seeding rates, good gemination, and timely cultivation. This is as true today as it was in the earliest years of the industry. In 1922, encouraging farmers to take up peanut production outside of Southwest Georgia, farmer W.T. Garrard wrote, "A perfect stand is absolutely necessary to a big yield" (Garrard, 1922, p. 11).

While uniform and vigorous emergence has become a self-evident truth for peanut farmers, mechanical and technological advancements have made the specific cultivation tactics prescribed by Garrard, who for all intents and purposes farmed organically, outdated for conventional producers farming on a modern scale. However, Garrard's formula for effective cultivation mostly holds true for Certified Organic peanut producers: "Run the weeder as soon as the peanuts begin to come up the way the rows run to tear off the crust and insure a better stand. Then run the weeder diagonally across the rows" (Garrard, 1922, p. 13). Two years earlier, in USDA Farmers' Bulletin 1127, "Peanut Growing for Profit," W.R. Beattie identifies the tine weeder as the proper cultivating implement for sandy soils:

“This tool is light, and can be dragged diagonally across the rows, first in one direction and then in the other, without serious injury to the plants. At the substation at Florence, S.C., it has been found that practically no hand hoeing is necessary where the crop is worked about twice a week with this type of tool until it ‘pegs’” (Beattie, 1920, 13-14).

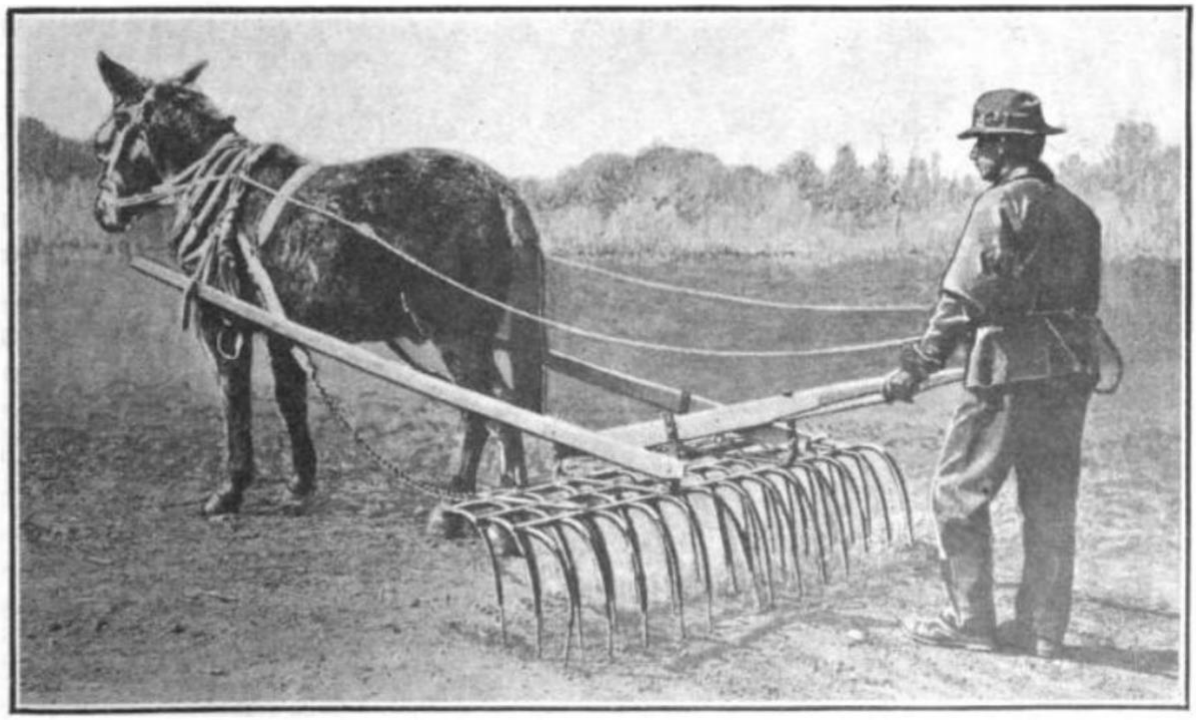


Figure 1. Early tine weeder featured in USDA Bulletin 1127

As a whole, this is essentially the cultivation strategy that has been employed over the last decade by organic producers involved in this project. However, as mule shoes have given way to tractor tires, the cross-diagonal pass significantly damages the peanut plants and is no longer viable. Modern organic peanut farmers must address the uncultivated spaces— in addition to gaps within the row resulting from poor germinatioin — that allows for weeds to take hold and potentially overwhelm the crop.

Since peanuts do not quickly achieve canopy closure, the first objective to control weeds is germination and emergence. Ongoing research by Dr. Baozhu Guo of the U.S. Department of Agriculture in Tifton, Georgia has shown that weeds in the subtropical climate of the Southeast quickly colonize voids in the peanut row and that “establishing a uniform stand is essential for optimum, cost-effective weed control” in an organic system (USDA Project #6048-22000-043-00D). Yet, without available seed protectants approved for Certified Organic production, organic peanut fields in Georgia are almost never without voids. In his preliminary results, Bao states there is “a small margin for error when growers plant organic peanuts and they must seed the crop when conditions are conducive for establishing a uniform stand” (USDA Project #6048-22000-043-00D).

