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# *Leaf tissue sampling, weed management and production budgets.*

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**2023 MID-ATLANTIC STRAWBERRY SCHOOL**  
**DR. JAYESH SAMTANI,**  
**ASSISTANT PROFESSOR AND SMALL FRUIT**  
**EXTENSION SPECIALIST**



# Outline of presentation

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1. Leaf tissue sampling
2. Weed control
3. Production budget sheets

# 1. Strawberry Tissue Sampling

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Photos and slides on tissue sampling provided by  
the experts at NCDA&CS  
<<https://www.ncagr.gov/agronomi/uyrplant.htm>>



# What is tissue analysis?

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Chemical processes that

- Measure concentrations of essential plant nutrients
- leaf analysis includes:
  - N, P, K, Ca, Mg, S (%)
  - Fe, Mn, Zn, Cu, B (ppm)
  - plus Na (%)
- petiole analysis:  $\text{NO}_3\text{-N}$  (nitrate-nitrogen)

Also includes

- Interpretation indexes
- Nutrient ratios
- Agronomist comments



# Why tissue sample?

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To monitor nutritional status

- Fine-tune fertility programs
- Predict hidden hunger prior to visual symptoms
- This is a predictive sample

To diagnose abnormal growth or color

- Detects when nutrients are outside of recommended ranges
- Identify & correct nutrient shortages swiftly
- Determine if the nutrient is corrected
- This is a diagnostic sample

# Routine tissue sampling

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Is very important in high-value crops like strawberries

- Evaluate the fertility program and nutritional status to prevent problems

Once a nutrient deficiency has occurred, yield is already lost

A nutrient deficiency is easier to correct and results in less yield loss, the sooner it is detected and corrected

# How to tissue sample - frequency

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For monitoring (predictive)

- Collect biweekly samples from early bloom through harvest
- This is the bloom (B) and fruit (F) growth stages

For diagnosing

- Collect samples as soon as abnormal plant growth or color is noted



# How to tissue sample – plant part

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Collect the most recently mature trifoliate leaves (MRML)

- Has three leaflets and a petiole
- Is full-sized and dark green
- Located 3-5 leaves back from the tip
- Is healthy--no diseases, insects or harsh environmental conditions (predictive)





# Representative tissue sample

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- Collected from random locations throughout the field
- Includes 20 -30 MRML
- Represents average nutritional status



\*\*\*NOTE: if leaves are small, include additional material\*\*\*



**\* REQUIRED**

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☒ In State (\$5) **OR** ☐ Out of State (\$25)

\*\*\*\*\*

**\*** ☒ Predictive **OR** ☐ Diagnostic

# PLANT SAMPLE SUBMISSION

**NCDA&CS Agronomic Division Plant/Waste/Solution/Media Section**  
 Mailing Address (USPS): 1040 Mail Service Center, Raleigh NC 27699-1040  
 Physical Address (UPS/FedEx/DHS): 4300 Reedy Creek Rd, Raleigh NC 27607  
 Phone: (919) 664-1600 **For lab results go to: [www.ncagr.gov/agronomi](http://www.ncagr.gov/agronomi)**

OFFICE USE ONLY

REPORT #

DATE REC'D

INITIAL

**PAYMENT****\* CLIENT** (please write legibly)**ADVISOR** (if applicable)

FARM ID	FEE TOTAL \$	LAST NAME	FIRST NAME	LAST NAME	FIRST NAME
	AMT PAID \$	MAILING ADDRESS		MAILING ADDRESS	
SAMPLING DATE	* METHOD OF PAYMENT :	CITY		CITY	
	<input type="radio"/> CASH /CHECK	STATE		STATE	
* COUNTY (WHERE COLLECTED)	<input checked="" type="radio"/> PAY ONLINE (CC)	ZIP		ZIP	
	<input type="radio"/> ESCROW ACCOUNT: (provide Account Name or #)	EMAIL ADDRESS		EMAIL ADDRESS	
NUMBER OF SAMPLES	* Party Responsible for Payment :	PHONE	PALS Client Account #	PHONE	PALS Client Account #

LAB NUMBER (lab use only)	* SAMPLE ID	* CROP NAME	* GROWTH STAGE (S, E, B, F, M) see p.2	WEEK	* PLANT PART (M, W, T, E, H, P)	PLANT APPEARANCE	CORRESPONDING SAMPLE ID <input type="checkbox"/> Soil <input type="checkbox"/> Waste <input type="checkbox"/> Media <input type="checkbox"/> Nematode <input type="checkbox"/> Solution	SPECIAL TESTS (\$2 EACH) Mo Cl NO <sub>3</sub>		

