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SOILLESS CULTURE

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Vegetable Production

Course content

1. Medium properties
2. Medium culture tomato (loose material)
3. Medium culture cucumber (preformed materials)

1. Medium properties

Medium choice

- The choice of the medium will be determined by availability, cost, quality and the type of soilless culture method to be employed.
- The medium must not contain any toxic materials.
- The physical and chemical properties of the medium should be suitable for the roots growing.

Characteristics of a good medium

- Should allow free air exchange.
- Should have a high buffer capacity.
- Should have a high cation exchange capacity.
- Should allow for free and rapid water drainage.
- Should be firm enough to hold the plant in position.
- Should be free of nematodes, insects, pathogens and weeds.
- Low in cost and light in weight .

Organic media:

Peat, coir, wood fiber, sawdust, bark, rice hulls ……

Inorganic media:

Sand, vermiculite, perlite, stone wool (rockwool), pumice……

Medium properties

Peat

- The most widely used medium
- Peat is formed by the slow decomposition of plants.
- Light and relatively stable.
- High water-holding capacity.
- Low pH (3~5.5)

Peat-based compound
peat:vermiculite = 2:1
(by volume)

Vermiculit

- Vermiculite is produced from a mica-related mineral which is heat-expended at 1200° C.
- Very light in weight
- High water-holding capacity
- High cation exchange capacity
- Free from pathogens
- pH ≥7

Medium properties

Rockwool

- Rockwool is manufactured by heating a mixture of three natural raw materials: diabase, coke and limestone.
- Light, artificial material
- Rockwool is synonymous with stone wool.

- Rockwool blocks are available as propagation blocks and growing slabs.
- It's also available in granulated form for potting plants.

(Grodan, 2003)

Advantages of Rockwool

Rockwool is an ideal medium for the propagation and long season cropping of many kinds of vegetables.

1) Uniform product quality
2) Control of air/water balance in the root zone
3) Superior capillary properties—efficient lift of water
4) Improved distribution of active roots
5) Reduced risk of contamination by soil borne diseases
6) Efficient crop turn-around

Disadvantage of Rockwool

(Grodan, 2003)

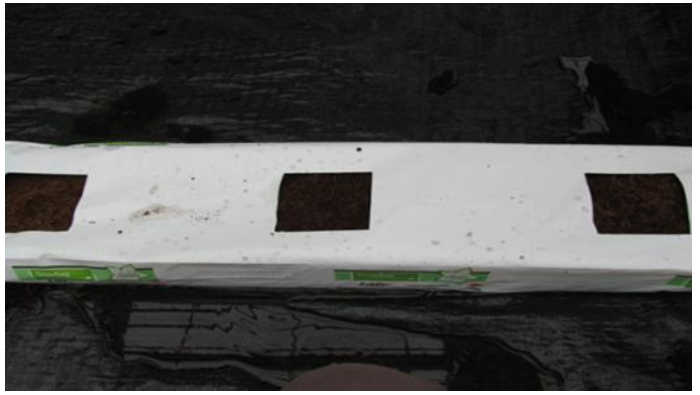
After one or two crop cycles, rockwool is usually discarded, producing an environmental issue. It can not easily be returned back to nature.

Medium properties

Coir

- Fibre from coconut shells
- When sodium, chloride and potassium levels are high in the coir, these elements have to be leached from the substrate before it used as a growing medium. The leaching was done with water or with water containing calcium nitrate
- There are different products produced from coir based on particle size.

Coir has been produced in the same shape of Rockwool blocks and slabs.



2. Medium Culture Tomato (loose material)

Cultivar choice

The selection of a cultivar depends on:

- Market demand
  - Consumer's preference, production purpose
- Growing conditions
  - Greenhouse, season







