Late Planting of Day Neutral Strawberries using Low Tunnels (LT) and Open Bed (OB) Regimes

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History of Strawberry (*Fragaria ×ananassa*) Production in the Tri-County Area


News: Eastern Shore Strawberry Crop Outlook Is Good

Shipment of railroad car as follows

- Fruitland (100)
- Marion Station (200)
- Pittsville (160)
- Salisbury (160)
- Princess Anne (100)

Marion, in MD was regarded as a strawberry capital of the world
History of Strawberry (*Fragaria ×ananassa*) Production on the Delmarva Peninsula

- A glimpse of 1925 USDA-NASS Census of Agriculture showed the strawberries acreage in MD, DE, & VA

<table>
<thead>
<tr>
<th></th>
<th>1925</th>
<th>2012</th>
<th>% Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD:</td>
<td>7000</td>
<td>220</td>
<td>97</td>
</tr>
<tr>
<td>DE:</td>
<td>2570</td>
<td>53</td>
<td>98</td>
</tr>
<tr>
<td>VA:</td>
<td>5798</td>
<td>290</td>
<td>95</td>
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</tbody>
</table>

Delmar, in DE was regarded as a strawberry capital of the nation

Why Day Neutrals and Protective Structures

Season Extension
Quality and Quantity
Protection from Diseases

Local Inclement Weather:
A: Excessive rainfall during the harvest of June Bearers (JB) and sowing of day neutral strawberries (DNS; Mar.-May)
B: Drought in association with high temperature during summer (July-Aug.)
C: Excessive rainfall during DNS harvest (Sep.-Oct.). 7 inches more this year

Drought and Heat Stress in California and Florida

Right Time for Local Production

• Evaluation of growth development of DNS using OB and LT regimes
• Disease management using nanoparticles
• Extension outreach
Field Preparation: 6/26/2018

A: Light Disking

B: Raised Beds:
I: Height: 7 inch
II: Width: 3 feet
III: Length: 100 feet
IV: Mulch: 1.25mil: White out side and black inside
V: Drip Tape: 0.28 gal.h⁻¹

Day Neutral Strawberries (*Fragaria × ananassa*)
Day Neutral Strawberries (*Fragaria ×ananassa*)

**B: Planting:** 7/5/2018

**I: March-May** (Recommended)

**II: Plant x Plant Distance:** 1 feet

**III: Row to Row Distance:** 1 feet

**III: Bed to Bed Distance:** 5 feet

**IV: 1 Bare root per hole**

**V: UMES Planting:** July 5, 2018 (very late)

Staggered double rows
Construction of Inexpensive Low Tunnels using Plastic Pipes

- 2 feet 1 inch PVC pipe
- Insert 1 foot under ground
- 10 feet 1/2 inch PVC pipe
- Insert 1 foot in 1 inch PVC pipes
- Total 8 feet outside
Construction of Inexpensive Low Tunnels using Plastic Pipes

T-Post at the each end of tunnel: 90 feet long tunnel

Duct Tape to seal both pipes

Duct Tape to fix side ½ inch pipes (10 feet long)
Construction of Inexpensive Low Tunnels using Plastic Pipes

Side view: Duct Tape to fix side ½ inch PVC pipes

Central twine to attach all the bent pipes together
Construction of Inexpensive Low Tunnels using Plastic Pipes

- Side twine around each hoop
- 3/16 inch twine: 100 Feet
- Roll plastic inside not outside
- Standard clear greenhouse film, 6mil 92% Transparency
Construction of Inexpensive Low Tunnels using Plastic Pipes

Cost: $57.68 for 90 feet long tunnel

Plastic Film: $122/yr = $30.5
1 inch PVC Pipe 7: $21.21/yr = $5.30
½ inch PVC Pipe 36: $47.52/yr = $11.88
Twine/Rope 3/16 inch: $22/yr = $5.5
T-post-2: $18/yr = $4.5
Total = $57.68
Installation of Solar Powered Electric Fence

- T-posts at every 20 feet
- Three rows of wire at 1.5 feet difference
- Apply peanut butter on wire

Effective up to 2 miles
Fertilizer

A: Plasticulture: N (Calcium Ammonium Nitrate): 60 lb/A broadcast

Once heavy bloom: N (CAN and KNO3): 5 lb/A through drip weekly

Alternate use of CAN and KNO3 at 7 days interval

Irrigation:

I: Soil moisture and scheduled once the moisture level reached to -30 centi bars.

