Season Extension and the Cucurbitaceae Family
Why Season Extension?

• Longer season = more opportunity to make $$$.
  ● Short season used to be June frosts, August frosts
  ● Global warming we are adding cool season crops
• Makes available for sale vegetables earlier than otherwise would be available.
  ● Tomatoes in June rather than late July
• Makes available vegetables that would not be able to be grown otherwise.
  ● Melon varieties – Honeydews
How do we accomplish season extension?

- Modify the crops environment with structures:
  - Greenhouses
  - High Tunnels
  - Cold Frames
  - Row Covers
  - Plastic Mulches.

- Cultural Practices
  - Raised beds
  - Transplants
  - Pre-sprouting e.g. Potatoes
  - Seed Priming
Cultural Practices

- **Raised Beds:**
  - usually for heavier soils
  - improve water drainage at root zone
  - Expose more soil surface to warm air

- **Green Sprouting:**
  - Promote sprout formation in potatoes before planting in the field using floating row cover

- **Seed Priming:**
  - Partially germinate the seed with acids used for slow to germinate seeds like carrots.
# Advantages and Drawbacks of Season Extension Tools

<table>
<thead>
<tr>
<th>Tool</th>
<th>Advantages</th>
<th>Drawbacks</th>
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</thead>
<tbody>
<tr>
<td>Double poly greenhouse, heated</td>
<td>Long growing season; has environmental controls</td>
<td>High initial expense; high utility cost to operate</td>
</tr>
<tr>
<td>Single poly high tunnel, unheated</td>
<td>Lower cost than GH.; extend growing season about month</td>
<td>Minimal frost protection</td>
</tr>
<tr>
<td>Cold Frames</td>
<td>Hardening off transplants</td>
<td>Limited volume restricts uses</td>
</tr>
<tr>
<td>Solid row covers</td>
<td>Enhance early growth in field</td>
<td>Can over heat; require hoops</td>
</tr>
<tr>
<td>Floating row covers</td>
<td>Enhance growth in field; exclude insect pests</td>
<td>Must be removed for pollinating; may tear in wind</td>
</tr>
<tr>
<td>Plastic mulches</td>
<td>Enhance early yield; easy to apply</td>
<td>Annual removal and disposal cost</td>
</tr>
</tbody>
</table>
Greenhouses

- Most expensive & effective form of microclimate modification
  - $5,000 for 21’x96’ steel
  - Heaters, Ventilation = $2-3000.

- Used mostly for:
  - Bedding plants & flowers
  - Transplants
  - Tomatoes
High Tunnels

• Simple greenhouse-like structures with less control of environment
  – One layer of plastic
  – Unheated
  – Rollup sides only
  – Can be home made
  – 14 ft wide
  – $3,000
Cold Frames

- Traditionally box-like structures low to the ground, unheated
- Used for hardening plants
- Supplemental heating
  - Fresh manure
  - Heating mats
  - Roll up sides
- Useful at end of season as well as beginning for display that needs protection
Row Covers

• Blanket-like sheets of material—two types:
  – Solid, slitted or perforated plastic
  – “breathable” spunbonded or woven polyester, polypropylene or other synthetic material
Non-woven fabric Covertan

• Prefer this type to plastic
  – Breathable
  – Lightweight “floating”
    • Don’t always have to use hoops
  – Moisture permeable
  – Cooler than plastic = +/- 10 F. not 15-20F.
    • Do not “fry” your plants
    • No humidity build up
  – Frost protection of about 2-3 F.
Prefer Covertan to other Spun-bonded types

- Excellent tear resistance
- U.V. Stabilized
- Up to 90% of light to reach crop
- .5 oz per square yard is a good weight
Plastic Mulches

Benefits

1. Increase earlier yields by raising the soil temperature, promoting faster plant development
2. Conserve soil moisture, reduces evaporation
3. Conserve soil fertility reduces leaching unless flooded, drip irrigation helps replace it
4. Suppress weed growth inhibit light penetration to soil, still weed the holes.
5. Decrease soil compaction caused by rainfall, no crusting of the soil = better environment for root growth
6. Protect Fruit:
   1. Cleaner reduces rain-splashed soil
   2. Reduces fruit rot from soil-inhabiting organisms. Protective Barrier
Plastic Mulches

