The production of transplants
Chapter 2: The practice!

Climax Conseils
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CLIMAX CONSEILS
Experts en production maraîchère sous serre

Recall

- In chapter 1: we saw…
  - Choice of resistant cultivars
  - Calculation of quantities and propagation space
  - The propagation calender
  - Equipment and facilities

Goals

- Reduce heating costs between planting and harvest:
  - By ensuring that the plants will be as advanced as possible before planting, while the heating costs per plant are minimal.
  - Ensure that the plant will establish itself as quickly as possible following planting because of its leaf development, which will be able to support aerial and root growth simultaneously.

Program chapter 2

- 1- Determine the stages
- 2- Parameters to control
  - Temperature
  - Watering
  - Acclimatization
  - Spacing
  - EC
  - Humidity
- 3- Tables of parameters by crop
- 4- Preparation: running in the systems
- 5- Hot water seed treatment

Program (continued)

- 6- Prevention of diseases and insects
- 7- Filling cells and pots
- 8- Watering tools
- 9- CE reading methods
- 10- Pinching method (double head)
- 11- Fertilization of seedlings and transplants
- 12- Soil preparation
- 13- Getting in the greenhouse
- 14- Planting and rooting

1- Cultivation stages

- For each stage, certain parameters are different, and also for each culture.
  - Let's first define the stages.

1- Stages of cultivation: from sowing to emergence

- We are talking here about the moment between the planting of the seed and the emergence; that is, until the cotyledons are deployed.
- It is here that lighting becomes necessary: 40W/m2 in the PAR in the seedling chamber: as soon as the germ becomes apparent.

- **The recommended temperature at this stage is that of the potting soil.**

1- Cultivation stages: from emergence to transplanting

- We are talking here about the moment between emergence (cotyledons deployed) until transplanting.
- **The recommended temperature at this stage is the temperature of the air in the seed chamber.**

1- Stages of cultivation: transplanting

- Transplanting: 1st leaf have reached 4 cm.
- The root ball should stand to be transplanted.
- There is no transplanting in the cucumber,

1- Cultivation stages: spacing

- As soon as the plants touch each other, space them out to give them all the light they need and avoid etiolation (stretching).
- We space only once to limit the working time.
- Aim for 12 heads per square meter of table surface.

1- Stages of cultivation: getting in greenhouse

- Get in the greenhouse (before planting) as soon as the plants touch each other: space them out to give them all the light they need and avoid etiolation.
- Usually one week before planting stage: about 6-8 true leaves.

1- Stages of cultivation: planting

- Planting: we want enough roots and a well-developed leaf area.
  - Tomato: 8-10 true leaves or first flower open at 50% of plants
  - Cucumbers: 4-5 true leaves
  - Peppers: First Y clearly visible
  - Eggplants: 12 inches tall

Ontario plant propagator limited

alibaba.com

2- Parameters to control

- 24 h Temperature
- Watering
- Acclimatization
- Spacing
- EC
- Humidity

2- Parameters to control: Temperature 24h

- For spring sowing which has natural light from the transplanting stage.
- Respectable range from targets:
  - Being 1-2 degrees below the targets will result in strong plants
  - Being 4-6 degrees below targets will make plants too vegetative and increase costs. You will heat a little, for a long time, without result!
- No day/night difference during this period: we are aiming for vegetative development.

2- Parameters to control: 24 h Temperature

- Why is it important to heat at night?
  - Unclog the sugars accumulated in the leaves will assure plant growth
  - Assure optimal photosynthesis the following day
  - Reduce cell elongation: the sugars in the leaves attract water by root pressure
  - Avoid edema and guttation due to lack of sweating

2- Parameters to master: Watering

- Aim for balance in the availability of water and air in the potting mix.
- As the transplants grow, you can dry out more and more between waterings .
- It is necessary to follow the evolution of the roots:
  - if they are on the surface, we oscillate between humidity and dryness on the surface
  - if they are at the bottom, we dry to the bottom

2- Parameters to master: Watering

- Tray weight technique makes watering timing decision more rational. Example:
  - Weigh an empty tray and record its weight. Ex: 50 g.
  - Weigh a tray that has been well watered about an hour after it has finished dripping = 100%. Ex: 1200g. Note this number.
  - It is considered that dry peat is worth 10% of the weight at its maximum water retention. So here: 1200g x 10% = 120g (10%)- 50g (tray) = 1030g water content. To note.
  - The maximum quantity of water in the tray is therefore:
    - 1200g – 120g (dry peat)- 50g (empty tray) = 1030g water content.
  - In post-emergence, a maximum drying of 30% is recommended. (1030 g * 30% = 309 g) So we should water no later than 890 g. (1200g –309g = 891g)
  - In growth, we recommend a maximum dryness of 50%. (1030 g * 50% = 515 g) So we should water no later than 685 g. (1200g – 515g – 685g)
- Good technique for both trays and pots.