**GROWING CONDITIONS****DIAGNOSTIC SAMPLE COMMENTS**

Planting date: \_\_\_\_\_ Date of last soil test: \_\_\_\_\_

Rainfall ☐ Below normal ☐ Normal ☐ Above normal ☐ Drip Irrigation

Temperature ☐ Below normal ☐ Normal ☐ Above normal

Production System ☐ Greenhouse ☐ Field ☐ High Tunnel ☐ Outdoor Container

Nutrient supply ☐ Granular fertilizer ☐ Liquid fertilizer ☐ CRF ☐ Organic

Growth substrate ☐ Soil ☐ Potting Media ☐ Hydroponic solution ☐ Other \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## INSTRUCTIONS FOR COMPLETING THE PLANT SAMPLE INFORMATION FORM

### TIPS:

- Send leaf tissue samples in **PAPER** bags. Do NOT use plastic bags.
- Be sure to send enough leaf material. A general rule of thumb is two handfuls of leaves.
- Do not send whole plants with roots. Submit leaves from multiple plants from a representative area.

### SAMPLE TYPE

**Predictive** (routine) analysis checks nutrient content and provides interpretation and general recommendations.

**Diagnostic** (troubleshooting) analysis identifies nutritional problems and provides interpretation and specific recommendations. Diagnostic analysis is most effective if the grower submits both a “good” (healthy) and a “bad” (unhealthy) sample.

**Research** is for samples submitted by private and university research facilities. An approved research agreement is required prior to submission.

**Out of state** is for samples submitted by or for non-North Carolina residents.

**SAMPLE INFORMATION:** FARM ID is an optional identifier associated with each sample. Please also specify the sampling date, who collected the sample, and the county where it was collected.

**SAMPLE ID:** Provide sample identification (no more than six letters). Put the same ID on the sample envelope or paper bag.

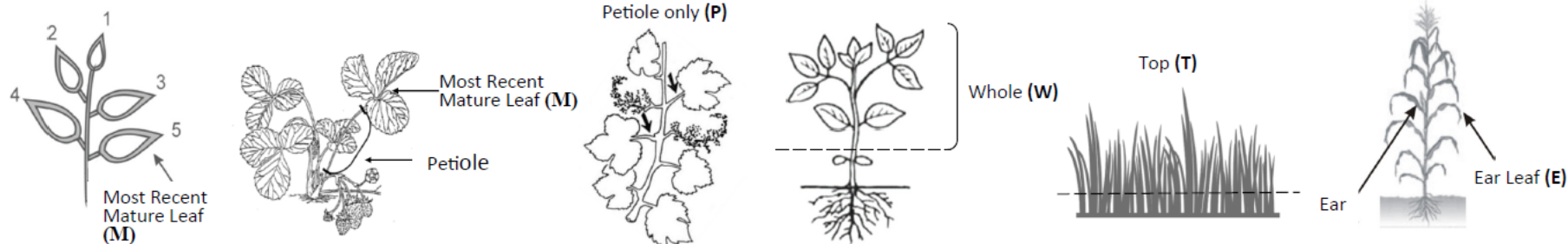
**PAYMENT INFORMATION:** Cost per sample is \$5 for N.C. residents, \$25 for out of state samples, and \$12 for in-state research samples. Reports are not released until fees are paid.

Special tests—petiole nitrate nitrogen, molybdenum (Mo) and chloride (Cl)—are an additional \$2. A petiole nitrate nitrogen test is required for cotton and strawberry samples and a molybdenum test is required for *Brassicas* (cabbage, kale, rapeseed, broccoli, Brussels sprouts, cauliflower, collards, turnips), spinach, alfalfa, and poinsettia. Payments can be made by cash, check, escrow or over the phone with a Visa or Mastercard. Beginning Jan. 2016, payments can be made online on the PALS site.

**GROWTH STAGE:** Identify plant growth stage using one of these letter codes: **S = SEEDLING**, **E = EARLY GROWTH**, **B = BLOOM**, **F = FRUITING**, **M = MATURE**

**WEEK:** For strawberry samples, list the number of weeks since the 1st week of bloom. For cotton samples, list the number of weeks the crop has been in early, bloom, or fruit stage. Providing the accurate week is essential for correct nitrogen recommendations. Separate petioles from leaves and submit both parts for strawberry and cotton samples.

