2019 Strawberry Preplant meeting

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Farm Planning

- ✓ Put sufficient time and thought into planning process.
- ✓ Know your farm operations well.

Questions to ask yourself:

- Do I have the labor to manage strawberry production from start to finish?
- Do I have a market where I can sell berries?
- In the past three years, have I been able to sell majority of berries produced?
- Are there berries that go unpicked at my site each year ?
- What has been the average profit I made in the past three years with berry production?
- What are pest issues that I faced in the past three years?

Planning for Commercial Strawberry Production

Site selection

Row orientation: North-South

Wildlife

Windbreaks

Soils

- Sandy loam to sandy clay-loam.
  Clay or rocky soils difficult to bed.
- pH 6.0 to 6.2.
- Slope of 5 to 7% ideal.
- Avoid sites previously under cultivation with tomato, potato, or eggplant.

<u>Soil amendment and nutrient management:</u>

-Soil test to determine how much limestone needs added.

-Apply 60 lbs N, 60 lbs P_2O_5 and 120 lbs K_2O/acre at preplant if no soil test conducted.

Fumigation

- Annual plasticulture gaining popularity
- Raised beds
- Plastic mulch
- Preplant fumigants

- What is fumigation?

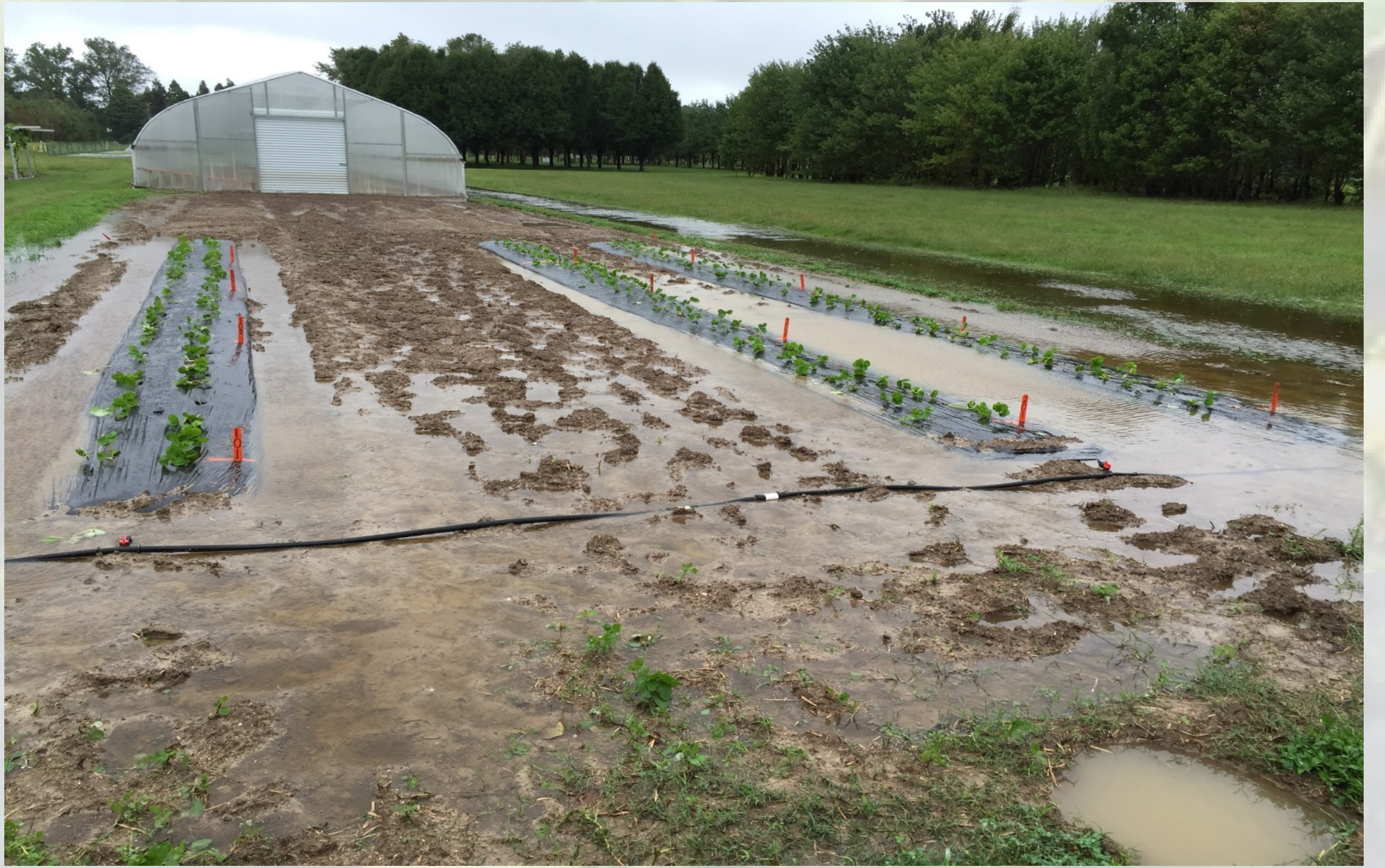
Fumigation is a method to suffocate or poison pests by filling an area with gaseous pesticides.