2- Parameters to master: Watering

- A time (number of seconds) is generally used to create an even watering.
- Beware of the borders: the peripheral cells of a board of 72 correspond to 44% of the tray...!
- Validate that the watering time is sufficient for the water to go down to the bottom.
- 1x out of 3, aim for a light dripping to rebalance uniformity.
- Water from above.
- No soaking: danger linked to the transmission of diseases.

2- Parameters to master: Watering

- Sufficient supply of air to the roots (drying out) will help create a strong root system:
  - in hydroponics, promote "air pruning " by drying the root tips so that they branch out.
  - in peat, oxygenate the young roots in the center of the pot to stimulate branching.
- This root ball will "grip" the ground much faster!

2- Parameters to master: Watering

- Possibility of installing drippers with French capillary.
- Pay attention to the flow/pressure.

2- Parameters to master: Acclimatization

- Vigilance when the transplants move from one environment to another or even from one light intensity to another!
- Avoid wilting by drying or heat:
  - the watering tools and ventilation must be ready and working before the plants arrive in the nursery!
- If the transplants spend a long time under artificial lighting only: a shade tarp can be a good option.

2- Parameters to master: Spacing

- Objective: never touch for a uniform distribution of light and avoid etiolation.
- The appearance of the first flower cluster will be earlier, therefore the production: it is played very early!

2- Parameters to control: Electrical conductivity (EC)

- EC = measurement of the mineral content of the soil solution
- Different targets according to the stages of growth (see tables)
- Too high:
  - Higher osmotic pressure makes access to water more difficult (young roots are more sensitive to it than mature roots)
  - Very dark and withering plants,
- Too low:
  - Risk of lack of food (deficiency)
  - Turgidity will creates fragile plants
  - Weak, pale and etiolated plants

2- Parameters to control: Air humidity

- Low humidity is felt as cold by the transplants:
  - this is why we will space out gradually to create a microclimate in the foliage zone.
- Problem seen with winter sowing or in seed chambers.
- Remember to wet the soil 3x a day if the relative humidity drops below 50%.
- In the greenhouse nursery, in the spring, it is much less of a problem.

3- Table Tomatoes in a diversified greenhouse

Organic TOMATOES for spring sowing					
Stage	**From sowing to emergence**	**From emergence to transplanting**	**Transplanting**	**Spacing**	**Greenhouse/planting**
Stage	seed sown	Sprouted seedlings	When the 1^{time} real leaf at 4 cm	As soon as the leaves touch	**As soon as leaves touch / planting when 25-50% of plants have an open flower**
Density (plants/m2)	410	410	43 pots (or 86 double heads)	12	2.7 - 3.5
24 h temperature	**25-27°C potting soil**	22-26°C AIR	22-25°	22-25°	21-23°
RH (DH)*		70-85% (3-5 g/m3)	70-85% (3-5 g/m3)	60-80% (3-7 g/m3)	60-80% (3-7 g/m3)
EC in the substrate in organic/soil	**0.5-1mS**	**1.0-1.5mS**	**1 - 1.5mS**	**2.0-2.5mS**	**2.5-3.0mS****
Irrigation	Prevent seeds from drying out	Maximum drying of the substrate: 30%	Maximum drying of the substrate: 50%		
Particularities	Cover lightly with vermiculite or fine potting soil.			Beware of the drying out of larger plants, sometimes you have to re-water before nightfall to avoid being too dry the following morning.	

Notes:

* young plants are able to withstand lower humidity. It is seen in greenhouses with young plants in April. The DPVs can be much higher and they do just fine. As long as the water is adequately supplied.