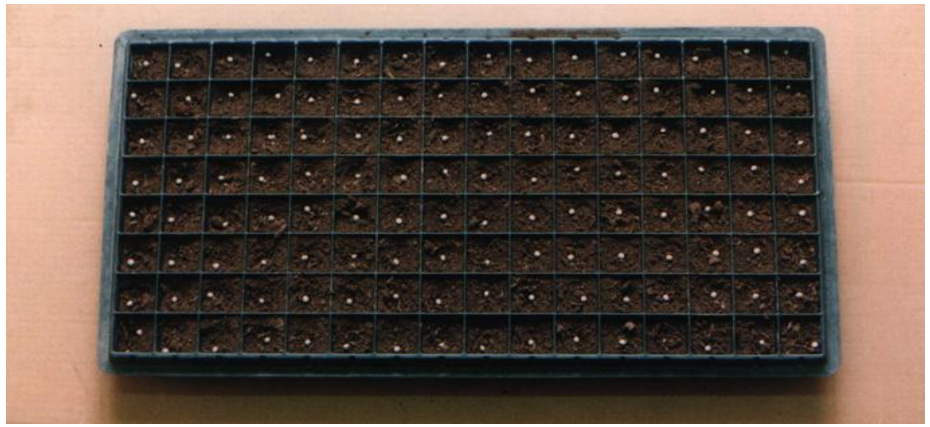

Cultivation schedule

There are two principal cropping systems for greenhouse tomatoes: two crops per year and one crop per year.

Cropping systems of greenhouse tomato (not including seedling culture)

Greenhouse types	Cropping system
Plastic house	Spring (March – July) (short cycle) Autumn (August – November) (short cycle)
Solar greenhouse	Spring (Feb. – July) (short cycle) Autumn (August – Dec.) (short cycle) Long cycle (September –next July)

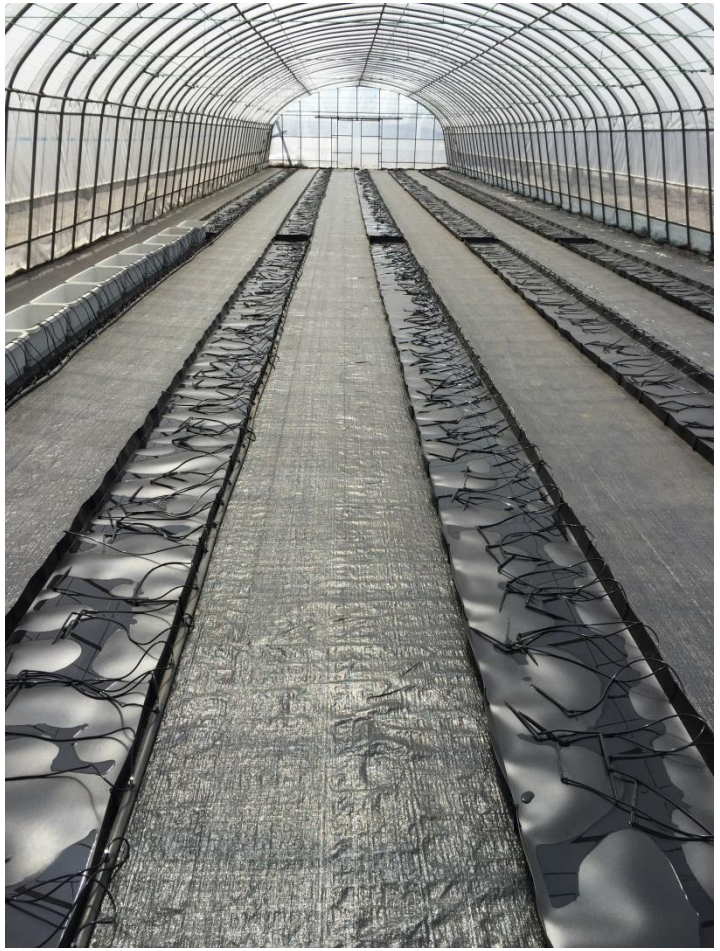
Seedling Culture



A good beginning is half done.


C7
C6
B6
B7

Preparing medium culture system



Transplanting

- Good quality transplants are essential to a good greenhouse crop.
- With tomatoes, the seedling should be set into the bed with some of its stem below the bed surface.
- Irrigate the plants as soon as possible after they are set.
- Properly set plants will not wilt after transplanting.