In the raised beds, fumigation is achieved by:

- Covering the beds with plastic layer .
- Injecting fumigant through the sub-surface (drip) irrigation system or with shanks on a bedder.
- Keeping the fumigant trapped in the soil air space to kill pests.

Multi-function bedder: shapes the bed, fumigates bed, lays plastic tarp. When beds are done, plastic should be firm, and in contact with the soil. Beds should be raised at least 6 inches and free of soil clods.

Bed dimensions



Shallow beds (≤ 4 inch high)

- Can cause temporary flooding.
- Promote crown and root rot.
- Increase incidences of leaf spots and mildew.
- Exposure to standing water at harvest season can result in mushy fruits.

Plant spacing

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- 12 Inches = 17,500 plants/A
- 14 Inches = 15,000 plants/A
- 15 Inches = 14,000 plants/A

Figure 9: Finished Strawberry Bed

Mark Hoffmann, 2018

Planting depth

Planting depths- Left: Too shallow; Center: Correct; Right: Too deep

Cover crop.

Annual ryegrass at 50 lbs/A

Timeline for June-bearing variety (Zone 6)	Activity
Collect soil samples for nutrient analysis	July, week 4
Delivery of fumigants, check fumigant equipment	Aug., week 1
Broadcast N-P-K in accordance with soil nutrient results. Disk to 6 inches depth.	Aug., week 2
Bed shaping. Fumigating + laying plastic and drip	Aug., week 3
Transplant.	Sept., week 2
Do not remove runners for three to four weeks after transplanting.	

Crown and branch

Oct-Nov. with average temp. of

50 F

Vigorous variety: 5-6 crowns by fruiting season

Less vigorous: 4-5 crowns by fruiting season

Leaf

Plant should have 3-4 fully green leaves after the 3 to 4-wk establishment period. 10 leaves by mid-Dec. and 8-inch plant dia.

One can correlate between yield and no. of leaves and total plant area in late fall/early winter.

Roots

Soil temp. above 45 F promotes root growth and health.

Prevent drying of beds/water stress during establishment phase.

Current Research

ASD 3-Steps

- Incorporate organic material (Optimal C:N 20:1 to 30:1, recommend C rate 4mg/g soil).
- Cover with oxygen impermeable tarp.
- Irrigate to field capacity.

ASD mechanisms

- Accumulation of **toxic/suppressive products** deriving from the anaerobic decomposition (e.g. organic acids, volatile organic compounds)
- **Biological control** by facultative anaerobic microorganisms
- Low pH
- Low oxygen
- Generation of Fe^{2+} and Mn^{2+} ions
- **Combination of all of these**

Objectives

- Evaluate the effect of local carbon sources in ASD treatments under controlled greenhouse environments.
- Evaluate the optimized ASD methods in field condition with tested C source.
- Provide relatively inexpensive, consistent and effective ASD recommendation for strawberry growers in Virginia and mid-Atlantic conditions.