Negatives

- **Mulch Removal and Disposal**
  - Most mulches are not Biodegradable they need to be removed. We cut the edges with a disk and then hand pull.
  - There are machines for lifting still need to pull
- **Disposal can be costly**
  - Some farmers burn the mulch
- **Specialized Equipment**
  - Bed press
  - Mulch layer
  - Mulch transplanter
Unbelievable Tool
Many Types of Mulches

- **Clear** = warmest, no weed suppression
- Black = not as warm, but excellent weed suppression, reasonably priced.
  - Must be laid tight to ground heats through contact i.e. conduction
- Selective Wavelength mulches = IRT (infrared transmitting)
  - Warms the soil by radiation as well as conduction
  - Good weed suppression
  - More expensive than black or clear
- **White** on Black mulch:
  - White reflects light to promote growth during lower light levels
  - Soils remain cooler b/c less radiant energy is absorbed by the mulch than if it were black.
- **Red**: wavelength shown to increase yield on tomatoes.
- **Blue**: increased yields on melons and cucumbers.
- **Silver**: limits aphid and other insect population.
Degradable Mulches

• Two Types: Photo and Bio

• Photodegradable:
  – Breakdown is triggered by a predetermined amount of ultraviolet (UV) light.
    • Becomes brittle, cracks develop, holes.
    • Small sections may break off & be blown around
    • Finally breaks down into small flakes and disintergrates into soil.
  – Edges that are covered with soil don’t start breaking down until exposed to light.
  – Different Formulations based on length of season

• Biodegradable:
  – able to broken now into simpler substances by the activities of living organisms and there fore unlikely to persist is the environment.
  – Films produced from cornstarch
    • Starch is natural polymer, a white, granular carbohydrate produced by plants during photosynthesis
  – End products are CO2, H2O and simpler chemical compounds, carbon, “microbial biomass”.
Emergency Frost Protection

• Season Extension is not without risks. The greatest perhaps is the threat of FROST!

• Protection:
  – .5 oz covers = 2-4 F.
  – .9 oz. covers = 4-6 F.
  – Irrigation
Irrigation for Frost Control

- Sprinkling provides cold protection b/c the latent heat of fusion is released when water changes from liquid to ice.
- When water is freezing, its temp is near 32 F. The heat liberated as the water freezes maintains the temp. of the vegetable near 32 F. As long as there is a mixture of both water and ice present, the temp remains near 32 F.
- For all of the plant to be protected, it must be covered or encased in the freezing ice-water mixture. Enough water must be applied so that the latent heat released compensates for the heat losses.
Cucurbitaceae—Gourd Family

Cucumbers, Melons, Summer & Winter Squash, and Pumpkins

• Let’s apply our newly acquired understanding of season extension to a family of vegetables which is extremely sensitive to the cold.
Melon Varieties
Muskmelon, Crenshaw, French Charentais, Galia
Plant Growth and Development

- Origin is not well known—Western Africa or the Middle East—Tropical in Origin
- Very Susceptible to frost and thrive in hot conditions.
- Excellent candidate for season extension and growth enhancement.
Seedling Germination and Development

- **Germination Temperatures:**
  - 59 F = won’t
  - 68 F = 8 days
  - 77 F = 4 days
  - 86 F = 3 days

- **Require Transplants**
  - Roots disturbance greatly delays harvest.
  - Sow in 2 inch speedling or individual cell-peat pot, can use larger pot or cell size
    - 2 seeds per cell
  - Prop mat
  - Grow on in Greenhouse
  - Not too much water don’t like wet feet
  - 4 week old transplant no later than the 3 leaf stage
The Following Field Preparation applies to all below
Field Preparation
while the transplants are growing in the greenhouse

• 20 tons of cow manure applied on all Cucurbit fields on an early sandy soil
• 500 lbs per acre of 10-10-10 applied to melon, cucumber, summer squash and zucchini fields because they will be fitted with plastic mulch and we do not sidedress them. Could put drip under and spoon feed.
• Wait for rain or irrigate to capture some but not too much water.
• Then apply plastic mulch
Mulch application

- Use Black Plastic on cucumbers and squash
- Use IRT on melons for additional heat
- Drip irrigation may be applied under the plastic as it is laid
  - Allow for fertigation
  - Excellent moisture control
Pick a clear sunny day or couple of days to plan to harden the plants for transplanting.