In other words, without the arsenal of synthetic fungicidal and herbicidal seed treatments and sprays available to conventional producers, successful organic peanut production requires almost perfect timing, but perfection is a high bar in the dynamic environment of the farm. If a uniform stand is unpredictable, then farmers need additional tools to combat weeds and enable peanut plants to crowd out competitors. Until recently, there had been no herbicide approved for Certified Organic production that demonstrated marginal efficacy in the Southeast, and subsequently no research on such a product. In 2019, four Certified Organic producers from the Georgia Organic Peanut Association each independently trialed a Eugenol-based herbicide in their peanut fields. The results were promising, with little injury to the peanut plants but with dieback of weeds, especially nutsedge, reported in all fields. However, application rates and timing were not controlled between farms, and no conclusive recommendations could be generated.

The farmers of the Georgia Organic Peanut Association cannot find any evidence that research involving Eugenol as a weed control tool in Certified Organic peanuts has occurred or is currently ongoing. As such, it saw an immediate need to assess the viability of Eugenol as an effective herbicide to complement mechanical cultivation in a Certified Organic system. In the absence of uniform stands, Eugenol could provide an important tool to attack voids and weed escapes arising from poor stands and weather-caused cultivation delays.

Objectives

The goal of this research project was to create a system of weed management specific to Certified Organic peanut production in the Southeast that could be replicated by farmers across the region, particularly new, beginning, and limited-resource producers. This system would combine physical cultivation employing a tine weeder and discs/sweep with a new broad-spectrum nonselective herbicide derived from Eugenol. An essential oil of cloves and molasses developed by Agro Research International, *Weed Slayer* has been approved for Certified Organic production by the Washington State Department of Agriculture and has been accepted by the respective certifying agents of the farmers participating in this project.

Additional objectives included

- Determining the effect of early versus late planting on peanut plant vigor and weed populations
- Determining the application rate, timing in relation to cultivation practices and weed maturity, and species-specific efficacy of Eugenol *Weed Slayer*
- Determining the cost-per-acre of an effective weed control system and develop an enterprise budget.

Materials and Methods

The project attempted to follow as closely as possible the method as it was originally conceived, and all activities took place on Certified Organic farms in Georgia (Chad Heard Farms, Shingler Farms, W.C. Bradley Farms, as well as others). The original scope of work:

The research will be conducted on four Certified Organic farms in Southwest Georgia: two loamy/clayey farms, two sandy farms. Each farm will conduct two plantings in the target May-June window between optimum soil temperature and peak damage caused by tobacco thrips. Each farm will plant according to recommendation for organic peanut production by former USDA ARS Research Agronomist Dr. W. Carroll Johnson: wide row spacings (rows approximately 91 cm apart) at a seeding rate to produce a final stand of 20 to 26 plants/m of row. Each farmer will use the same variety of peanut, likely Georgia-12Y, a high-yielding, medium-seeded, runner-type (the actual variety cannot be stated as fact since the availability of Certified Organic or nonorganic untreated seed is inconsistent from year to year).

Based on the literature review and farmers' experience, weed control will commence at all sites when the peanuts reach the vegetative emergence state of growth, or begin to "crack" the soil surface. Farmers will employ a tine weeder, a series of spring-steel rods arranged in multiple rows that eradicates weeds through the vibration of the tines against the soil surface. Tine weeders "are very effective on annual grasses and seedling dicot weeds with fibrous root systems, with maximum performance occurring when weed seeds have germinated, but seedlings not fully emerged" (Johnson, 2019, p. 59). The tine weeder will be used 5-7 times on each farm for six weeks.

After 5-7 passes with the tine weeder, each farmer will use cultivator sweeps in 2-3 weekly intervals to uproot remaining weeds between the rows. Eugenol will be applied on an as-needed basis when weather or other events make regular cultivation with tines or sweeps impossible. Farmers will use the manufacturer's rate recommendation for effectiveness, mixing Eugenol and a pH reducer. Farmers will record the date, time, and weather conditions each time they conduct a mechanical or chemical weed control activity. Based on recent history, it is expected that one test field — most likely one of the sites with clayey soils — will be abandoned due to weed pressures after rain events prevent mechanical cultivation. In that case Eugenol will be used in this field until the conclusion of the two month cultivation window, as a comparison to mechanical results.

Data from all fields will be compiled and compared after the peanut season. Farmers will also supply their costs to operate equipment and apply Eugenol. Outcomes will ultimately be measured by assaying the number and species of weeds in a designated area (24"x24" and 36"x48"), comparing units across planting dates and soil types. Key weeds species that will determine project success, as decided by input from GOPA farmers, are

- Florida beggarweed (*Desmodium tortuosum*)
- Coffeeweed/Sicklepod (*Cassia obtusifolia*)

- Palmer Amaranth (*Amaranthus palmeri*)
- Tall morningglory (*Iopmoea purpurea*)
- Citronmelon (*Citrullus lanatus var. citroides*)
- Yellow Nutsedge (*Cyperus esculentus*)
- Texas panicum (*Panicum texanum*)

Two weed assessments will take place during the project, the first at the conclusion of the approximate eight weeks of active cultivation and the second prior to harvest.

Before harvest at the site of the weed samples, peanut plants will be assessed visually for vigor and disease/pest symptoms. Canopy measurements will be taken, and no fewer than three plants will be pulled to make healthy pod counts.

Project Results

Because of COVID-19, poor seed quality, disease, and weather delays, planting, mechanical cultivation, and application of Eugenol did not occur on schedule. Germination was by far the biggest issue, and farms had to replant in order to achieve a sufficient stand, which completely threw off the weed control program of this project. Participating farmers also had such varying experiences with weed populations based on the unique conditions in their fields that certain results were anecdotal, at best, and Project Directors could not always troubleshoot or verify results in-person due to safety precautions resulting from the coronavirus pandemic.