Hypotheses

❖ **Enhance ASD effect**

Hypothesis: distilled yeast could enhance the efficiency of carbon sources in achieving ASD.

1. Bioethanol fermentation could be conducted in field using forage crop with enzymes (Honda et al.,2008 and Kitamoto et al., 2011).
2. Residual organic substances in the bioethanol fermentation products enhanced the effect of the ASD treatment (Horita & Kitamoto, 2015).
3. BSG could be used to produce bioethanol (Liguori et al., 2015).

Material and Method

Greenhouse

- Determinate proper C source
- Focus on Eh, pH, T, weed control, nematode bioassays
- Site: AREC

Small-scale trial

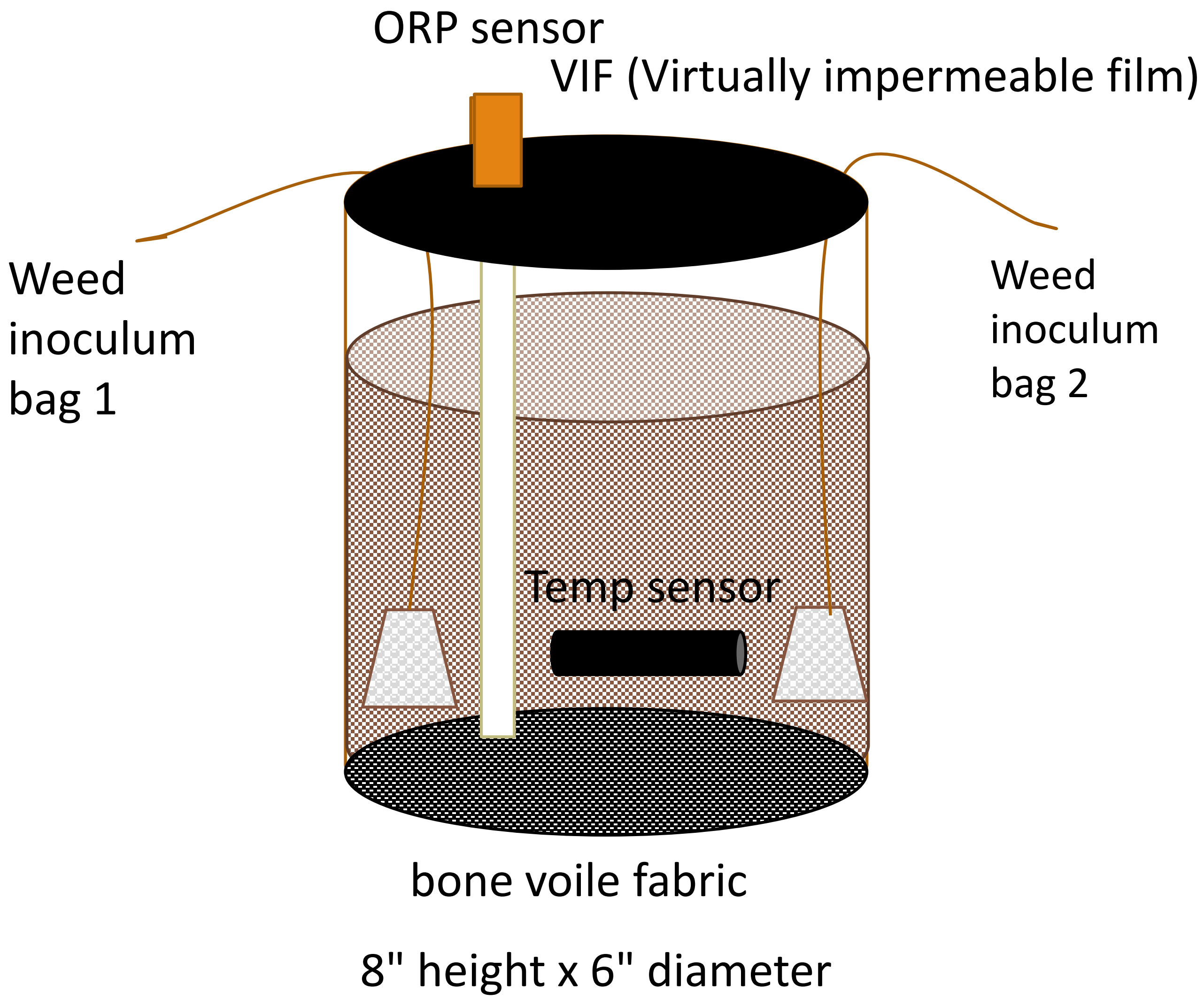
- Evaluate effect of C source in field
- Focus on weed control, crop yield and fruit quality
- Site: AREC