**PLANT PART:** For the majority of crops, the **most recent mature leaf (M)** is the proper plant part to sample. For seedlings, sample the **whole plant (W)** cut 1” above the soil line. For grasses and grains prior to head formation, sample the **top three inches (T)**. For corn at tasseling, sample the **ear leaf (E)**. **H = Harvest leaf** (tobacco only). **P = Petiole only** (applies only to vinifera grapes).



**PLANT POSITION:** This field is only necessary for **harvest stage tobacco** leaves. For these leaf samples, specify whether the leaves were collected from the **(U) = Upper**, **(M) = Middle** or **(L) = Lower** position of the plant.

# How to tissue sample

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Detach the petioles

- Snap leaves off at the stem then separate the blades from the petioles



Measure  $\text{NO}_3\text{-N}$  on petioles

A great predictor of soil N availability

# Submit the sample

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Place the sample in a paper bag or envelope

Complete the *Plant Sample Information* form

Include the appropriate fee for each sample



Get the sample to the lab within 24-48 hours!!!!



# Plant sample information form

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Properly identify the growth stage and week

- Bloom/fruit (B/F) has 12 consecutive weeks
- Week 1 of B/F is characterized by the presence of 5–10 open blossoms on at least 50% of the plants
- Or to state it another way – it means strawberries will be ready to pick in 4½ to 5 weeks
- Week 5 of B/F growth stage coincides with first harvest



# Growth Stage and Week

Growth Stage	Week	NO <sub>3</sub> -N Sufficient Range (ppm)*	Nitrogen recommendation when petiole NO <sub>3</sub> -N		
			Below-	Within-	Above-
			the sufficient range		
B/F	1	600-1500	7 lb N/a/wk	5.25 lb N/a/wk	None
	2-3	4000-6000			
	4	3500-6000			
	5-8	3000-5000			
	9	2000-4500			
	10	2000-4000			
	11	1500-3000			
	12	1000-2000			

\*Campbell CR, Miner GS. 1994. Strawberry nitrogen fertilization and plant nitrate monitoring. In: Proceedings of the 1994 Southeastern Strawberry Expo. Raleigh (NC): North Carolina Cooperative Extension Service. p 3–9.

# Understanding the Plant Report

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## Concentrations of 11 essential nutrients

- N, P, K, Ca, Mg, S (%)
- Fe, Mn, Zn, Cu, B (ppm)
- plus Na (%)
- And petiole  $\text{NO}_3\text{-N}$