** Direct reading in the pot solution AND in 2:1 in the soil at planting

3- Table Cucumbers

Organic CUCUMBERS for spring sowing					
Stage	**From sowing to emergence**	**From emergence to 2 nd leaf**	**Growth**	**Spacing**	**Greenhouse/planting**
Stage	seed sown	seedlings		As soon as the leaves touch	**4-5 true leaves**
Density (plants/m2)	98	98		12	1.6-3 depending on type and tutoring
24 h temperature	**28°C potting soil**	23-26°C AIR	25-28°	25-28°	21-23°
RH (DH)*		70-85% (3-5 g/m3)	60-80% (3-7 g/m3)	60-80% (3-7 g/m3)	60-80% (3-7 g/m3)
EC in the substrate in organic/soil	**0.5 -1mS**	**1.0 - 1.5mS**	**1.8-2.2mS**	**1.8-2.2mS**	**1.8-2.2ms****
Irrigation	Prevent seeds from drying out	Maximum drying of the substrate: 30%	Maximum drying of the substrate: 50%		
Particularities	Cover lightly with vermiculite or fine potting soil.			Beware of the drying out of larger plants, sometimes you have to re-water before nightfall to avoid being too dry the following morning.	

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** Direct reading in the pot solution AND in 2:1 in the soil at planting

3- Particularities: Cucumbers

- Direct sown cucumber in 4 inch pots.
- Sensitivity to high salinities (high EC)

3- Peppers Table

Organic PEPPERS for spring sowing					
Stage	**From sowing to emergence**	**From emergence to transplanting**	**Transplanting**	**Spacing**	**Greenhouse/planting**
Stage	seed sown	seedlings	At the 1^{time} true leaf	As soon as the leaves touch	**First Y clearly visible**
Density (plants/m2)	410	410	86	15	2.8 - 3.6***
24 h temperature	**25-26°C SOIL**	24-25°C AIR	23-26°C	23-26°C	22-23°C
RH (DH)*	100%	70-85% (3-5 g/m3)	70-85% (3-7 g/m3	70-85% (3-7 g/m3	60-80% (3-7 g/m3)
EC in the substrate in organic/soil	**0.5-1.0mS**	**0.5-1.0mS**	**1 - 1.5mS**	**1.5-1.8mS**	**1.5-2.0mS***
Irrigation	Prevent seeds from drying out	Maximum drying of the substrate: 30%	Maximum drying of the substrate: 50%		
Particularities	Cover lightly with vermiculite or fine potting soil.			**Avoid stretching and tight plants. Causes lower leaves to drop.**	**A larger plant at planting will have better fruit set.**

Notes:

* young plants are able to withstand lower humidity. It is seen in greenhouses with young plants in April. The DPVs can be much higher and they do just fine. As long as the water is adequately supplied.

** Direct reading in the pot solution AND in 2:1 in the soil at planting

*** In pots: the 2nd head starts from the first V.

3- Eggplant Table

Organic EGGPLANTS for spring sowing					
Stage	**From sowing to emergence**	**From emergence to transplanting**	**Transplanting**	**Spacing**	**Greenhouse/planting**
Stage	seed sown	Sprouted seedlings	At the 1^{time} true leaf	As soon as the leaves touch	**Size: 25-30cm**
Density (plants/m2)	410	410	86	15	2.1 to 4.2 ***
24 h temperature	**26-27°C Soil**	23-26°C AIR	23-26°C	23-26°C	22-23°C
RH (DH)*		70-85% (3-7 g/m3	70-85% (3-7 g/m3	70-85% (3-7 g/m3	60-80% (3-7 g/m3)
EC in the substrate in organic/soil	**0.5 -1mS**	**1.0 - 1.5mS**	**1.8-2.2mS**	**1.8-2.2mS**	**1.8-2.2ms****
Irrigation	Prevent seeds from drying out	Maximum drying of the substrate: 30%	Maximum drying of the substrate: 50%		
Particularities	Cover lightly with vermiculite or fine potting soil.			Beware of the drying out of larger plants, sometimes you have to re-water before nightfall to avoid being too dry the following morning.	

Notes:

* young plants are able to withstand lower humidity. It is seen in greenhouses with young plants in April. The DPVs can be much higher and they do just fine. As long as the water is adequately supplied.

** Direct reading in the pot solution AND in 2:1 in the soil at planting

*** In pots: e 2nd head appears once in the greenhouse; and according to the caliber by choosing a sucker under a flower.

3- General features

- Covering with vermiculite or fine potting soil at the start helps maintain the surface humidity of the trays without over-watering.
  - A layer of about 3 mm is sufficient
- In a diversified greenhouse, one will follow the climate of the main crop (usually the tomato) and the others will adapt.
  - In spring sowing, we have enough light: we do not manage the temperature to the nearest joule!
- The EC is the element that must be particular to each.
- Be careful when watering the pots when the plants are large: sometimes you have to re-water a small amount in the afternoon to avoid getting too dry the following morning.