Large-scale trial

- Extended field test
- Focus on yield and cost
- Site: Conventional Farms

Experimental design

- Completely Randomized Design
- Four replicates
- Experiment unit: bioreactor
- Experiment period: 3 weeks



Measurements

❖ **Redox Potential (Eh)**

Cumulative soil anaerobicity (mV · hr)

=∑|Eh-CEh(critical redox potential)|

❖ **Temperature**

* Data were recorded every hour for 3wks

Weed count

Yellow nutsedge *(Cyperus esculentus)*	10 tubers/bag
White clover (*Trifolium repens)*	100 seeds/bag
Redroot pigweed (*Amaranthus retroflexus*)	100 seeds/bag
Common chickweed(*Stellaria media*(L.) Vill.)	100 seeds/bag

*The non-germinated seeds were treated by Tetrazolium Chloride (TZ) test, and then counted.

Treatments

Trial 1 **Evaluation of local carbon sources**

1 Sorghum-sudangrass	67g / container	6.4 t/acre
2 Cowpea	74g / container	7.2t/acre
3 Buckwheat	80g / container	7.6t/acre
4 Paper mulch	32g / container	3.1t/acre
5 Rice bran	63g / container	5.9t/acre
6 Nontreated control (NTC)		

* C rate 4 mg of C/g of soil

Trial 2-1 **Evaluation of C-source combined with ethanol**

1 Brewer`s spent grain (half dose,32g/pot 3t/acre) + 70% ethanol 50ml applied at 1 wk

2 Brewer`s spent grain (full dose,64g/pot 6t/acre)

3 Coffee ground (half dose,56g/pot 5t/acre) + 70% ethanol 50ml applied at 1 wk

4 Coffee ground (full dose,112g/pot 10t/acre)

5 Paper mulch (half dose,16g/pot 1.5t/acre) + 70% ethanol 50ml applied at 1 wk

6 Paper mulch (full dose,32g/pot 3.1t/acre)

7 Rice bran(half dose,32g/pot 3t/acre) + 70% ethanol 50ml applied at 1 wk

8 Rice bran(full dose,63g/pot 5.9t/acre)

9 NTC

* C rate full dose=4 mg of C/g of soil

Trial 2-2 **Evaluation of bioethanol fermentation during ASD**

1. Brewer`s spent grain (BSG) + yeast
2. Brewer`s spent grain
3. Coffee ground + yeast
4. Coffee ground
5. Paper mulch + yeast
6. Paper mulch
7. Peanut shell + yeast
8. Peanut shell
9. Rice bran + yeast
10. Rice bran
11. NTC

* C rate 4 mg of C/g of soil   Yeast rate 4.1kg/acre

Carbon source or yeast	Average Carbon source Carbon rate	Weight (g/pot)	Weight (t/acre)
Sorghum-Sudangrass	0.42	67g	6.4
Cowpea	0.37	74g	7.2
Buckwheat	0.35	80g	7.6
Paper mulch	0.87	32g	3.1
Brewer`s spent grain	0.44	64g	6.0
Rice bran	0.45	63g	5.9
Coffee ground	0.25	112g	10.6
Peanut shell	0.45	63g	5.9
Distiller`s dry yeast		0.06g/pot	4.1kg/acre

Results

Table 1. Weed germination rates and cumulative soil anaerobic conditions after anaerobic soil disinfestation (ASD) process with several different carbon sources.