The Project Directors, GOPA's all-farmer board, and Dr. Carroll Johnson, retired weed scientist with USDA ARS and consultant on the project, reviewed project activities and outcomes. Their main takeaways from the project were as follows:

- Eugenol does not provide effective control either broadly applied or as a spot treatment in Certified Organic fields in South Georgia. It does show some effectiveness against nutsedge and minor grass weeds, such as crowfoot, but these weeds mostly survived herbicide injury and eventually grew inside of the peanut canopy.

- Eugenol has some effect controlling sicklepod and morningglory, but it does not control pigweed (Palmer Amaranth), the primary broadleaf weed in peanut fields.

- Eugenol may be effective in prolonged dry conditions, but these are not predictable in the humid subtropical environment of the Southeast.

- The best production program for Certified Organic peanuts is still quality seed, good germination, repeated tillage with a tine weeder over the rows to eradicate small seedlings, and plowing between the rows.

    - However, until 2020, farmers would have assumed the presence of quality seed and would not have thought to state it explicitly as part of a production program. Due to unfavorable harvest conditions in September 2019, peanut seed in Georgia in 2020 was infected with Aspergillus crow rot, and all of the Certified Organic producers who were part of this project had to either replant fields entirely or plant on top of rows to cover empty stretches where the seeds had rotted.

    - While digging between the rows with sweeps uproots pigweed, farmers reported that the plant re-rooted if it was not removed manually from the field.

    - The next step to evolve a Certified Organic peanut system should be no-till or planting into a cover, according to Johnson.

- Because of the ineffectiveness of Eugenol, it was not productive to develop a new enterprise budget for Certified Organic peanuts. Currently, controlling weeds in Certified Organic peanuts with machinery and labor can cost as much as $400/acre.

- Seed problems and weather issues led to a significant number of unfilled pods (or pops) despite plants appearing visually healthy. These pops cut some yields by 35-50 percent. It is uncertain if the cause was poor seed, dry weather that prevented Calcium uptake, or later rains that pushed Boron out of the root zone. Whatever the cause, it also undermined any assessment of Weed Slayer on plant health.

- Uniformly, the best peanuts and the farms with the least incidence of weed competition were in farms newly converted from timber or pasture. This is not surprising considering that newly-broken soil is likely to have fewer weed and fungal pressures. But it has potentially troublesome implications for Certified Organic production and the carbon cycle in the Southeast, as it may encourage conversion of long-term wild and commercial forest stands into highly-tilled production fields.

Table 1. The table below was used as a measurement tool to assess the effectiveness of the project's weed control program. This sample was from one field that had been converted from a pine timber tract. Weed Slayer was not applied on this field, and it served as sort of control against an adjoining field that had been in continuous organic production. Results from the table are reflected in Figures 4-7, 8, 10, and 11. Note that peanuts crowd out less vigorous broad-leaf competitors.

Site Location	**Planting Date**	**Planting Notes**	**Date Observed**	**Soil Condition**	**Grass**	**Broad-Leaf**	**Tine Weeder Passes (Double), Dates**	**Sweep Passes & Dates**	**Weed Slayer Application, Rates, & Dates**	**Weather Events & Dates (UGA Weather Station @ Jones Center – approximately 5 miles from each field) — Only precip. amounts > .1 inches**
					Counts/ Kinds	Counts / Kinds				
Sandy Hill, Baker Co. - 24"x24"	6/1/20	Neem & humate in-furrow	6/18/20	Sandy, Dry	0	—Florida pusley - 9	6/6/20, 6/10/20, 6/18/20	NA	NA	—Current - 86 degrees high, dry, 20.1% soil moisture @12 inches —Recent - Rain: 6/5-6/9 = 2.32 in total
Sandy Hill, Baker Co. - 36"x36"	6/1/20	Ibid.	6/18/20	Sandy, Dry	0	—Florida pusley - 14 —Palmer amaranth - 1	6/6/20, 6/10/20, 6/18/20	NA	NA	Ibid.
Sandy Hill, Baker Co. - 24"x24"	6/1/20	Ibid.	7/8/20	Sandy, Wet	0	—Florida pusley – 0 —Palmer amaranth - 0 —Indian chickweed / Green carpetweed -1	6/6/20, 6/10/20, 6/18/20	7/4/20	NA	—Current - 90 degrees high, 23.6% @ 12 inches —Recent - Rain: 7/1-7/7 = 4.74 in total
Sandy Hill, Baker Co. - 36"x36"	6/1/20	Ibid.	7/8/20	Sandy, Wet	0	—Florida pusley – 0 —Palmer amaranth - 0 —Indian chickweed / Green carpetweed -1	6/6/20, 6/10/20, 6/18/20	7/4/20	NA	Ibid.

Table 2. The following table shows results from combining the tine weeder, cultivating sweeps, and Weed Slayer. The field where these actions took place had been fallow and, consequently, suffered enormous weed pressure. It also has significant clay content, which can be less conducive to the effects of a tine weeder than sandy soil. Lastly, this was the farmer's first experience with Certified Organic peanut production, and it is a daunting enterprise at first. All data was supplied by the farmer and could not be verified independently due to concerns at the time over Covid-19.