Without sunshine the soil temperatures may drop below 55-60 F. At these soil temperatures the plants cannot absorb water. When the sun does shine, water transpires from the leaves much more rapidly than the roots absorb water, resulting in SUDDEN WILT and death.

No control for this problem except working around the weather and the use of row covers may help.

The earlier the planting the higher the likelihood of this problem occurring.
## Melon Seeding and Planting Schedule

<table>
<thead>
<tr>
<th>Plantings</th>
<th>Seeding Date</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. Extra Early</td>
<td>4/20</td>
<td>5/20</td>
</tr>
<tr>
<td>2. Main Crop</td>
<td>5/4</td>
<td>5/31</td>
</tr>
<tr>
<td>3. Late Crop</td>
<td>5/19</td>
<td>6/11</td>
</tr>
</tbody>
</table>
Planting Conditions = Warm, 60s slightly overcast
2 plants every 3 feet rows 6 feet apart, Irrigate!!!
Grow +/- 30% extra plants; Fill planter with warm water containing high Phosphorous solution 8-45-15
Collage of Row Covering
Growing On

• Air Temperature for good cucurbit vegetative growth range from 65F to 90F
• Tolerant short periods of drought prefers around 15 inches of water per crop.
• Tolerate poorly excessive moisture & poor drainage
• Not heavy feeders but do appreciate sidedressing of 25-30 N per acre at the time of vine initiation. (Not necessary when using manure, broadcast & transplants)
• Row covers remain on for 3-4 weeks or until plants are ready to crawl off the plastic and the hermaphroditic flowers start to bloom
Muskmelons = predominately andromonoecious, bearing both perfect (hermaphroditic) and male (staminate) flowers on the same plant. Sometimes they like watermelons are monoecious, bearing separate male and female (pistillate) flowers.
Pollination

• Flowers open only one day
• Insect pollinated, provide hives
• Inadequate pollination can result in fruit abortion or distortion of the mature fruit
• Typically rainy, cool weather affects crops frequently
  – 5 years: 1 excellent, 2 good, 1 ok, 1 poor.
  – Used hive under a wide row cover
Melon Varieties

Halona, Hannah’s Choice, Edonis, Arava, Lily
Red & Yellow Watermelon, Honeydew, & Canary Sunshine, Sweet Favorite
Weed Control

- As you can see, we rototill along the edges usually 2x before the plants crawl.
- Weed each plant once.
- Lightly hand weed around the crawling vines
- Usually remains a DISASTER. Can count on the melons to mess up the field for a few years.
Irrigation

• Because grow on sandy soils consistent supply of water is important.

• Young transplants need to be watered in soon after planting and for several days especially if the weather is sunny and warm.

• California crops = 18-24 inches

• We apply 1 inch per week. Very attentive during flowering and after fruit set.

• Drip Irrigation is a very good alternative
Insects

- Stripped Cucumber Beatle perhaps the most serious pest of melon crops in North America
- Attracted to the plant by cucurbitacin, a compound found in all cucurbits
- Feed on plant tissue especially young transplants. Row covers help tremendously in giving the plants a jump on the beetle.
  - Make the plant look like a skeleton
- Vector for Bacterial Wilt
- Control pesticide usually only once per season.
Diseases

- Lots: Bacterial, Fungal, Viral
  - Bacterial Wilt
  - Fusarium Wilt
  - Anthracnose
  - Powdery Mildew
  - Downy Mildew
  - Gummy Stem Blight & Black Rot
  - Alternaria Leaf Spot
  - Viral Diseases CMV, WMV-1,2, SqMV