Treatments	Weed germination rate (%) [a]			Cumulative soil anaerobic conditions (V hr)[a]	Mean temperature(°C)
	Common chickweed	Redroot pigweed	Yellow nutsedge		
Buckwheat 80 g	23.0 b	24.0 b	5 bc	159 ab	20.0
Cowpea 74 g	34.0 b	33.2 b	20 b	261 a	20.4
Velvet bean 56 g	32.2 b	26.7 b	10 bc	100 ab	20.4
Paper mulch 32 g	22.5 b	22.6 b	5 bc	179 a	20.1
Rice bran 63 g	21.1 b	20.0 b	5 bc	226 a	20.5
Non-treated control	68.6 a	66.7 a	65 a	0 c	20.2
P value	0.010	0.007	<0.0001	<0.0001	

[a] Means followed by different letters within a column are statistically different using least significance difference at $P \leq 0.05$.

Table 2. Weed germination rates and cumulative soil anaerobic conditions after anaerobic soil disinfestation (ASD) process with several different carbon sources and ethanol application.

Treatments	Weed germination rate (%) [a]			Cumulative soil anaerobic condition (V hr) [a]	Mean temperature(°C)
	Common chickweed	Redroot pigweed	Yellow nutsedge		
Brewer's spent grain 64 g	22.2 b	24.5 bc	25.0 bc	309 a	17.4 b
Brewer's spent grain 32 g + 70% ethanol 50 ml	14.0 c	11.9 e	28.8 b	163 d	17.5 b
Paper mulch 32 g	19.5 bc	22.3 bcd	10.0 bc	257 c	17.3 b
Paper mulch 16 g + 70% ethanol 50 ml	17.5 bc	18.9 bcde	5.0 bc	279 b	23.5 a
Rice bran 63 g	15.5 bc	15.2 de	0 c	150 e	17.3 b
Rice bran 31 g + 70% ethanol 50 ml	11.5 c	11.8 e	11.3 bc	91 h	17.3 b
Non-treated control	83.8 a	85.2 a	74.4 a	4.8 f	17.5 b
P value	<0.0001	<0.0001	<0.0001	0.01	

[a] Means followed by different letters within a column are statistically different using least significance difference at $P \leq 0.05$.

Treatments	Weed germination rate (%) [a]				Cumulative soil anaerobic conditions (V hr) [a]	Mean temperature(°C) [a]
	Common chickweed	Redroot pigweed	White clover	Yellow nutsedge		
Brewer's spent grain 64 g	22.0 de	25.5 cd	21.3 bcd	7.5 c	195 a	22.4 a
Brewer's spent grain 64 g+ 0.06 g yeast	17.5 ef	19.5 e	10.8 ef	0 d	191 a	21.9 ab
Coffee grounds 112 g	34.0 b	33.7 b	28.5 b	22.5 b	165 ab	20.7 b
Coffee grounds 112 g+ 0.06 g yeast	23.0 d	20.0 de	18.0 cde	0 d	116 ab	22.0 ab
Paper mulch 32g 32 g	31.5 bc	26.5 c	15.0 def	0 d	91 ab	22.2 ab
Paper mulch 32 g+ 0.06 g yeast	29.5 bc	25.5 cd	10.0 ef	0 d	51 bc	22.0 a
Peanut shell 63 g	23.3 d	20.5 de	16.5 def	0 d	80 bc	22.0 ab
Peanut shell 63 g+ 0.06 g yeast	14.5 f	17.5 e	8.3 f	0 d	206 a	22.2 a
Rice bran 63 g	28.5 c	26.5 c	26.5 bc	0 d	154 ab	22.1 a
Rice bran 63 g + 0.06 g yeast	21.5 de	19.5 c	11.0 ef	0 d	103 ab	22.1 ab
Non-treated control	83.3 a	86.5 a	72.8 a	80.0 a	3.4 c	22.29 a
P value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	