Irrigation System

Drip irrigation

Formulae of Tomato (based on pure water)

Nutrient	Formulae（ppm）		
	Transplant-First truss flowering	First truss flowering -fifth truss flowering	Fifth truss flowering-
NO_3^-	220	220	220
NH_4^+	20	20	20
$H_2PO_4^-$	40	50	50
K^+	340	370	380
Ca^{2+}	210	240	190
Mg^{2+}	60	70	70
SO_4^{2-}	80	80	80
Fe	2.5	2.5	2.5
Mn	0.8	0.8	0.8
B	0.33	0.33	0.33
Zn	0.33	0.33	0.33
Cu	0.15	0.15	0.15
Mo	0.05	0.05	0.05

Irrigation strategy

- Irrigation starting time :1 hour after sunrise
- Irrigation stopping time : 1∽2 hour before sunset
- Irrigation frequency:
  (1) timer-based; (2) sensor-based
- Water volume per irrigation:
  (1) look and feel; (2) timer-based; (3) sensor-based

Training and Pruning

- Tomato plants are usually pruned to a single stem, removing all side shoots (suckers).
- Double-stem plants applied when the seeds are very expensive.
- Pruning affects the density.

Single stem plants

Double-stem plants

Training and Pruning

Tomato is herbaceous plant.

- Supporting tomato plants by using strings.
- Attach the string to a cable above the plant row.

Training and Pruning

- Optimal leaf numbers: 15-17 functional leaves/plant
- Removing old and unhealthy leaves.
- Pruning involves the removal of small fruits from the cluster, leaving 4-6 best fruits of uniform size.

Training and Pruning

Topping plants

- According to the crop cultivation schedule.

  Short cycle: 4-8 clusters

  Long cycle: 20-30 clusters

- Leave 2 leaves above the highest cluster to shade the fruit and prevent sun scald.

Pollination

- Tomatoes are self-pollinated; pollen from a flower pollinates the same flower.
- Outdoors, wind assists in pollen dehiscence, but in the greenhouse, the flowers must be vibrated.
- Pollination is achieved by vibrating the flower cluster for a second or two manually or with some sort of electric vibrator.
- Without vibration, poor fruit set, shape, and size could result.

Bumblebee Pollination

Certain species of bumble bees have been used in greenhouses for pollination. These bees are commercially cultured and supplied to the grower.

Increased yield and fruit quality

Diseases and pests control

- Increase the immunity of vegetables
- Physical control
- Biologic control
- Chemical control

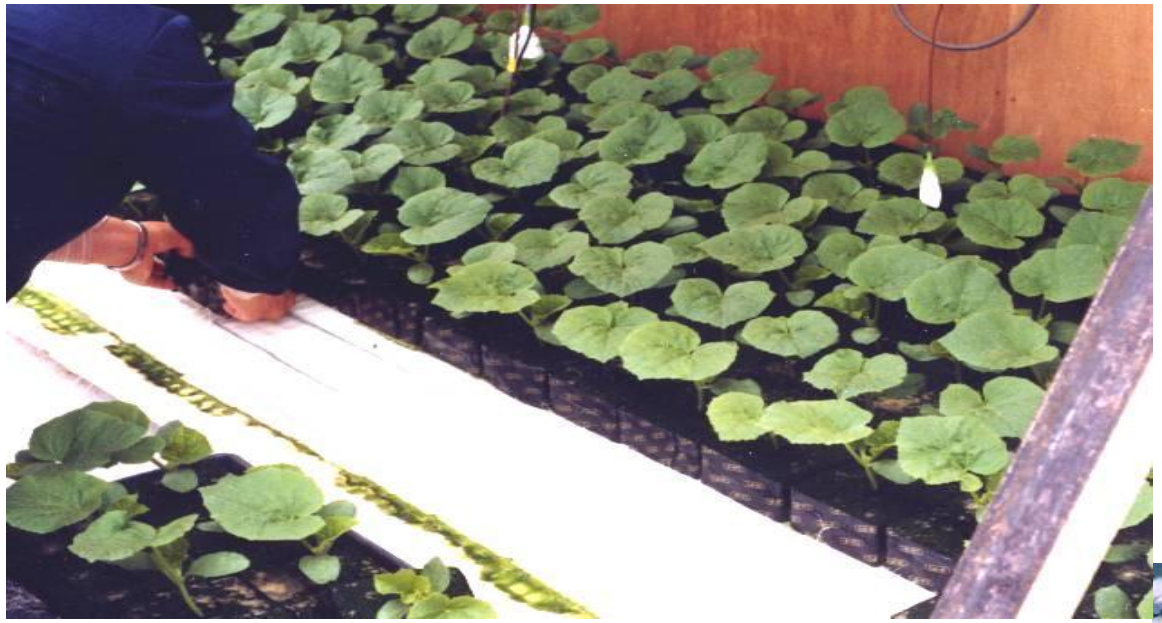
Preventing is the most important.