## Interpretation Indexes


- Scale - 0 to 124
- Ranges - deficient, low, sufficient, high, excessive

## Nutrient Ratios

- N:S, N:K, Fe:Mn

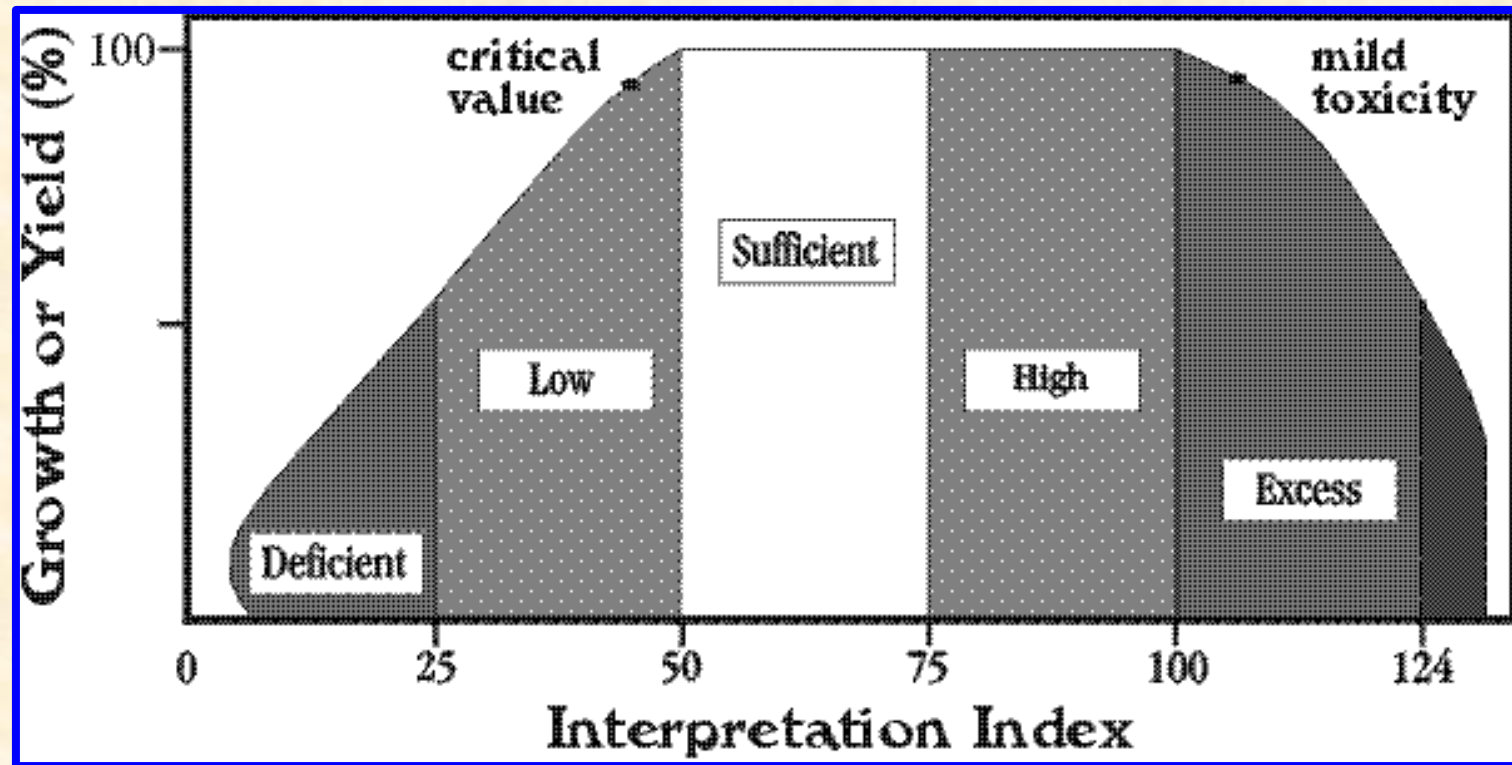
## Agronomist Comments

# Understanding the Plant Report

NCDA&CS Agronomic Division		Phone: (919) 733-2655		Website: <a href="http://www.ncagr.gov/agronomi/">www.ncagr.gov/agronomi/</a>		Report N FY12-P001870																																			
		Predictive		Client: <span style="background-color: black; color: black;">[REDACTED]</span>		Advisor:																																			
		Plant Tissue Report		County: Alamance		<a href="#">Links to Helpful Information</a>																																			
		Sampled: 05/17/2012		Received: 05/18/2012		Completed: 05/23/2012																																			
				Farm:																																					
<b>Sample Information</b> Sample ID: 1 Crop: Strawberry Growth Stage: B Week: 7 Plant Part: M Plant Position: U Plant Appearance: Normal		<b>Nutrient Measurements</b> <table border="1"> <tr> <th>N (%)</th> <th>P (%)</th> <th>K (%)</th> <th>Ca (%)</th> <th>Mg (%)</th> <th>S (%)</th> <th>Fe (ppm)</th> <th>Mn (ppm)</th> <th>Zn (ppm)</th> <th>Cu (ppm)</th> <th>B (ppm)</th> <th>Mo (ppm)</th> </tr> <tr> <td>2.21</td> <td>0.28</td> <td>1.42</td> <td>0.97</td> <td>0.29</td> <td>0.14</td> <td>58.8</td> <td>11.9</td> <td>1.83</td> <td>0.66</td> <td>29.1</td> <td></td> </tr> </table>										N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	B (ppm)	Mo (ppm)	2.21	0.28	1.42	0.97	0.29	0.14	58.8	11.9	1.83	0.66	29.1		<b>Nutrient Ratios</b> N:S 15.5 : 1 N:K 1.56 : 1 Fe:Mn					
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		<b>Other Results</b> <table border="1"> <tr> <th>Na (%)</th> <th>Cl (%)</th> <th>C (%)</th> <th>DW (g)</th> <th>NO3-N (ppm)</th> <th>Ni (ppm)</th> <th>Cd (ppm)</th> <th>Pb (ppm)</th> <th>Al (ppm)</th> <th>Se (ppm)</th> <th>As (ppm)</th> <th>Li (ppm)</th> <th>Cr (ppm)</th> <th>Co (ppm)</th> </tr> <tr> <td>0.01</td> <td></td> <td></td> <td></td> <td>690</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>												Na (%)	Cl (%)	C (%)	DW (g)	NO3-N (ppm)	Ni (ppm)	Cd (ppm)	Pb (ppm)	Al (ppm)	Se (ppm)	As (ppm)	Li (ppm)	Cr (ppm)	Co (ppm)	0.01				690									
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0.01				690																																					
<b>Agronomist's Comments:</b> Nitrogen and sulfur are below the recommended ranges in the leaf blade sample. Petiole nitrate nitrogen is also low for bloom/fruit week indicated. Our recommendation is to inject the equivalent of 7 lbs N per acre per week. Consider injecting 10 lbs. of Epsom Salt per acre to supply sulfur.																																									