Summary

1. Distiller`s dry yeast had potential to enhance ASD effect using C source such as rice bran

2. Proper C sources or C sources combination candidates:

- Paper mulch
- Peanut hull (& yeast)
- Coffee ground & yeast
- Brewer`s spent grain & yeast

Information from greenhouse trial

- The yeast application had significance effect for ASD on the suppression of weeds.
- The yeast application significantly enhanced the weed suppression effect for treatments using brewer`s spent grain, coffee ground and rice bran as carbon source.
- Yeast had non significant effect on ASD treatments using paper mulch as carbon source and had inconsistent effect on treatments using peanut shell as carbon source.
- Brewer`s spent grain, coffee ground and peanut shell, and those carbon sources with yeast had comparable results on weed controlling as rice bran, or even better than rice bran, which indicate those three carbon sources would be proper carbon sources for ASD.

- Basing on cost and localization consideration, brewer`s spent grain with yeast would be recommended choice for further field trial, because:

1. brewer`s spent grain could get from local brewery for free;
2. there are over 100 craft breweries in Virginia with an increasing trend recent 6 years;
3. brewer`s spent grain as a main waste from brewery, could be provided regardless of season;
4. brewer`s spent grain with yeast had better effect compared to coffee ground, and consistent yeast effect compared to peanut shell.

Treatments, Small-Scale Field Trial

1 Fumigant (Pic-Clor-80, 290lbs/acre)

2 Brewer`s Spent Grain 6 ton/acre + Yeast

3 Brewer`s Spent Grain 3 ton/acre soil + Yeast

4 Brewer`s Spent Grain 6 ton/acre soil No Yeast

5 Brewer`s Spent Grain 3 ton/acre soil No Yeast

6 Non-treated + Yeast

7 Non-treated No Yeast

* Yeast application rate: 9.1 lbs/acre, cost $72.8/acre

Brewer`s spent grain could get for free


BEFCO
Full
Full

Distillers Active Dry Yeast

- A specially selected strain of *Saccharomyces Cerevisae* designed for distillers use in grain mash fermentations for ethanol.
- DADY will produce maximum alcohol yields under controlled temperatures (around 90 F)
- It has been the choice of many producers in North America for over 20 years.
- It has been used for the manufacture of light spirit and Whiskeys. It is also used on corn mash and syrup fermentations
- Cost $8 /lb

Timeline

ASD C source apply	Aug 14 2018
Fumigant applied	Aug 17 2018
ASD-irrigation	Aug 24 2018
Post-ASD break	Sep 17 2018
Strawberry plugs transplanting	Oct 3 2018
Weed count	Nov 2018-Mar 2019
Harvest	Apr 2019-June 2019

Bacterial endophyte study- *Bacillus velezensis*

Bacillus species are ubiquitous and of great economic importance

- Ability to colonize plants
- Produce spores, biofilms and antibiotics
- Induce synthesis of plant hormones

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The Institute of Advanced Learning and Research

Braehead Farms

Treatment	Marketable yield (g/plant)	Total Yield (g/plant)
B. *velezensis* IALR 619	270 (+12%)	343 (+11%)
B. *velezensis* IALR 585	231	300
B. *velezensis* IALR 308	220	298
3 B. sp. Combo	206	300
Untreated	241	310

Aaron's Creek Farms

Treatment	Marketable yield (g/plant)	Total Yield (g/plant)
B. sp. 619	336 (+15%)	355 (+17%)
B. sp. 585	264	264
B. sp. 308	280	294
3 B. sp. Combo	210	223
Untreated	293	303

Greenbrier Farms

Treatment	Marketable yield (g/plant)	Total Yield (g/plant)
B. sp. 619	104 (+8 %)	170 (+15%)
B. sp. 585	105	170
B. sp. 308	132	195
3 B. sp. Combo	126	206
Untreated	96	148

