

Title: Effect of biofumigation and solarization on strawberry plant growth and yield under three different climatic conditions in Arkansas.

Final Report

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Research Grant

Name(s), mailing and email address(s) of principal investigators

M. Elena Garcia
University of Arkansas Division of Agriculture
Extension Fruit Specialist- Horticulture
Dept of Horticulture
316 PTSC,
Fayetteville AR 72701
megarcia@uark.edu
479-575-2789
Fax: 479-575-8619

Terry Kirkpatrick
University of Arkansas Division of Agriculture
Plant Pathology-Extension
Southwest Res. & Ext. Center
362 Hwy. 174 N
Hope AR 71801
tkirkpatrick@uaex.edu
870-777-9702

Donn T. Johnson
AGRI 320, Dept. of Entomolgy
University of Arkansas Division of Agriculture
Fayetteville, AR
72701dtjohonso@uark.edu
479-575-2501

Objectives:

The objectives of this project are: 1) to determine the effect of biofumigation and solarization on diseases (particularly anthracnose, leaf spots, and red stele), insects, nematodes, and weeds 2) to evaluate the effect of these practices on plant growth, yield, and fruit quality, and 3) to estimate the economic feasibility of these practices in a plasticulture system.

Justification:

There are approximately 300 acres of plasticulture strawberries in Arkansas and acreage is increasing. Strawberry plasticulture is an annual hill training system in which 'green' strawberry transplants (freshly dug or plug plants) are planted in early fall (late September to early October,, depending on location) in double rows at densities of 15,000 to 17,400 plants per acre. A standard practice is to produce the crop in raised beds that have been methyl bromide-fumigated and covered with black plastic mulch. The two most commonly planted cultivars across the southern U.S., including in Arkansas are 'Chandler' and 'Camarosa'. Improved crop growth and yield are expected to result from the use of methyl bromide as it controls all major soilborne plant pathogens of strawberry as well as certain insects, nematodes and weeds. However, the use of methyl bromide for pre-plant fumigation is being phased out because of its acute toxicity to humans and because it is an ozone depleting substance. Less harmful alternatives to fumigation with methyl bromide are needed, but these alternatives must be both efficacious in controlling soilborne pests, compatible with current production practices, and economically feasible.

Biofumigation is a term that describes the use of *Brassica* species such as canola and Indian mustard in rotation or as green manure crops to suppress soil-borne pests. Plant tissues of certain brassica species contain high levels of secondary metabolites called glucosinolates, which can be converted to isothiocyanates, thiocyanates, nitriles, or other compounds by enzymatic hydrolysis as they decompose in the soil. These compounds are volatile and can be toxic to many organisms including bacteria, fungi, nematodes, insects, and germinating seeds. Biofumigation (soil amendment) with brassicas has been studied for suppression of soilborne pathogens on soybean, pea, tomato and cotton (10). Many factors influence the biofumigation potential of the brassicas and include environment and ontogeny.

Solarization is another technique that is used for suppression of soilborne plant pathogens and other pests including, insects and weeds and weed seeds. The effectiveness of solarization when compared to chemical controls methods in strawberries varies according to location, time of year, and type of plastic being used. Some studies indicate positive results (12) while others indicating a lack of effectiveness .

Methodology:

This research was conducted at two sites in Arkansas. Site 1: UA Vegetable Research Station- Kibler, located in Arkansas River Valley and Site 2: Southwest Research and Extension Center- Hope in the southwestern part of the state. At each site, the experiment will be set up as a randomized complete block design with four replications of each treatment. Individual plots will be a single row 35 feet long. Six treatments will be included at each site. Plastic mulch will be VIF plastic at all locations and in all treatments.

TRT 1- Control: No pre-plant fumigation, solarization, or biofumigation.

TRT 2- Methyl bromide fumigation in early September following standard commercial application procedures.

TRT 3- Biofumigation: A *Brassica* that will grow during the summer (likely an oilseed radish or a mustard such as ‘Hot Stuff’ or ‘Caliente’ will be sown broadcast over the rows in early June and allowed to grow until approximately 1 month before transplanting strawberries. Biomass will be shredded with a flail-type mower and incorporated by disking about September 1.

TRT 4- Solarization: The rows where the strawberry plugs will be planted will be covered with clear plastic about July 1. Soil moisture will be maintained at near field capacity until planting time. Immediately prior to transplanting, the plastic will be spray painted black to moderate soil temperatures after planting.

TRT 5. Combination of biofumigation and solarization: The *Brassica* will be sown, shredded, and incorporated as in TRT 3. Immediately after incorporation, beds will be formed and covered with clear plastic mulch. At the time of transplanting (ca. October 1 in Kibler and Newport and October 10 at Hope), plastic will be spray painted black.

TRT 6- Mustard meal was incorporated into beds at a rate of 1000 lb/A or 408 kg/A treatment.

Strawberry Test 2009-2010, SWREC-Hope, AR

Site preparation began on 6-15-09 with the incorporation of 100 g of 13-13-13/plot. Seven Top turnips were planted on plots for treatments 2 and 5. A 1-ft² biomass subsample was taken from each plot, dried, and weighed. Turnips were tilled under on 8-21-09. Beds were made and covered with black plastic, except for treatments 4 and 5, which were covered with clear plastic on 8-26-09. Treatment 6 called for the incorporation of mustard meal at a rate of 1000 lb/A or 408 g/treatment.

