



## Module 6: Cultivation Technics for Horticulture Crops (cont'd)

### Popular Crop selected by SHEP Farmers: Onion Cultivation



#### 1) Introduction

- Onion is widely used in Zambia as a vegetable in soups, seasoning and fast foods. It is a good source of vitamin C, folate (B9), B6, potassium and sulphur.
- The crop performs **better in the cool season** and grows best in sandy loamy soils.
- In Zambia, only adaptable **short-day cultivars** should be grown because the crop is sensitive to day length.
- Onions make up the genus known as Allium, of the family called Liliaceae or Amaryllidaceae. The true onion is classified as *Allium cepa*, while the green onion or common leek as *Allium ampeloprasum*.

#### Contents

- 1) Introduction
- 2) Cultivation Environments
- 3) Cultivars Choice
- 4) Field Management
- 5) Pest and Disease Control
- 6) Harvesting and Storage

#### 2) Cultivation Environments

##### Appropriate Temperature

- From 15°C to 20°C.

##### Soil Condition

- Onions grow best in sandy loams, silt loams and such light soils
- Onions grow best in pH range 6.0 – 6.8
- Onions are fairly tolerant to alkaline conditions.
- Hybrid cultivars have low tolerance to acid soils.
- Onions grow best in full sunlight and well-drained soils.
- Onions **prefer fertile, loose, friable soil** that is well drained with lots of organic matter to extend the roots.

## 2) Cultivation Environments (cont'd)

### Cultivation Season

- The best crop is produced from planting **s between March and April**. Such a crop would mature between September and October, before the onset of the rainy season.
- Most onion cultivar **do not perform well in the rainy season in Zambia** due to a higher occurrence of pests and disease.

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## 4) Field Management

### ① Land Preparation

(Basal fertilizer, Broadcast Application)



## 3) Cultivars Choice

### Average yield, Maturation period and storage in Zambia

Cultivar	Days to maturity	Bulb yield (ton/ha)	Storage
Red granex	130	17	Poor
Henry special	131	33	Poor
Early lockyer brown	133	28	Poor
R 23 74	135	23	Poor
Tropic ace F1	138	27	Poor
Yellow granex F1	139	29	Poor
Texas early grano 502	143	29	Poor
Yellow dessex F1	145	33	Good
Red Creole	136	26	Good
Pusa red	150	35	Good

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## 4) Field Management

### ① Land Preparation

#### Basal Fertilizer

- In Zambia, 800kg/ha of 'D' Compound (**80g/m<sup>2</sup>**)
- It is advisable to use compound fertilizer containing sulphur due to its role in enhancing bulb keeping quality (shelf life) and pungency.
- 2kg/m<sup>2</sup> of manure should be broadcasted then mixed into the soil using a hoe.
- Manure/compost should be applied at least 1 – 2 weeks before transplanting
- Plough deeper than 30cm

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## 4) Field Management

### ②Nursery establishment and transplanting

#### Seed rate

- On average, 500 grams/ha (0.05g/m<sup>2</sup>) is recommended based on the spacing. The closer the spacing the more seed will be required, and the wider the spacing the lesser seed will be required.

#### Nursery

- Before transplanting, seedlings should have been growing on the nursery for about 6-8 weeks. Emergence takes place 5-10 days from sowing.
- Basal dressing fertilizer should be applied to the seedbed before sowing. Manure or compost may also be incorporated at 1.5-3.0 kg/m<sup>2</sup>. At about 2-3 and 4-6 weeks of age, the seedlings should be top-dressed with 35g/m<sup>2</sup> of ammonium nitrate.

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Photo: SHEP PLUS

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### ②Nursery establishment and transplanting

### ②Nursery establishment and transplanting

- Bed covered with a layer of clean-disinfected grass to reduce the effect of heat from the
- Water the seedbed using a watering-can to avoid seed splashing.
- First watering should be done to field capacity. Where the seed has germinated, one watering in the morning is sufficient. At no time should the beds be over-watered.
- Older seedlings should be watered 2 or 3 times a week only. Watering should be done regularly until the seedlings are **pencil size (until transplanting)**
- Under hot conditions, direct heat from the sun may lead to poor germination. It is advisable to **shed the bed with clean grass**. The shed should be at least 30cm above the ground and should be gradually reduced or removed to **harden-off** the seedlings once they have germinated.
- Seedlings are transplanted at 6-8 weeks old. In order to reduce losses at transplanting, seedlings should be **hardened** before being lifted from the bed.
- The seedlings should be watered thoroughly a day before transplanting.