4- Preparation: running the systems

- Before sowing: have you tested your equipment?
- Make sure your potting soil is the right temperature before you start.
- Validate that your heating is capable of maintaining the requested temperature at night.

5- Hot water seed treatment

- The hot water treatment is mainly used to prevent the risk of bacterial diseases from seed (bacterial canker).
- The treatment makes it possible to reach the bacteria present inside the seeds.
- Delays the moment of contamination (less damage in harvest)
- Be aware! Primed seeds cannot be treated in hot water. Check with your retailer. It's often the case specialy for rootstocks.

- b01so09pdf (agrireseau.net)

6- Prevention of insects

- Main active insects in the soil
  - Thrips
  - Sciarids
  - Shore flies

  - Control preventively with:
    - *stratiolaelaps scimite*
    - *Gaeolaelaps gillespiei*
    - *Nemasys steinernema feltiae*
  - They are introduced 2 to 3 weeks before planting. Remember to place your order on time!

6- Disease prevention

- It is strongly recommended to colonize the soil with *trichoderma harzianum* (Rootshield) against *Fusarium* , *Pythium* and *Rhizoctonia* .
- Can be used as pellets in the potting mix and the soil or into a wettable powder by watering.
- Can be done on the ground during cultivation or through the irrigation system.

7- Moistening the soil

- Moisten the soil before filling the containers to avoid overwatering initially and compressing the soil.
- Properly moistened soil springs back into shape when compressed in the hand.
- It should not be made to lose its porosity.
- Avoid filling cells and pots too far in advance and stacking them.

7- Filling cells and pots

- Trays: we want to see the edge of the plastic seperating the cells!
- Shake the tray once and remove the over: do not tap too much, the substrate must remain light
- Leave 1/8 inch of soil free to prevent water runoff when watering.
- Pots: fill to the line, leave room for watering and add solid fertilizers during culti

8- Watering tools

- Mist is used for sowing but after the cotyledon stage, it is risky to damage the foliage.
- Switch to the spray handle with a low-flow shower head.
- Have a valve to adjust the flow: watering is the key to beautiful transplants!

Aim for uniformity in everything!

- Filling the trays
- Sowing depth
- Watering
- Temperature and climate
- Spacing

    - The greenhouses that have the best yields are uniform!

9- EC and reading method: 2 possible methods.

- In multi cells or in pot: pee juice method
- Post-planting in soil: 2:1 method

9- EC and reading method: pee juice method

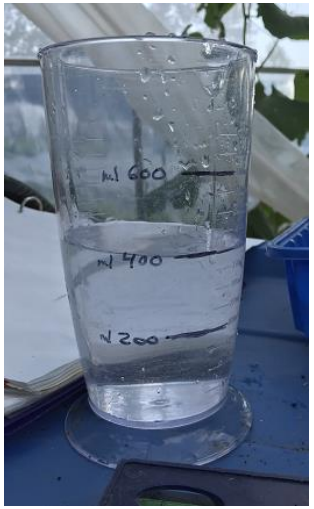
- In multi cells and in pots
- 1 hour after watering
- Take a small amount of potting soil and compres a clean container.
- Have clean hands or wear gloves.
- Take the reading directly.

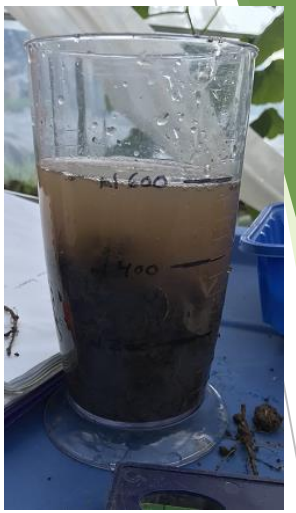
9- EC and reading method: 2:1 method

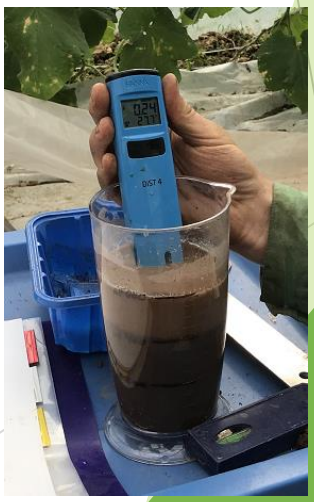
- In the ground
- When the ground is wet
- Take 4-6 soil samples from the root zone to a depth of 15-20 cm, having previously removed the first 1 cm of soil containing the fertilizers.
- Beware of contamination by soluble fertilizers, this can distort your data!
- Mix the bulk sample in a clean container

9- EC and reading method: 2:1 method

- Use a clean graduated container.
- Fill with 2 parts distilled water.
- Add the soil sample to make it to 3 parts.
- Stir well and wait 30 minutes.
- Stir again and wait 5 minutes for the suspensions to fall.
- Take the reading in the supernatant, and multiply by 1.8.