II: 6 inch depth

III: Drip Tape: 0.28 gal.h$^{-1}$
Fertilizer

EZ Flow 4.25 Gallon Tank
Protection - Low Temperature

Tunnels closed when temperature $\leq 12 \, ^{\circ}\text{C}$ or $54 \, ^{\circ}\text{F}$

Overhead Irrigation when temperature $< 2 \, ^{\circ}\text{C}$ or $35 \, ^{\circ}\text{F}$
Protection-High Temperature

Tunnels opened at 21-25 °C or 70-77 °F
Plot Design

Low Tunnels (LT): 4 (90 Feet x 3 Feet)
Open bed (OB): 4 (90 Feet x 3 Feet)
Variety: 4
  - V1: Redstart (weak day neutral)
  - V2: Albion
  - V3: Mara Des Bois
  - V4: Portola (strong day neutral)
Replicates: 4 X 40 = 160 for each variety in each regime (LT/OB)
Design: RCBD
Date of Planting (DAP): 07/05/2018
Observations: 30 DAP on Plant Height, Leaf area, Ground Area, FW & DW of Leaf and Stem, No. of Flowers, Fruits, Runners & Crowns/Plant, Yield, LAI, RGR, CGR, NAR, SLA, and Disease Incidence etc.
Day Neutral Strawberries (*Fragaria Xananassa*)

**Low Tunnel:** Portola

**Open Bed:** Portola

60 days after planting
Total Yield (g/plant) in DNS

V1: Redstart; V2: Albion; V3: Mara Des Bois; V4: Portola

Non-marketable

34.6% more

36.8% more

Total Yield under OB and LT

July Aug Sep Oct Nov Dec

V1-OB V1-LT V2-OB V2-LT V3-OB V3-LT V4-OB V4-LT

Non-marketable
Low Tunnel (Portola): 465 g

Open Bed (Portola): 305 g

34.6% more yield using low tunnel conditions
Number of Flowers/Plant in DNS

V1: Redstart; V2: Albion; V3: Mara Des Bois; V4: Portola

Number of flowers/plant

Varieties under OB and LT

V1-OB  V1-LT  V2-OB  V2-LT  V3-OB  V3-LT  V4-OB  V4-LT

Aug  Sep  Oct  Nov  Dec

25% more
31.0% more
Number of Fruits/Plant in DNS

V1: Redstart; V2: Albion; V3: Mara Des Bois; V4: Portola

- 36.7% more
- 29.2% more

Varieties under OB and LT

Number of Fruits/Plant

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ob</th>
<th>Lt</th>
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<tbody>
<tr>
<td>V1</td>
<td></td>
<td></td>
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<tr>
<td>V2</td>
<td></td>
<td></td>
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<tr>
<td>V3</td>
<td></td>
<td></td>
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<tr>
<td>V4</td>
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- Sep
- Oct
- Nov
- Dec
Leaf Spot (*Mycosphaerella fragariae*) infection in Portola Open Bed

**JULY-2018**

**Aug-2018**

**Sep-2018**

**Oct-2018**

**Nov-2018**

**Dec-2018**
Leaf Spot (*Mycosphaerella fragariae*) infection in DNS

V1: Redstart < V2: Albion < V3: Mara Des Bois < V4: Portola

Varieties using OB and LT

- **July**: Blue bars
- **Aug**: Orange bars
- **Sep**: Grey bars
- **Oct**: Yellow bars
- **Nov**: Blue bars
- **Dec**: Green bars

- **V1-OB**: 2% less
- **V1-LT**: 60% less
- **V2-OB**: 7% less
- **V2-LT**: 12% less
- **V3-OB**: 7% less
- **V3-LT**: 2% less
- **V4-OB**: 60% less
- **V4-LT**: 12% less
Extension Outreach Impact

Strawberry Workshop in September-2018

Growers visit from Virginia in August-2018
Three small farmers ordered DNS for the current season
One grower will build low tunnels in current season
Conclusions:

• Low tunnel cultivation of DNS showed improved yield and protection from leaf spot.
• We expect early DNS planting in association with Low tunnels may further increase the yield.
• Redstart, Albion, & Mara Des Bois showed poor performance in OB and LT regimes
• Portola showed improved performance in LT and OB, but highly susceptible to leaf spot.
Effects of Common-ZnO on Soybean Looper (Third Instar Larvae)

Five larvae were released in each petri dish.

A) Control
B) Common NZO

0% mortality within 5 to 24 hr.)
Effects of Common-ZnO on Soybean Looper (Second Instar Larvae)

Five larvae were released in each petri dish

0% mortality within 5 to 24 hr.)
Effects of Common-ZnO on Soybean Looper (First Instar Larvae)

Five larvae were released in each petri dish

0% mortality within 5 to 24 hr.
Effects of Nano-ZnO (10-30 nm) on Soybean Looper

Treatment

100% mortality within 5 to 24 hr.)
Effects of Nano-ZnO (40-60 nm) on Soybean Looper

100% mortality within 5 to 24 hr.
Effects of Nano-ZnO (80-100 nm) on Soybean Looper

100% mortality within 5 to 24 hr.)
Effects of Nano-ZnO (200 nm) on Soybean Looper

100% mortality within 5 to 24 hr.)
Nanotechnology & Fire Blight

Isolated two strains
Yet to be confirmed

Method A
Method B
4 days old colonies
Thanks and Questions