Key observations:

- Horsenettle is a not a common weed in peanut fields, and its presence owes to the recent conversion of the field from fallow/grazing land to production.
- Nutsedge could be considered the most difficult weed to control for Certified Organic peanut producers. It tends to congregate around the peanut plant and can reach between the peanut vines for sunlight. Here, nutsedge populations actually increased over time.
- The combination of tine weeder, sweeps, and Weed Slayer is most effective for weeds growing between rows (see sicklepod and palmer amaranth). Unfortunately, one mature palmer amaranth is a problem because of the volume of seeds it can return to the soil.
- Weed Slayer did not terminate weeds outright, but they were injured and stunted for a 4-day period, approximately. This suggests that Weed Slayer might be more effective if it is applied 1-2 days prior to running a tine weeder, thus allowing the weeder to uproot weakened plants.

Site Location	**Planting Date**	**Planting Notes**	**Date Observed**	**Soil Condition**	**Grass**	**Broad-Leaf**	**Tine Weeder Passes (Double), Dates**	**Sweep Passes & Dates**	**Weed Slayer Application, Rates, & Dates**	**Weather Events & Dates (UGA Weather Station @ Sunny View Farms - approx. 20 miles from field) — Only precip. amounts > .1 inches**
					Counts/ Kinds	Counts / Kinds				

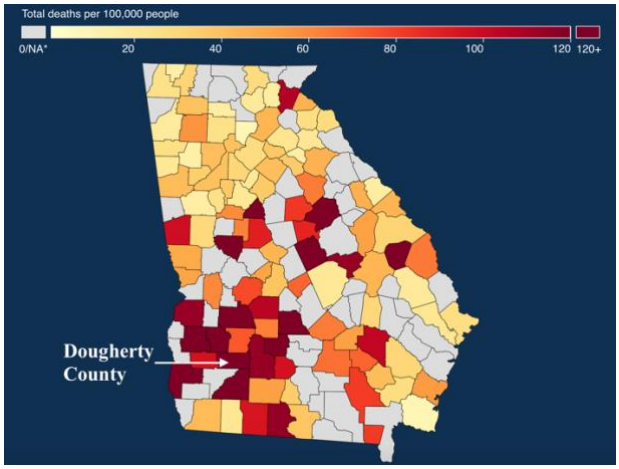
W.C. Bradley, Chattahoochee Co. - 24"x24"	5/25/20	No chemical or mineral application; planting followed precipitation in 7 out of 8 days preceding.	6/10/20	Clayey, wet	—Nutsedge - 8 —Texas panicum - 2	—Horsenettle - 1 —Palmer amaranth - 2 —Lambsquarter - 3 —Tall morningglory - 0 —Sicklepod - 0	6/2/20, 6/4/20	NA	NA	—Current - 90 degrees high, overcast w/showers, 19.2% soil moisture @ 12 inches —Recent - Rain: 6/5-6/9 = 1.64 in total
W.C. Bradley, Chattahoochee Co. - 36"x36"	5/25/20	Ibid.	6/10/20	Clayey, wet	—Nutsedge - 15 —Texas panicum - 3	—Horsenettle - 1 —Palmer amaranth - 4 —Lambsquarter - 6 —Tall morningglory - 0 —Sicklepod - 1	6/2/20, 6/4/20	NA	NA	Ibid.
W.C. Bradley, Chattahoochee Co. - 24"x24"	5/25/20	Ibid.	6/26/21	Clayey, moist	—Nutsedge - 24 —Texas panicum - 0	—Horsenettle - 0 —Palmer amaranth - 2 —Lambsquarter - 2 —Tall morningglory - 1 —Sicklepod - 0	6/2/20, 6/4/20	6/15/20, 6/16/20	2% dilution applied over the top via boom sprayer—6/19/20, 6/20/20	—Current - 88 degrees high, overcast w/showers, 17.8% soil moisture @ 12 inches —Recent - Rain: 6/22-6/26 = .98 in total
W.C. Bradley, Chattahoochee Co. - 36"x36"	5/25/20	Ibid.	6/26/21	Clayey, moist	—Nutsedge - 33 —Texas panicum - 0	—Horsenettle - 0 —Palmer amaranth - 2 —Lambsquarter - 4 —Tall morningglory - 1 —Sicklepod - 0	6/2/20, 6/4/20	6/15/20, 6/16/20	2% dilution applied over the top via boom sprayer—6/19/20, 6/20/20	Ibid.

Conclusion and Discussion

Before any discussion of conclusions from the project can take place, the challenges to executing the project must be covered. At this point, it almost goes without saying that COVID-19 presented an unforeseen and nearly insurmountable obstacle. The project and its activities were conceived prior to the pandemic, and ensuring that it achieved its goals demanded quick improvisation and enduring faith in the earnestness of farmers. If the project had taken place in a university setting, it is probably unlikely that it would have progressed as well as it did since safety regulations would have limited participants' ability to meet and conduct research. But farmers had to plant and grow regardless, and for this reason and their willingness to carry out experimentation in their production fields, the project delivered interesting and useful information.

COVID's primary effect was to complicate the project severely as activities had to be managed remotely. This was inefficient, it drove up personnel hours and costs, and it reduced the Project Directors' ability to monitor field activities and their effects as closely and regularly as was originally intended. In turn, farmers were asked to spend more of their time recording and transmitting data from their fields. This was somewhat problematic since the information could be imprecise and irregular. The fault was not with the farmers: They were not accustomed to the fine details of a research project, they had other real-time obligations on their farms, and they were limited by the quality and their command of communication technology. Added to this problem was the vexing issue of insufficient internet in rural Georgia. In Georgia's Second U.S. Congressional District, where both the Project Directors and the majority of the project's farmers live, 16 percent of the population (106,516) is unserved by broadband according to the Georgia Department of Community Affairs. At one Project Director's home office, internet connection was either unstable or nonexistent consistently between 10 a.m. and 5 p.m. in 2020. This situation has improved slightly in 2021.