# Understanding the Plant Report

Interpretation Index



# Concluding remarks

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Plant tissue analysis is a tool – use it properly

- Consider everything else you know about the field
  - Environment
  - Temperature and rain
  - Soil pH and fertility
  - Disease/insect pressure
  - Production practices
  - Fertilization
  - Irrigation



# Lab. sources

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NCDA: <http://www.ncagr.gov/agronomi/uyrplant.htm>

Waypoint analytical: <https://www.waypointanalytical.com/PlantTissues>

## 2. Weed Management

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Understand field history.

Proper identification is necessary.

Implement a strategy when weeds are small.

Limited postemergence option thus important to use a preplant herbicide.

Prevent weeds from producing seeds. Hand pull weeds if needed.

Follow herbicide labels including rotational restrictions/carryover potential.





Photo by: Jayesh Samtani





Photo Credit: JayeshSamtani



Photo Credit: JayeshSamtani





Photo Credit: JayeshSamtani



# Fumigants for preplant weed control

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Pic-Clor60: 125-175 lb/acre in-row.

Metam potassium: K-Pam (American Vanguard Company),  
Sectagon K54 (Novasource)

Metam sodium: Vapam (AMVAC), Sectagon 42

Dominus (allyl isothiocyanate)

# Henbit

## Preplant

**Chateau 51 WDG** (flumioxazin): 3 oz/acre  
Apply to soil surface of pre-formed beds at least 30 days before transplanting prior to mulch being laid.

**Spartan 4F** (sulfentrazone): 4 to 8 oz/acre

**Sinbar 80WDG** (terbacil): for matted row production



Photo: J. Samtani

# Chickweed



\* Matted row production

**Chateau 51 WDG** (flumioxazin): 3 oz/acre

Apply to soil surface of pre-formed beds at least 30 days before transplanting prior to mulch being laid.

**Spartan 4F** (sulfentrazone): 4 to 8 oz/acre

**Devrinol 2XT 2EC** (napropamide): 8 qt or 8 lb/acre

\***Dacthal 6L or Dacthal 75-W** (Dactal): 8 to 12 pt or 8 to 12 lb/acre

\***Sinbar 80 WDG** (terbacil): see label

\* **Ultrablazer 2L** (acifluorfen)





# Horseweed

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**Chateau 51 WDG** (flumioxazin): 3 oz/acre

Apply to soil surface of pre-formed beds at least 30 days before transplanting prior to mulch being laid. Do not apply after fruit set.





Photo: Howard F. Schwartz, Colorado State  
University



Photo: Bruce Ackley, The Ohio State University, Bugwood.org

# Nutsedge

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**Spartan 4F** (sulfentrazone): 4 to 8 oz/acre

Anaerobic soil disinfestation

**Eptam 7E**: 3.5 to 7 pt/acre. Apply 45 d before planting



# Vetch

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## Stinger 3EC

Limited weed spectrum but very effective

Vetch, dock, red sorrel, clover, dandelion

Do not tank mix with other pesticides

No adjuvants

Apply at least 30 days before planting

Crop row: 0.33 to 0.5 pt/acre

Row middle: 0.33 to 0.67 pt/acre

# Clover



Photo: J. Samtani

# Grass control

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Annual and perennial grasses:

Arrow, Select 2EC (clethodim): 6 to 8 oz/acre

Select max 1EC, Intensity one: 9 to 16 oz/acre

Poast 1.5EC (sethoxydim): 1 to 1.5 pint/acre

Fusilade DX (fluazifop): 12 to 24 oz

## **Nonselective grass/broadleaf:**

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Glyphosate (various formulations),

Paraquat (Gramoxone SL 2L)

Pelargonic acid (Scythe 4 EC): annual broadleaf weeds



# 3. Strawberry Budgets

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

Go to the Resources tab → Click on High tunnel and open-field strawberry budget



Virginia Department of Agriculture and Consumer Services (VDACS)

Hatch Act of 1887

*Horticulturae* **2022**, 8, 1139. <https://doi.org/10.3390/horticulturae8121139>



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**Thank you!**