3. Medium culture cucumber (Preformed materials)

Sowing

(Grodan,2003)

Cucumber seeds can either be placed directly into a pre-moistened 10 cm rockwool block with a 15 mm deep hole, or they can be placed into a propagation cube which is later transplanted into a 10 cm rockwool block.



Seedlings

During the initial propagation phase, the plants can be placed block tight. As the plants increase in size, they should be spaced accordingly so that spatial competition is minimized.

Greenhouse and installation preparation

- The soil needs to be profiled to give a very gentle slope along the length of the bed to channel water to drainage ditch or pipe.
- If the slabs are placed on the ground, the complete area of soil in the greenhouse is better to be covered with polythene film after the soil has been profiled.

(Grodan,2003)

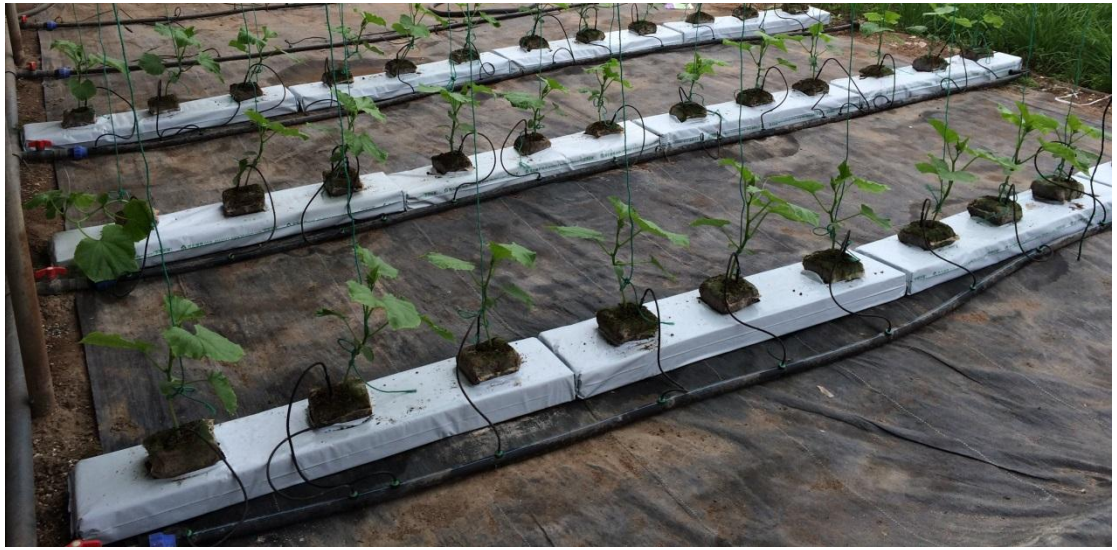
Greenhouse and Installation Preparation

- Choose a drip irrigation system of good quality that produces an even distribution of water.
- In recent years, rockwool slabs have been placed in various types of gutters laid on the greenhouse floor.
- Single rows of rockwool slabs are evenly spaced across the greenhouse 1.5-2 meters apart. The dimensions of each slab are 100×20×7.5cm. The slabs are laid down, end to end, in a single row.
- **All the slabs should be totally saturated with nutrient solution before transplanting.**

Seedling Ready for Transplanting

When seedlings have 3-4 true-leaves, they can be transplanted.

Transplanting



Put the seedling blocks onto the slabs, each slab has three plants. There is no disturbance to the root system during the transplanting.

Training and Pruning

As the plants grow they are trained upward to the overhead wires.