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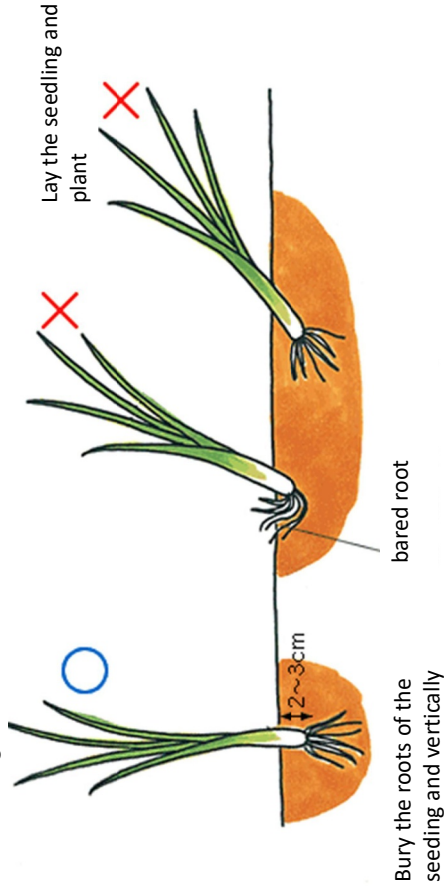


### ②Nursery establishment and transplanting

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## ②Nursery establishment and transplanting

How to transplant the seedling



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## ②Nursery establishment and transplanting

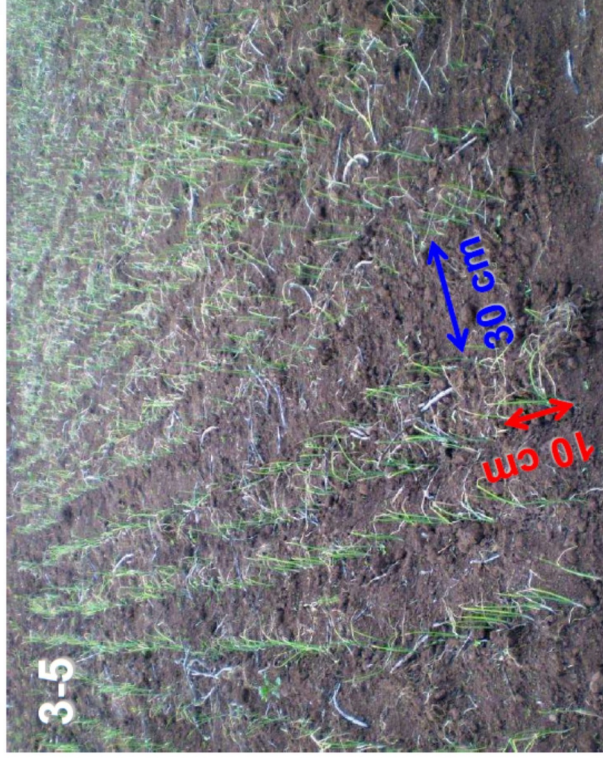


Photo: SHEP PLUS

## ②Nursery establishment and transplanting

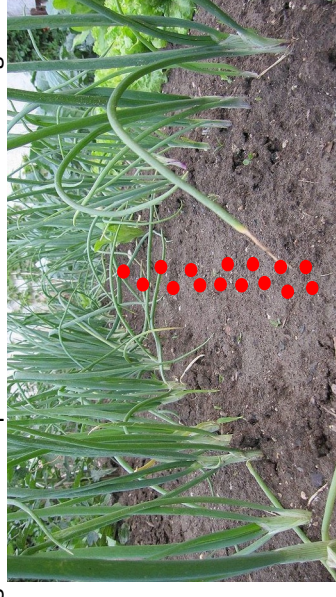


- Transplant during the morning or late in the afternoon when it is cool or on a cloudy day.
- When seedlings are 6-8 weeks old, they should be transplanted into the main field. Spacing in the main field may be affected by the objective regarding the desired bulb size. The bulbs are bigger when spaces are wider and small when the spaces are closer.
- The seedlings are transplanted in 2.5 – 3 cm deep trenches at a spacing of 30 cm between rows and 8 – 10 cm between plants (when using furrow irrigation) Irrigate field well a day before transplanting

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## ③Top-dressing

- The crop should be applied with a top dressing when they are 4-5 weeks old after transplanting.
- Apply ammonium nitrate at the rate of 200kg/ha (20g/m<sup>2</sup>) or Urea at 150kg/ha (15g/m<sup>2</sup>) during top dressing.
- In case of boron deficiency, apply borate at 5kg/ha.
- **Strip/banding method** is preferred over broadcasting as it is more effective
- Too much nitrogen results in thick necks
- Top-dressing should be completed before initiation of bulbing