The other real effects of COVID were as follows: The project was focused in Southwest Georgia because, for the most part, travel between field sites did not require overnight stays. None of the farms in Southeast Georgia that were intended to have a small role in the project were visited, and no activities there were observed firsthand. No outreach events, such as field days, were held, and project results were not disseminated at conferences or other events, all of which were cancelled or were moved to a virtual format that would have limited true farmer-to-farmer communication. Planting took place in May and June, which was during the first few months of the pandemic when stay-at-home orders were in place and, thus, the Project Directors could not visit farms to witness herbicide applications and cultivation activities at the moment they were taking place. In fact, as



COVID-19 began to take hold across the U.S., Dougherty County and Southwest Georgia became a hotspot for infection, with the Albany metro area leading the country in COVID deaths per capita at one point (see image above from Georgia Department of Public Health). Consequently, it was not until October 2020 that the Project Directors, GOPA's Executive Director, President, and Board Chairman all met in person. Until that time, all meetings had occurred outdoors on farms and involved as few participants as possible. COVID also caused innumerable logistical delays so that herbicides and equipment required for the project did not arrive in a timely manner.

From a research standpoint, COVID prevented the establishment of good control groups on each farm. As stated above, farmers had to make decisions in dynamic environments with an eye toward profitability, travel was restricted, and supplies could not be evenly distributed. The negative of this situation was that results had to be amalgamated from different farms, all of which had different soil types, moisture conditions, field rotations, and access to organic fertilizers — to say nothing of weed seed in the ground. On the other hand, findings are probably more relevant and actionable because they arise out of the actual conditions of a Certified Organic farm.

Beside COVID, the two other major challenges were seed quality and weather. All of the farmers participating in the project had significant problems with germination. This was not just the case with untreated seed available to Certified Organic producers but also with conventional producers planting peanut seed treated with fungicides. The likely culprit was a brutally hot and dry September 2019, which led to "a build up of pathogens in and on the seed" as peanuts were being harvested and stored" (Huber). University of Georgia Cooperative Extension specialists reported an abundance of Aspergillus crown rot (*Aspergillus niger*) across the state. Crown rot affects peanuts 14 to 40 days after planting and can decimate a field if the soil is hot and dry. In addition to seed treatments, conventional farmers have in-furrow fungicides at their disposal, and most peanut producers also have overhead irrigation, which can help peanut plants survive and grow out of crown rot. For the Certified Organic farmers in this project, not only do they not have the same access to an effective fungicide, most also do not have irrigation on their Certified Organic fields. In some organic fields, few peanuts emerged at all, and farmers were forced to plant three times over a month, which disrupted their weed control program and jeopardized their crop. (For reference, the University of Georgia recommends planting peanuts between late April and May 20. This is an ideal window after the potential for significant damage from thrips and before soil temperatures are too hot for germination. Peanut producers have to plant before June 15 to comply with their crop insurance policies. But peanuts are a 120 to 150-day crop, and peanuts planted in mid-June or later will likely have poor yields and suffer from late-season disease due to cooler weather.) Lastly, all of the Certified Organic producers planted Georgia-06G variety peanuts, which is the standard for the Southeast, but there is increasing suspicion that the vitality of the genetics of this peanut is starting to play out, as pests adapt to its resistance packages. Furthermore, it was a product of the evolution of seed breeding that prized kernel size over vigor, with the idea that chemical inputs would make up for its sluggishness after emergence. Nothing could be more important than early-season vigor for the Certified Organic farmer.

Those farmers who were blessed with a decent stand had to deal with a low-pressure weather system that formed in the Gulf and brought consecutive days of rain over the first and second week of June. Although the rain was welcome to dryland fields, it happened during a critical time for mechanical cultivation, and weeds were able to take root in the row, where they could not be killed or removed except by hand.

All of the challenges notwithstanding, a lot of good, pertinent information was still harvested from the project.

First and foremost, the farmers taking part in the project have determined that Eugenol in its formulation in Weed Slayer[1] (6 percent Eugenol and 94 percent water and molasses) is not an effective herbicide in a Certified Organic peanut system. Three farms used it in conjunction with mechanical cultivation. It was used most thoroughly at W.C. Bradley Farms in Omaha, and the farmer, Derek Lynch, reported that grasses and broadleaf weeds suffered some dieback but eventually grew through herbicidal injury. Peanut plants were not damaged. This was confirmed by other farmers associated with GOPA who visited his farm. Compared to an average yield for Certified Organic peanuts of 2500-3000 lbs./acre, the W.C. Bradley farm yielded only 9,600 lbs. of peanuts on ten acres, and one lot had visible aflatoxin contamination and had to be segregated. It should be stated that 2020 was the first time Lynch had ever grown Certified Organic peanuts, so it is no surprise that his peanuts would not be of the same quality of practiced veterans. His fields had a very heavy weed load. Also, because peanuts were not a cornerstone of his cropping plan and because W.C. Bradley has ample resources, he probably had the most leeway to experiment, whereas others could only spray once or had to skip an application altogether to make a profitable crop.