- Solutions Include
  - Resistant cultivars
  - Clean seed
  - Sanitation control
  - Control of host
Solutions to Melon Diseases

- Resistant cultivars
- Clean seed
- Sanitation control
- Control of hosts and vectors like stripped cucumber beetle
- Field rotation
- Discriminate use of insecticide and fungicides
Harvesting

- Edible quality of melon associated with the sugar content in the fruit
- Over half of the final concentration of sugars in the fruit = last 2 weeks of ripening
- No starch reserves in the fruit = No increase in the sugar content of the fruit after harvest.
- Full Maturity = flesh is crisp, just beginning to soften & color is deep and bright
  - What the hell is this?
Determining Maturity & When to Harvest

• Muskmelons and some others in the Reticulatus group develop a clear abscission layer between the pedicel & the fruit during maturation. The melons separate themselves.

• Called Slip
  – Half slip—”forced”
  – ¼ slip—”nudge”
Determining Maturity & When to Harvest
More Difficult

- Honeydews & Crenshaws
  - No abscission layer
  - Experience helps
  - Color of skin changes from lime green to creamy white
  - Blossom end of fruit softens
  - Wait too long some varieties crack

- Cut from vine
Harvesting Watermelons

• Mystique – no sure method only experience

• Criteria Include:
  – Browning of tendril across the stem from the pedicel of the fruit
  – Color changes on the belly of the fruit
  – Changes in the pitch of the sound from rapping the side of the fruit

• Plug varieties to get an idea
Storage Temperatures

• Not usually done if going to sell within a few days. Depends upon temperature and supply of melons.
  • Muskmelons = 36-41 F.
  • Honeydews = 45 F.
  • Watermelons = 50-60 F.
Summer Squash and Zucchini

- **Cucurbita pepo**: Origin North America-northern Mexico & southwestern U.S.
- Field prep, seeding, planting, row covering all the same as melons.
Patty Pan or Scallop Squash
# Summer Squash Seeding and Planting Schedule

3 week old transplant, 2 seeds per cell

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1.</td>
<td>4/30</td>
<td>5/20</td>
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<tr>
<td>2.</td>
<td>5/21</td>
<td>6/17</td>
</tr>
<tr>
<td>3.</td>
<td>6/11</td>
<td>7/1</td>
</tr>
</tbody>
</table>
The Solar Power of the Row Cover
Flowers monoecious require bees for pollination, despite male flowers appearing first usually a lot of early fruit abortion.
Harvest & Storage

- The name “summer” squash derives from the state of maturity of the fruit when utilized, namely in the immature state when the rinds are very soft.
- The size of the fruits depends on market preference. We harvest them when they are about 6-8 inches and about 2 inches in diameter. Remember in the 80s we grew monsters.
- Daily harvests are required or fruits will get over mature and reduce total yields. Harvest whether you have market or not.
- Fruit bruise easily. In fact, vines which have spines will injure them by scratching them.
- Harvest with knife or twist them. Put in bucket. Heavy, tiring job. Vines scratch arms. New varieties are spineless.
- We do not wash them unless heavy rains.
- We pack them into half bushel boxes.
- Store in cooler at 45-50 F. 1-2 weeks.
- Harvest for about a month. Depends upon the time of year.
Insects & Diseases

• Stripped cucumber beetle big problem too

• Powdery Mildew: foliar fungal disease of cucurbits. It colonizes leaf tissue during periods of high humidity, attacking both the top and the bottom of the leaf. The disease usually occurs in August but I have seen it in July. Reduces the vigor and over all yield of plant

• Control =
  – cultivar selection = Sunray & Judgement III
  – Fungicides: read from manual noting fungi resistance.
Cucumber varieties
Greenhouse, American slicing, & Pickling
Classification, Origin, History
Production & Industry