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#### ④ Irrigation

- The crop requires frequent, light irrigations which are timed when about 25 percent of available water in the first 0.3 m soil depth has been depleted by the crop.
- Irrigation from emergence to full bulb size stage should be done at suitable intervals to keep the soil. Irrigation application every 2 to 4 days is commonly practiced.
- Irrigation should be withdrawn when the crop has started maturing (when 20-50% of the crop leaves fall).
- In heavy soils, light irrigation may be necessary to facilitate easy lifting of bulbs. Excessive irrigation and nitrogen are known to reduce storage life of onions.
- Recommended amount to irrigation water for one square meter of land is one bucket of 15 liters.

#### ⑤ Weed control

- Shallow cultivation (strictly not deep) by hoe in between rows is recommended. Care should be taken not to damage bulbs during weeding. Recommended herbicides can also be used.

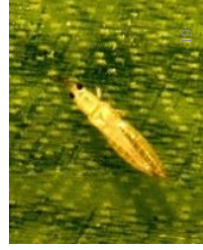
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## 5) Pest & Disease Control

### Insect Pest

#### Onion Thrips

- When the insect feeds on the surface of young leaves, white dots appear. If the damage is severe, plants wither.
- Considerable damage can be observed at the early growth stage of plants.
- The incidence of the insect tend to increase at high temperature and in the case of light rain.
- It was also shown that the insect populations increased when the content of soil nitrogen was high and the contents of soil phosphate and potassium were low.



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## 5) Pest & Disease Control

### Insect Pest

- The most problematic is the **onion thrip**, classified as Thrips tabaci of the order Thysanoptera. These are small greenish insects that suck the cell sap from the leaves of onion. Infested onion leaves develop whitish-grey spots that they appear as if they have been splashed with soil. The attack is often severe during the hot and dry season in Zambia.



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## 5) Pest & Disease Control

### Insect Pest

#### Onion Thrips : Control

- Weeding to remove their habitat.
- Stopping the fertilizer which contains high nitrogen.
- Practice crop rotation.
- Sow early (right after the rainy season).
- Avoid moisture stress by regular irrigation.
- Isolate the new from the old crop.
- Apply any systemic insecticide; Endosulfan 50% wp, Malathion 50% ec, 100 gs/100 lts water.



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## 5) Pest & Disease Control Disease

- The most common is **purple blotch**, which is a fungal foliar disease. The disease is manifested by the blotching of the leaves. The disease occurs mainly in rainy season.

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## 5) Pest & Disease Control Disease

### Purple Blotch: Control

- Practice crop rotation.
- Use of resistant variety such as Red Creole.
- Reduce plant density.
- Apply fungicide named "Luna Experience 40% SC" 100cm<sup>3</sup> mixed with 100 liters of water.
- Apply fungicide named "Chlorothalonil", "Mancolanxl" or "Ben late".



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## 5) Pest & Disease Control Disease

### Purple Blotch

- The disease affects leaves and flower stalks.
- Lesion are ellipsoidal or spindle shaped, 1-3 cm in size, slightly sunken with a pale brown margin.
- The disease spreads **at the late stage of growth** when plants become weak or in case of nutrient deficiency.
- High temperature and abundant precipitation on conducive to the disease occurrence.



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## 5) Pest & Disease Control Disease

### Downy Mildew

- The fungus disease affects leaves and flower stalks.
- Yellow and large ellipsoidal or spindle shaped lesions appear on old leaves and flower stalks.
- This disease mainly occurs if the **precipitation is abundant**.



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## 5) Pest & Disease Control

### Disease

#### **Downy Mildew : Control**

- Practice crop rotation.
- **Pick up and burn it the infected crop.**
- Cultivate in land which has a proper drainage system and applies the proper amount of fertilizers and irrigation water.
- Spray with one of the following recommended fungicides.

Pesticide	Amount
Acrobat Mancozeb 69% WG	250 gm/ 100 litres of water
Tazolen 72% WP	250 gm/ 100 litres of water
Ridomil Gold Plus 71.5% WP	200 gm/ 100 litres of water



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## 6) Harvesting & Storage

### Curing

- Allow the onions to dry for **two to three weeks or until the tops and the necks feel dry to the touch and the outer onion skin is shrinking and papery.**
- Curing is a process intended to dry off the necks and outer leaves of bulbs
- The main objective is to prolong shelf life by preventing moisture loss and attack by diseases
- It can be done in the field or in a protected environment away from adverse weather conditions, such as rain or direct sunlight