10- Pinch methods / double head (tomato)

- Three possibilities:
  - To the cotyledons
  - At the 3rd leaf
  - Sucker under the first cluster

10- Pinch methods / double head (tomato)

- To the cotyledons
- Allows you to position the plants in a V: one head on each wire.

10- Pinch methods / double head (tomato)

- At the 3rd leaf
- Allows you to position the plants in a V: one head on each wire.

10- Double head

- Use the sucker under the first cluster
- The 2 heads will then be hung on the same wire.
- This method is also used for eggplants.

10- Pinch methods / double head (tomato)

2 stems at the level of the 1st and 2nd leaf	2 stems at the cotyledons	2nd stem initiated under the first bouquet
ADVANTAGES		
ÿ It's easier to get the suckers out at the level of the true leaves vs the cotyledons. ÿ Faster technique to obtain 2 stems in the nursery vs cotyledons. ÿ Generative system which gives the first bouquet very low on the 2 stems. However, if the light is poor, it is necessary to reduce the number of fruits on the first cluster.	ÿ The two stems are very equal and the plants are very uniform. ÿ Generative system which gives the first bouquet very low on the 2 stems. However, if the light is poor, it is necessary to reduce the number of fruits on the first cluster.	ÿ The period of preparation of seedlings in the nursery is the shortest. ÿ No risk of splitting the rootstock at the level of the initiation of the 2 stems, because the 2nd stem is initiated higher up on the plant.

10- Pinch methods / double head (tomato)

2 stems at the level of the 1st and 2nd leaf	2 stems at the cotyledons	2nd stem initiated under the first bouquet
DISADVANTAGES ÿ		
The period for the preparation of the seedlings is longer by approximately 5 to 7 days. ÿ There is a risk that the stems will not be equal if the emergence of the suckers is not simultaneous or if the spacing of the plants in the nursery is not uniform. ÿ There is a risk that the rootstock will split under the 2 stems, because the stems are normally lowered in opposite directions. This slot will become a favorable place for the development of certain fungal diseases *(Botrytis, Fusarium)*. To reduce this problem, the 2 rods should be tied as low as possible.	ÿ Especially if the light is poor, the emergence of the suckers at the cotyledons can take a long time. The nursery period is the longest, 7-10 days longer. ÿ There is a risk that the rootstock will split under the 2 stems, as the stems are normally lowered in opposite directions. This slot will become a favorable place for the development of certain fungal diseases *(Botrytis, Fusarium)*. To reduce this problem, the 2 rods should be tied as low as possible.	ÿ There is a risk that the stems will not be equal if the exit of the sucker under the 1st bunch is not well done. The head of the plant should always be lowered in front of the sucker. ÿ The first harvest may be less abundant, because the first bunch of the 2nd stem will come out later.

Adapted from:
https://www.agrireseau.net/legumesdeserre/documents/TPno2_greffage_d%C3%A9c_05.pdf

10- Double Head Methods

- In the case of peppers, the double head will be done with the first Y.
- For eggplant, keep the sucker under the first flower.

11- Organic fertilization

- Organic fertilizers require time to mineralize and become assimilable to the plant.
- It is necessary to anticipate drops in EC to supply the plant continuously.
- The EC reading of seedlings and transplants should be measured every 2 days to respond adequately.
- It is necessary to provide a reserve of fertility in the pot for the rooting period.
- Have some fertilizers on hand to be able to react to fertility declines as needed: Fish emulsions / Liquid algae / Actisol small pellets.

11- Fertilization of seedlings

- Fish emulsion or liquid seaweed:
  - Chose a product that contains all 3 elements NPK priorising N.
  - The doses vary from 5 to 25 ml/litre of water depending on the product: always read the labels!
  - Acts directly on leaves or at the roots.
  - Short term: 2-3 days

11- Fertilization of transplants (pots)

- Actisol (5-3-2) in small pellets
  - 1 tablespoon (15 ml) per 6 inch pot
  - 10 ml for 4 inch pots (cucumbers)
  - Must not be in direct contact with the stems.
  - Must be wet to mineralize to be assimilated by the plant.
  - Delay of 3 to 7 days to act.
- Fish emulsion or liquid seaweed
  - Used while waiting for solid fertilizer mineralization
  - Acts directly on leaves
  - 5 to 25 ml/ liter of water depending on the product: read the labels!