One line of irrigation drip tape was laid under the plastic. Fertilizer (17-17-17) was incorporated at the time the beds were made at a rate of 250 lb/A or 230 g/plot. Plastic on 4 and 5 were painted black at this time. No Midas was used in this test due to excessive soil moisture, unavailability of product, and the shortage of time for the fumigant to dissipate before planting.

Planting of the strawberry cultivar Camerosa began on 10-12-09. Strawberries were planted on raised beds, 20 plants per 20' of row (harvested 10 plants for data analysis). Fertilizer (20-20-20) was applied at a rate of 1200 g/2 gal of water through drip lines on 11-23-09. Soil moisture and temperature monitors were put in place at the time of planting. All plots were sampled for fertility and nematodes. All strawberry plants were covered with frost protection cloth 1-5-10 when temperatures reached 9°F. Fertilizer was applied at a rate of 1200 mL/2gal of water through drip lines on 3-8-10. Applied 15 fl oz/A of ABOUND fungicide on strawberries on 3-11-10 (81 mL/3 gal water) through CO₂ back pack sprayer with 4 nozzle boom. Petiole and foliar samples were collected and sent for analysis on 3-15-10. Results indicated all nutrients were in the sufficiency ranges listed (acceptable). Fertilizer was applied on 4-2-10 (20-20-20) 1000 mL/2 gal water through drip irrigation lines. Nutrient analysis collection continued throughout the season and fertilizer applications were based on these results. Harvest began on 4-21-10. However, on 4-28-10 pest (raccoons) ate the entire crop

Strawberry Test 2009-2010,UAVRS, Kibler, AR

Site preparation began on 6-29-09. Seven Top turnips were planted on plots for treatments 2 and 5. On 8-26-09, mustard meal was applied to plot 6 at the rate of 1000 lb/A. All plots received fertilizer (10-20-10) at a rate of 550 lb/A. No Midas was used in this test due to excessive soil moisture, unavailability of product, and the shortage of time for the fumigant to dissipate before planting.

Beds were formed, drip irrigation lines were laid, black and clear plastic were put down to cover the plots. Soil moisture and temperature sensors were put in place at this time. Soil samples were taken and sent to the nematode lab and Mandy Cox (graduate student) on 9-02-09. Chandler strawberries were planted on 10-20-09 at the rate of 41 plants per 20' of row (this rate was double the rate that was planted at the Hope Station). Clear plastic was sprayed with black latex paint on 11-06-09. No Midas was used on this test because of excessive soil moisture, unavailability of product, and the shortage of time for the fumigant to dissipate before planting.

Row cover protection began in the middle of January. Petiole and foliar collection for analysis began on March 31 and continued throughout the season. Fertilizer applications were based on these results.

Results

SWREC-Hope, AR

At the SWREC there were no significant differences for total berry weight. However, the solarization treatments had the lowest yield. The same trend was followed for marketable weight (Table 1

Table 1. Effect of biofumigation and solarization on strawberry plant yield, Hope, AR, 2010.

| Treatment | Total Berry Wt. (g)* | Marketable Wt. (g) |
|----------------------------------|----------------------|--------------------|
| (1) Check | 582.3 a | 499.6 a |
| (2) Check (No Midas application) | 337.5 a | 283.1 ab |
| (3) Biofumigation | 562.1 a | 429.5 ab |
| (4) Solarization | 265.1 a | 214.5 b |
| (5) Biofumigation + Solarization | 262.0 a | 212.88 b |
| (6) Mustard seed meal | 499.4 a | 414.4 ab |

Means followed by the same letter do not significantly differ (P=.05, Duncan's New MRT).
*Yield /10 row ft.

UAVRS, Kibler, AR

Treatments 1, 2, 3, and 4 were significantly different from treatments 4 and 5 for both total berry weight and marketable yield at Kibler. The treatments where solarization was used. Yield, although not significantly analyzed was higher at Kibler than Hope.

Table 2. Effect of biofumigation and solarization on strawberry plant yield, Kibler, AR, 2010.

| Treatment | Total Berry Wt. (g)* | Marketable Wt. (g) |
|---|-----------------------------|---------------------------|
| (1) Check | 801.8 a | 782.0 a |
| (2) Check (No Midas application) | 923.5 a | 916.3 a |
| (3) Biofumigation | 737.8 a | 730.0 a |
| (4) Solarization | 415.3 b | 406.5 b |
| (5) Biofumigation + Solarization | 266.0 b | 257.0 b |
| (6) Mustard seed meal | 972.8 a | 953.5 a |

Means followed by the same letter do not significantly differ (P=.05, Duncan's New MRT).
*Yield/10 row ft.

Conclusions

The 2009 summer was an unusually cool and cloudy in Arkansas and could have possibly contributed to the lack of treatment effect. The early destruction of the crop by pest at the Hope station could have contributed to lack of significant differences among the treatments and the lower yield at this location.

Impact Statement:

The data obtained from this research was used to submit a pre-proposal to SSARE Research and Education grant system by Dr. Kirkpatrick. We were invited to submit a full proposal which was submitted on Nov.11.

Citation(s) for any publications arising from the project:

None to date.