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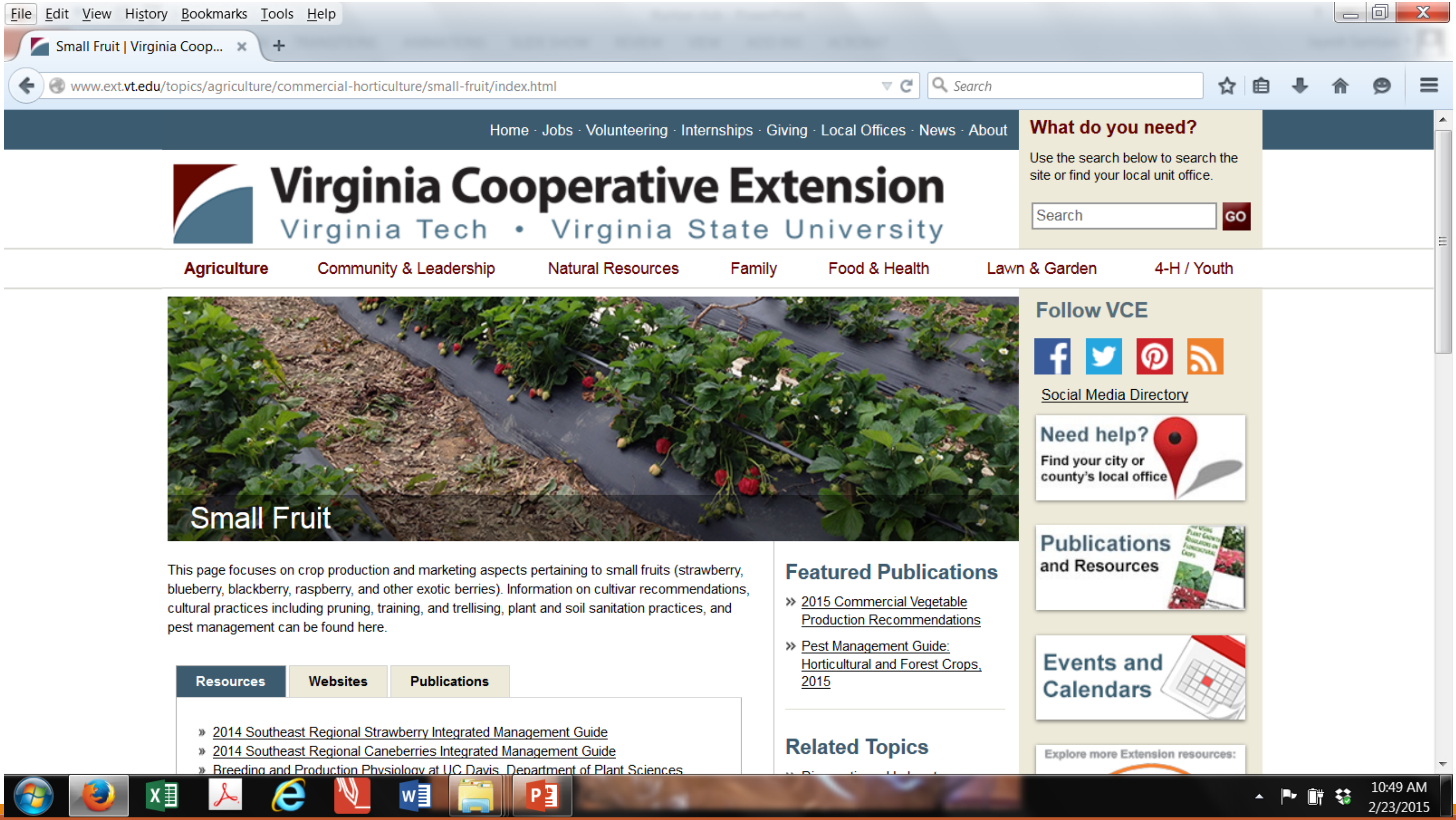
https://ext.vt.edu/small-fruit.html



Thank you!