On the opposite side of W.C. Bradley in the sandier southeastern portion of the state, Deep South Farms did not apply Weed Slayer but produced organic peanuts at a rate of 4000 lbs./acre. This was without a doubt a record in Georgia and a revelation to other producers. Deep South Farms had two practices that set it apart from other Certified Organic operations. First, it is located in the Vidalia onion region of the state, and the farm also grows Certified Organic onions. Deep South Farms' crop rotation (and the manual labor required in onion production) may give it an advantage in weed control compared to GOPA's other farmers, who rely on a traditional row-crop rotation of wheat-peanut-rye-corn. This is interesting but not necessarily transferable to other operations. Second and more important, Deep South Farms liberally applies dry poultry manure from its broiler houses at a rate three to four times of that recommended by Cooperative Extension. In peanut agronomics it is conventional wisdom that farmers should apply lime for a pH of 6.0-6.5, apply Phosphorous and Potassium if necessary, inoculate with the proper rhizobium in fields without peanut for four years, apply Boron, and

[1] In December 2020, the California Department of Food and Agriculture issued a stop-use order for Agro Gold Weed Slayer after testing showed diquat and glyphosate. It is the understanding of GOPA's farmers that this test was an aberration, and Agro Research International, LLC has applied for re-certification. Based on the experience of farmers in this project, the product was so ineffective that it could not have contained either herbicide.

foliar feed Manganese if necessary. Because peanuts are legumes, it is believed that Nitrogen is not necessary because plants can scavenge from the soil what they cannot make themselves. However, the results from Deep South Farms suggest that peanuts in an organic system need Nitrogen to stimulate early-season growth and to encourage the plants to vine out and shade out weed competition. Broiler litter has about 72 lbs./ton of total Nitrogen.

In other words, the solution to the dilemma of weed control in an organic peanut system may lie more with promoting the health of the peanut plants than fighting back the weeds. GOPA farmers with access to chicken litter have followed Deep South Farms' lead in 2021. They are dealing with vicious weeds, but the plants are vigorous, and the ultimate determinant of success will be yield. The track of fostering long-term fertility is obvious in theory, especially in organics, but it is quickly forgotten in practice as farmers watch weeds take over their fields. This half of an organic peanut system is worth more exploration, and more attention should be paid to pairing vigorous seed variety with beneficial soil bacteria and with Nitrogen and Calcium.

In 2021, there has been no problem with germination. In June 2021, as an augmentation of the project, Chad Heard Farms tried to substitute Weed Zap into the weed control program of mechanical cultivation and organic herbicide. Manufactured by JH Biotech, Inc., Weed Zap is an OMRI-listed "contact, non-selective, broad spectrum, foliar-applied herbicide" (product label). Whereas Weed Slayer was only 6 percent Eugenol, Weed Zap is 45 percent Eugenol, 45 percent cinnamon oil, and 10 percent lactose and water. Heard broadcast Weed Zap across the field using a mixture that was half of the 5 percent application rate on the label because he feared he might damage his peanuts. Unlike Weed Slayer, this product was effective despite the weaker solution. The peanuts were unharmed, and Weed Zap killed nearly all of the grasses it contacted (Figures 16-19). Heard believes it deserves more research since its higher concentration of active ingredients seems to translate into real efficacy. In 2022, he intends to band it in the row at the recommended application rate as soon as peanuts begin cracking the soil surface. This technique should offer some cost savings.

There are two final points significant to this discussion. First, this is a much more expensive project than what was originally believed. Hours committed to the project far exceeded original estimates. Even without COVID, substantial time is required to travel to farms, document activities, and work with farmers to deliver quantitative results. Farmers were also generous to the project with their time and their resources. A better project would provide larger honorariums for producers since it requires them to sacrifice acreage and revenue for the sake of research. Because research is happening in a production field, sometimes farmers have to make decisions in the interest of short- and long-term profitability to the detriment of the research, or they simply do not have the capacity to perform activities according to a neat schedule. At the same time, the project has encouraged GOPA to look into acquiring specialized equipment, like a tine weeder, that it can lend to beginning, socially disadvantaged, and limited-resource producers. While farmers were willing to share their equipment, it does not always work out satisfactorily when time is of the essence.

Second, it is no accident that the best yields of Certified Organic peanuts and other commodities in the Southeast are taking place on land that had been out of production (timber, pasture, etc.). This is probably not a positive development for the environment because it encourages the conversion of perennial systems into annual ones and releases carbon. The demand for Certified Organic products and farmers' pursuit of profitable crops is encouraging rapid growth in Certified Organic production in the region (GOPA is both a cause and result of this phenomenon). But farmers can barely withstand the financial cost of transitioning land to organic and producing conventional crops from it in the meantime. Yields are poor at the outset, and it is an incredible expense to invest in the land to control weeds. The answer is not a transitional label, which Certified Organic farmers say will only muddle the marketplace. Instead, there must be some financial mechanism — a subsidy or cost-share — that prevents farmers from losing money during the three-year transition period. Without that, they are almost incentivized to break new land and have it certified.

Outreach

GOPA is in the process of articulating the results of the project and sharing them on its website and a newsletter, which it will launch in late July 2021. Originally, the project included two fields days at Chad Heard Farms to observe the effects of the intended weed control programs, especially applications of Weed Slayer and the action of a tine weeder over the rows. This latter was deemed especially important because the tine weeder has become obsolete and disappeared from almost all of Georgia's farms with the advent of conventional herbicide. Not only are farmers not used to the equipment, they are unfamiliar with the level of aggressiveness with which it must be deployed in peanuts fields in order to disturb and extirpate weed seedlings. These field days were postponed and then cancelled out of a concern for safety arising out of the pandemic. GOPA also did not want to be responsible for facilitating transmission of the virus and attaching OFRF to potentially unsafe activities in any way.