• Genus = Cucumis sativus
• Native to India
• Cultivated for 3,000 years
• Commercial production in the U.S. is divided almost equally between processing and fresh market types
  – Pickle Production Leader? = Michigan
• Grown world wide = China, India, Russia & U.S.
• Greenhouse production = northern Europe & Japan.
• Important crop for us =
  – 6 tons of slicers = $8,000
  – Pickler = 2,500
  – Greenhouse = 1,500
  » $12,000
Plant Growth and Development

- Characterized by a prostrate vining type of growth, which results from the branching of the main stem into several trailing laterals.
- Three distinct types of vine growth:
  - Indeterminate = continue to grow until the plant dies with constant internode length.
  - Determinate = vines have similar internode length as indeterminate but their vines terminate in a flower cluster.
  - Compact = considerably shorter internodes than either of the other two.
Flowering and Sex Expression

normally monoecious, producing both male and female flowers separately on the same plant. Many modern cultivars are GYNOECIOUS, whereby only female flowers are produced. A monoecious pollinator is added to the seed packet. These “all-female” hybrids tend to be early in maturity, outyield standard cultivars and produce a concentrated fruit set.
Fruit Set and Development

- For normal fruit set and development to occur, pollen from the male flower must be successfully transferred to the female. Poor pollination is one of the main causes of fruit abortion, misshapen fruit, or poor fruit set.
- BUT some cucumber cultivars can set fruit without pollination and sexual fertilization. These are known as PARTHENOCARPIC fruits. From Greek parthenos means virgin and karpos means fruit = virgin fruit. These varieties are used in greenhouses. These fruits do not have seeds. Some are occasionally present. Explains why seeds are expensive
# Cucumber Seeding and Planting Schedule

3 week old transplant, 3 seeds per cell

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<td>1.</td>
<td>4/28</td>
<td>5/20</td>
</tr>
<tr>
<td>2.</td>
<td>5/14</td>
<td>6/6</td>
</tr>
<tr>
<td>3.</td>
<td>5/30</td>
<td>6/21</td>
</tr>
<tr>
<td>4.</td>
<td>6/15</td>
<td>7/6</td>
</tr>
<tr>
<td>5.</td>
<td>6/30</td>
<td>7/21</td>
</tr>
<tr>
<td>6.</td>
<td>7/7</td>
<td>7/28</td>
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</tbody>
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Diseases

• Scab: caused by the fungus Cladosporium cucumerinum, which produces sunken, dark brown spots on the fruits. Disease is favored by cool, moist weather. A gummy substance oozes from the fruits. The organism overwinters in old refuse and on the seed.

• Controls:
  – Copper fungicides
  – 2 year-crop rotation
  – Resistant cultivar – most are
Harvesting & Postharvest Handling

• Slicing Cucumbers are graded by fruit diameter, length, shape, and color. The fruit should be firm, straight, uniformly smooth, and deep green.
• The desired length is 6.0 to 8.5 inches, with a diameter of 1.5 to 2.5 inches.
• Standard grades include: “U.S. Fancy”, “U.S. Extra No. 1”, “U.S. No. 1”, “U.S. No. 1 Large”, U.S. No 1 Small”, & “U.S. No. 2”.
• We harvest all sizes. Generally, locals prefer small cucumbers and “flatlanders” prefer larger ones.
• Wholesale sort a medium size cucumber.
• We harvest every other day. When the weather is hot the cukes mature very quickly—a 40% increase in weight in 24 hours.
• We use small paring knives to harvest; some twist.
Crop Cover Cost