12- Soil preparation

- Tillage: Rototiller, rotary harrow and/or broad fork
  - Aim for max 10-12 inches of loose soil for roots to establish easily.
  - Caution soil heating pipes.
  - To incorporate recommended starting intake based on standard analysis.

12- Soil preparation

- Raised beds?
  - Only if special drainage is needed.
  - More disadvantages along the season.

12- Soil preparation and fertilization

- The soil should be ready to take over when the roots come out of the pot!
- Pre-planting fertilization:
  - The first dose of the fertilization plan should be applied a week in advance to ensure that it is available to the roots when they need it.
  - To mineralize, the fertilization must be wet and the soil must be warm enough!

12- Soil preparation: minimum soil temperatures

- Tomato: 18ºC
  - K deficiency
- Cucumber: 20ºC
  - If < Risk of Pythium
- Peppers: 20ºC
- Eggplant: 20ºC

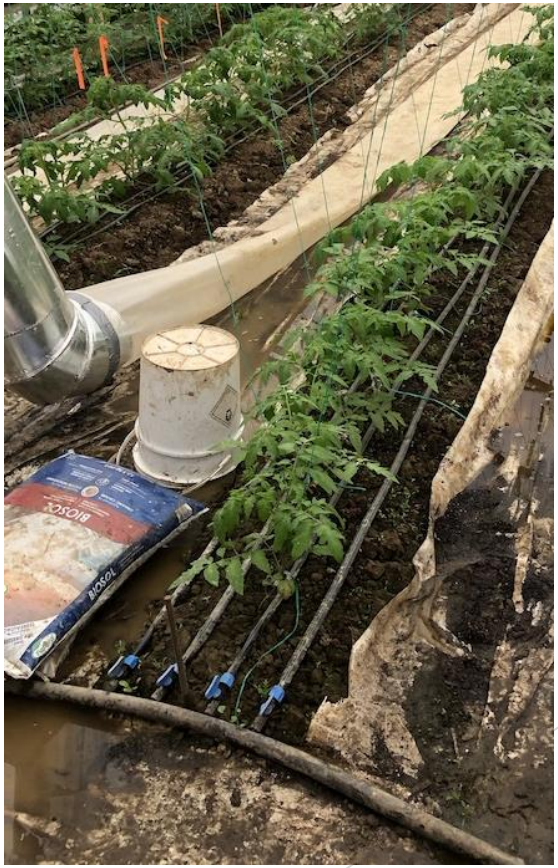
- If planting at the end of April and later, no need for soil heating normally.
- Transparent tarp:
  - Good for Temperature;
  - But zero for weeds!

13- Getting in greenhouse before planting

- It is possible to do much of the establishment before planting:
- Place the pots on wooden slats
- Install 2 drips on the pots held by skewers
- Tie the ropes to the plants, leaving a slack in the rope to provide for the descent of the pot into the ground.

13- Positioning of the irrigation system:

- 4 drip tape per bed each with manual valves
  - 2 on each side
  - Sometimes 3 + 1



13- Positioning the plastic ground cover

- white on black
  - Braided vs Plastic
  - Width
- U anchor
- Purpose:
  - Promote the mineralization of fertilizers
  - Avoid evaporation of soil moisture
  - Avoid the development of weeds
  - Avoiding thrips pupation

14- Planting and rooting

Planting consists of putting the roots in the ground.

- Press just enough to create contact between the roots and the soil.
- Cover lightly: you should not see the bare roots.
  - Be careful not to bury the neck of the cucumbers!
  - Be careful not to bury the grafts!

14- Planting and rooting

- Watering is CRUCIAL at planting and in the days that follow.
- The soil must be wetted beforehand to prevent it from pulling water from the root ball by capillary action.
- We bring water to the roots and not the other way around!
- The center drip should be OVER the root balls, as long as the roots do not come out of the pots.
- We will reposition the drip as the roots develop.

14- Planting and rooting

At planting:

- The 24h temperature will be reduced by 1-2 degrees C for a few days.
  - We can increase them again as soon as the crown of roots is 1 inch all around the root ball.
- The day/night intervals will begin one week after planting.

Thanks!

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Reviewer: Jacques Thériault

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