In addition, GOPA's board chairman, its Executive Director, and project consultants intended to present on the project's activities and findings at the annual Georgia Organics' conference in Columbus, Georgia in February 2021. As with almost every other agricultural event in the state over the past year, this event was cancelled as a result of COVID. With the apparent subsidence of COVID and the gradual return to a normal state of affairs, GOPA should be able to make up for this lost opportunity by presenting at Georgia Organics' 2022 conference.

Ideally, GOPA will be able to host its own mini-conference for Certified Organic and transitional row-crop producers southern Georgia, southern Alabama, and northern Florida in 2022. This event will have, at the very least, a full day dedicated to weed control in organic cropping systems. GOPA is currently pursuing funding for this event.

Financial Accounting

Budget Category	Actual Costs
Personnel Costs and Fringe	$7,200.00
Equipment rental or purchases	$0.00
Stipends for farmer/rancher cooperatives or student labor	$5,500.00
Travel/Mileage	$1,566.00
Other: Supplies (Field)	$1,284.00
Other: Supplies (Office)	$200.00
Other: Equipment Transportation	$1,200.00

Leveraged Resources

In 2020, GOPA applied for and received a small simplified grant from the Beginning Farmer and Rancher Development Program in the USDA National Institute of Food and Agriculture, which will conclude in September 2021. In addition to connecting new, beginning, socially disadvantaged, and limited-resource producers to sufficient market and revenue opportunities through Certified Organic production, one of the primary objectives of this project is to transfer the knowledge of effective weed control in organic systems from experienced farmers to new and beginning farmers. This vital information, which is as much art as science, is currently held by a small number of older producers and is in danger of being lost. GOPA is utilizing small workshops and a mentoring program to accomplish its aims. However, restrictions and precautions stemming from COVID-19 have made coordinating face-to-face meetings difficult, and alternative forms of communication are unsatisfactory due to the unreliability of rural internet. Point in case, GOPA coordinated a Zoom presentation from Dr. Kathryn Taylor, Senior Risk Management Specialist with the USDA RMA regional office in Valdosta, on leveraging GOPA's production contract and the Contract Price Addendum to insure Certified Organic peanuts at a fair rate and mitigate risk; however, Dr. Taylor's internet connection was unstable, and producers lost the chance to hear her full explanation of an important subject, though one heavy with statistics and dry information.

GOPA has continued to apply for other Federal funding to continue its important work to enhance the resilience of producers and fortify the next generation of Certified Organic farmers. However, to be frank, it has also found that foundation and public funding tends to flow to metro areas, such as Atlanta, where grant-making is partly a function of social networks and projects have higher visibility. These projects also favor smaller, diverse specialty-crop systems. While this type of agriculture is vital and deserving in its own right, the greatest opportunity in Georgia to grow Certified Organic acreage, reduce the use of toxic chemicals in the environment, and take meaningful steps to slow and reverse climate change lies with the scale of row-crop producers in the state's rural southern half.

Pragmatically, investment in Certified Organic research may not lead to hundreds of farmers immediately transitioning to Certified Organic production. But as it produces results applicable to conventional agriculture in the form of chemistries and mechanical techniques that can be substituted for more caustic, persistent, and expensive inputs, it holds the promise of broad, transformational impact. This truth has been articulated by Dr. Albert Culbreath, researcher in foliar fungal diseases and Tomato Spotted Wilt Virus (TSWV) in peanuts at the University of Georgia. Dr. Culbreath has been an early and faithful ally of Certified Organic producers and has worked closely with GOPA farmers to identify vigorous and disease-resistant peanut varieties suitable for organic production. The progression of Culbreath's research has brought him back to examining sulfur as an effective fungicide. While he wholeheartedly supports the endeavors of small, diverse farms to be chemically free, he believes he can make a greater contribution to farmers' wellbeing and the environment by working to reduce and replace one substance — chlorothalonil-based fungicides, which are toxic to bees and possibly carcinogenic to humans — on Georgia's 800,000 peanut acres with sulfur, other naturally-derived products, and proven practices that are part of the retained culture and individual innovation of Certified Organic farms.

References

Beattie, W.R. (1920). *Farmers Bulleting 1127*: *Peanut Growing for Profit.* Washington, D.C.: United States Department of Agriculture.

Garrard, W.T. (1922). Successful Peanut Culture in Middle Georgia. *The Peanut Promoter, Vol. 5. No. 2.* 11-13.

Huber, Amanda (2020). "Crop Wrap-up." *The Peanut Grower.* November 2020. 10-12.

Johnson III, W. Carroll (2019). A Review of Weed Management Challenges in Organic Peanut Production. *Peanut Science: January 2019, Vol. 46, No. 1*. 56-66.

U.S. Department of Agriculture. (2019, November 25). Integrated Management and Ecology of Weed Populations in Southeastern Field Crops. Retrieved from https://cris.nifa.usda.gov/cgi-bin/starfinder/773/crisassist.txt.

Photos and Addenda

Figure 2. Chad Heard and Dr. Carroll Johnson, retired weed scientist with USDA ARS, digging for peanut seed on Heard's field in Mitchell County (6/18/20). Like other Certified Organic peanut farmers, Heard's crop suffered from poor germination, and he was forced to replant, interrupting the schedule of his weed control program. Johnson consulted on the project.

Figure 3. Peanuts were planted at a rate of 6/row foot. The lack of germination is more severe in the next row at the top of the picture. Timely and vigorous emergence is critical for Certified Organic peanuts to compete with weeds. Cbad Heard Farms, Mitchell County, 6/18/20.