Feed Formulae for Different Phases of Cucumber Production in Rockwool. (Sonneveld and Straver, 1994)

Nutrient	Feed formulae (mg/l)		
	Phase I (0-7 weeks)	Phase II (7-11 weeks)	PhaseIII (11+ weeks)
NO_3	190.0	246.0	213.0
NH_4	17.5	17.5	17.5
P	39.0	39.0	39.0
K	270.0	345.0	293.0
Ca	185.0	210.0	170.0
Mg	33.0	33.0	36.0
SO_4	228.0	195.0	132.0
Fe	2.3	2.3	2.3
Mn	0.55	0.55	0.55
B	0.4	0.4	0.4
Zn	0.3	0.3	0.3
Cu	0.05	0.05	0.05
Mo	0.05	0.05	0.05

pH and EC

- During the whole growing period, cucumbers like a pH range from 5.5 to 6.5.
- At the time of seeding the cucumbers in the block, the EC is 1.2-1.8 mS/cm. After transplanting, EC is adjusted according to different conditions.

  Summer: the EC should be lowered. (2-2.5 mS/cm)

  Winter and early spring: light intensity and temperature are low, the EC in the slab can be raised.(2.3-2.6 mS/cm)

Check the nutrient solution

- After each feeding, some nutrient solution (referred to as leachate) should drain from the bottoms of slabs. If there is no leachate, the plants are probably not getting enough water.
- Check the EC of the drip solution and leachate. The EC of the leachate should be fairly close to the EC of the drip solution.
- The pH and EC of drip solution is better to be measured daily to ensure that the irrigation equipment is working accurately.

Coir culture

Coir has been produced in the same shape of Rockwool blocks and slabs. Tomatoes grown in coir compared very well with those grown in Rockwool.

Common problems

Yellow leaves

Yellowing leaves can be caused by several situations.

1) Low nitrogen or potassium or magnesium
   - Nitrogen deficiency shows up as a general yellowing of the entire plant.
   - Potassium deficiency will appear as bright yellow leaf margins (edges) on otherwise green leaves.
   - Interveinal yellowing on older leaves is from low magnesium.

2) Shading - As the plants mature, the bottom leaves get heavily shaded and naturally turn yellow as they senesce (age). Any yellowing leaves are no longer productive and should be removed to improve air circulation.

3) Diseases.
   - Early Blight (fungus)
   - Virus (such as yellow leaf curl virus)

Other reasons……

For all suspected nutrient problems, a tissue analysis is recommended.

Common problems

Why do the plants get flowers, but don't get fruit?

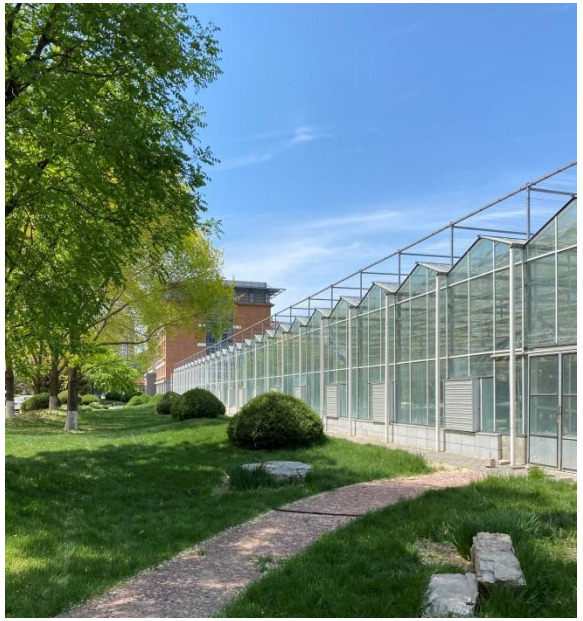
Any kind of stress on the plants can prevent fruit set.

1) Temperature too high
2) Temperature too low
3) Drought stress
4) Using too much nitrogen - this often creates very healthy, lush, dark green plants, but few flowers or fruits;
5) Salt stress - if the EC in the root zone is too high.
6) Other than stress conditions, it is important that flowers be pollinated every other day to get good fruit set.

Tomato yellow leaf curl virus

Malformed fruits (low temperature)

Conclusion



Environmentally friendly

Good quality and high yield

Clean and comfortable

Thanks to:

- **WFP Centre of Excellence for Rural Transformation,**
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Thank You

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