• .5 oz Covertan 72 inches x 1000 feet costs $105 + shipping ($11 in 06) = 12 cents per foot. It is good for 3 seasons. Annual cost of 4 cents per foot.
• 1 hour of labor to apply 400 foot row (4 workers take 15 minutes) @ $12 per hour = $12 per 400 foot row or 3 cents per foot.
• Cost of annual application of crop cover = $.07 ft.
• 2006 applied 13,000 feet of crop cover @ $.07 ft. = $910.
What do they have in common?
<table>
<thead>
<tr>
<th>Cucurbita Species</th>
<th>Pumpkins</th>
<th>Summer Squashes</th>
<th>Winter Squashes</th>
<th>Gourds &amp; Ornamental Squashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. pepo</td>
<td>Field &amp; pie, miniatures</td>
<td>Yellow Scallop Marrow zucchini cocozelle</td>
<td>Acron Fordhook Spaghetti Delicata Sweet Dumpling</td>
<td>Gourds</td>
</tr>
<tr>
<td>C. maxima</td>
<td>Decorative or Jumbo</td>
<td>Yellow Scallop Marrow zucchini cocozelle</td>
<td>Hubbard Buttercup Kabocha</td>
<td>Turban</td>
</tr>
<tr>
<td>C. moschata</td>
<td>Large Cheese &amp; crookneck</td>
<td>Yellow Scallop Marrow zucchini cocozelle</td>
<td>Butternut</td>
<td></td>
</tr>
<tr>
<td>C. mixta</td>
<td>Cushaw</td>
<td></td>
<td>Cushaw</td>
<td></td>
</tr>
</tbody>
</table>
Classification

**FAMILY**: CUCURBITACEAE (GOURD FAMILY)
pumpkin, squash, cucumber, honeydew melon, muskmelon & watermelon.

- **Genus**:  
  - Cucurbita: pumpkins, squash, gourds  
    - **species**  
      » pepo  
      » maxima  
      » moschata  
      » mixta  
  - Cucumis: cucumber & muskmelon  
    - **species**  
      » sativus = cucumbers  
      » melo = muskmelons  
  - Citrullus: watermelon  
    - **species**  
      » lanatus = watermelon
Growth

• Germination and growing on is the same as the other cucurbits.
• We use transplants.
• The industry direct seeds and many Vermont growers do too.
• We do not because of late frost. We want to wait until danger of frost has passed. We have only so much irrigation for frost control.
• We do want to ensure a crop so we transplant. We aim to plant around June 7 so we sow seeds in the greenhouse May 17.
Planting

- We do not transplant on black plastic. We transplant into bare ground.
- We do not use row covers.
- No row covers = WATCH for stripped cucumber beetles.
Cultivation

• The Eco Weeder: pto driven in-row weeder
  • [http://univerco.net/](http://univerco.net/)
• Spacing between Winter Squash Pumpkins 3-6 ft in the row.
• Saves lots of hoeing time
• Use in corn, peas, beans, strawberries.
• Use rototillers & tractor between rows
• Some years hand weeding.
Diseases
From Vern’s Vegetable and Berry News

- Plectosporium or ‘white speck’ of pumpkin and squash.
  - This blight has **only recently been showing up** in northern growing areas, including Vermont. It causes small, distinct lesions on infected vines, petioles, leaves, handles and fruit.
  - Symptoms include light tan to pure white ‘spindle-shaped’ lesions that have a dry, scabby appearance. These small ‘white specks’ often coalesce to form large, dry scabby whitish-tan areas on infected plant parts. Heavy vine infection can lead to complete defoliation and handle and fruit infection can ruin aesthetic fruit quality.
  - Control of white speck begins with
    - multi-year rotations with crops other than cucurbits.
    - Maximum coverage of foliage and fruit with fungicide applications is necessary for control of White speck once it gets established.
Harvest & Post Harvest handling

- Harvest with knife usually when fully mature = full size, deep color, hard rinds.
- Before any frost
- Careful not to bruise fruit = entry point for decay. Gloves to avoid fingernails.
- After harvest cure for about 10 days at temperatures of 80 F. & relative humidity of 80%. This practice promotes healing of mechanical injuries and also ripens immature fruits, so they store better.
Storage

- **Hubbards:**
  - long winter storage 6 months or more
  - @ 55-60F. & fairly dry 50-75% relative humidity.
  - Root Cellar is ideal.

- **Butternut:**
  - up to 6 months
  - Esp. sensitive to cold injury

- **Buttercups = 2-3 months**

- **Acorns = 5-8 weeks**
Winter Squash Varieties
Winter Squash Varieties cont.
Pumpkin Varieties