Figure 4. Retired USDA weed scientist Dr. Carroll Johnson examining the field for soil moisture and seed depth. Cbad Heard Farms, Mitchell County, 6/18/20.

Figure 5. Aspergillus crown rot on young peanuts. Peanut seed in Georgia was compromised by extreme heat and dry weather in September 2019. Chad Heard Farms, Baker County, 6/18/20.

Figure 6. Germination and plant health were better in this field, which had been converted from timber and contained more moisture and organic matter. Chad Heard Farms, Baker County, 6/18/20.

Figure 7. Two- and three-foot marks to measure plant growth and weed competition. Chad Heard Farms, Baker County, 6/18/20.

Figure 8. Two- and three-foot marks more than two weeks later. Because this field had been converted from timber, it had very little weed seed and could be managed through cultivation with a tine weeder over the rows and sweeps between them. In this picture cultivation had not occurred on schedule due to rains. Chad Heard Farms, Baker County, 7/8/20.

Figure 9. The distinction between newly planted land and established Certified Organic acres is clear in this picture. The peanuts are hidden beneath pigweed on the right. Due to rains, neither side has been sprayed with Weed Slayer or been cultivated with a tine weeder as necessary. Chad Heard Farms, Baker County, 7/8/20.

Figure 10. A closer picture of peanuts within pigweed from Figure 8. Sweeps have been run between the rows, but pigweed and morningglory have taken root next to the peanut plants. Chad Heard Farms, Baker County, 7/8/20.

Figure 11. Same view as Figure 5. Chad Heard Farms, Baker County, 9/11/20.

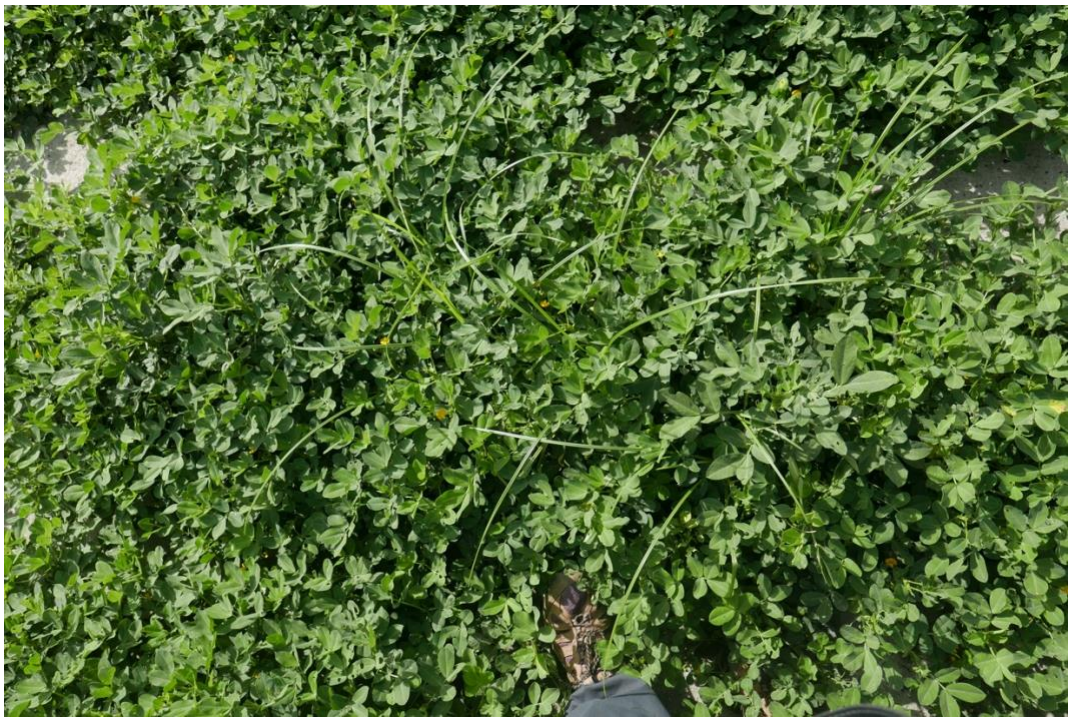


Figure 12. Two- and three-foot marks on 9/11/20. Peanuts have closed the rows and shaded out competition from broad-leaf weeds. Grasses, like nutsedge, have still emerged through the plants. Chad Heard Farms, Baker County.

Figure 13. Sweeps about to run between peanut rows. This perspective is looking back toward where the pigweed stood in Figure 8. The pigweed has been pulled by hand, but grasses have taken hold. Chad Heard Farms, Baker County, 9/11/20.

Figure 14. Conventional peanuts for comparison. Mitchell County. 7/9/21.

Figure 15. Tine weeder in operation, Shingler Farms, Early County, 7/12/21.

Figure 16. Rows cultivated by a tine weeder on a field converted from pasture. Shingler Farms, Early County, 7/12/21

Figure 17. 2021 Certified Organic peanuts prior to weed control program. Chad Heard Farms, Mitchell County, 6/14/2021.

Figure 18. Same field after application of Weed Zap applied at half of the label rate. Center rows are control and were not sprayed. Chad Heard Farms, Mitchell County, 6/14/2021.

Figure 19. Effect of Weed Zap on grasses. Peanuts were not damaged. Chad Heard Farms, Mitchell County, 6/14/2021.

Figure 20, Cultivation after applying Weed Zap. Chad Heard Farms, Mitchell County, 6/14/2021.

Figure 21. Certified Organic sunflower field at W.C. Bradley Farm (table 2). Picture provided to demonstrate persistence of nutsedge and palmer amaranth after aggressive tillage.