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## 6) Harvesting & Storage

### ① Harvesting

- Should be done when bulbs are fully mature, **after attainment of 75% leaf fall**. Bulbs harvested under moist conditions are likely to rot in storage. It is recommended to completely **withdraw irrigation for at least 7 days before harvesting.**
- Harvesting should be done in a good sunny day

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## 6) Harvesting & Storage

### ② Field Curing



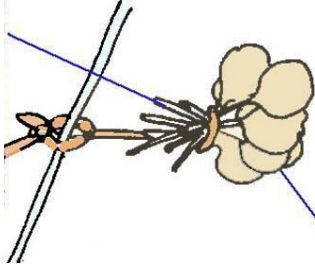
- Curing can be done in the field if the maturity and harvesting coincides with dry months
- Harvested onions are placed in rows with leaves partially covering the bulbs to prevent sunburn or greening
- Onions are then left in the field until the outer leaves and neck are completely dry and papery
- Field curing can take **2 – 3 weeks** depending on the environmental condition

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## 6) Harvesting & Storage

### ③ Protected Curing

15 cm of leaves remain



Trim the root



- Drying of Onions in a protected environment. Curing is done in a warm, dry and well-ventilated location protected from direct sunlight and rain
- Onions can be cured by tying tops of bulbs in bunches and hanging on a horizontal pole in well ventilated shade

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## 6) Harvesting & Storage cont'

### ④ Storage

- Red cultivar such as Pusa Red have longer shelf life.
- Bulbs to be stored should be free of injuries and should be kept well ventilated, either on racks or by hanging.
- After harvest, bulb onions could be stored in small shady housed that can easily be constructed using locally available building materials such as straw, wood or clay.

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## Module 6: Cultivation Technics for Horticulture Crops (cont'd)

### Popular Crop selected by SHEP Farmers:

#### Okra Cultivation



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### 1) Introduction

- Okra belongs to the botanical family known as Malvaceae. The scientific or botanical name for okra is *Abelmoschus esculentus*.
- Okra is a popular vegetable crop whose immature pods and leaves are used as relish in Zambia.
- It is a good source of dietary fiber, vitamin C, A, Magnesium, Calcium and Potassium.
- Crop prefers warm weather and is sensitive to frost. It is adapted to high temperatures throughout the growing season.
- Okra is very sensitive to water logging through it can thrive on a wide range of soils. However, the crop prefers well-drained, matured loamy soils.
- Higher soil temperature and moisture are critical for seed germination.

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- 3) Cultivars Choice
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- 6) Harvesting & Storage

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### 2) Cultivation Environments

#### Appropriate Temperature

- **Okra is a warm season crop and does well during warm and moist weather.**
- During dry summer; plants can grow and produce under good irrigation. However, the growth rate may not reach the same as that of rainy season. **Plants are very sensitive to cold weather and very susceptible to frost.**
- Appropriate temperature is 25-30°C.

#### Soil Condition

- Okra grows well on a wide range of soils. Best growth is achieved in sandy loam or loam soil.
- Appropriate soil pH is 6.0-6.5.

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## 2) Cultivation Environments (cont'd)

### Cultivation Season

- Planting could be done from September to March. Basically, okra is a rainy season crop needing warm humid weather for optimum growth and production.

### Crop Rotation

- Land should not have been planted with Okra, Tomatoes, Melons, Eggplants, Potatoes or Peppers for the past 3 seasons to avoid nematodes build up.
- Okra is very susceptible to root knot nematodes.

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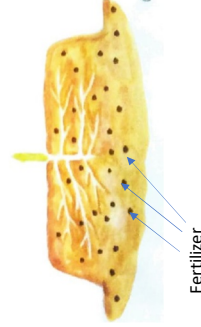
## 4) Field Management

### ① Land Preparation

#### (Basal fertilizer, Broadcast Application)

- Incorporate into the soil compost or livestock manure in advance of sowing.
- Apply 8 x 50kg bags/ha of compound "D" (40 g/ m<sup>2</sup>)

i. After application of lime and manure, land should be ploughed. Then, fertilizer will be broadcasted.  
系に肥料をまく



Fertilizer



iii) Make a ridge (bed) after one to two weeks



ii) Mix soil with fertilizer



iv) level the ridge (bed) and finish  
④菜面をならして  
できあがり!



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## 3) Cultivars Choice

- The commonly grown okra cultivar is **Clemson spineless**. It can give pod yields of about 20 t/ha. Other recommended cultivar are **Green velvet**, **Perkin spineless** and **Pusa swani**, which give about 15 t/ha pod yield.
- All cultivars except Pusa sawani mature about 9 weeks after sowing. Pusa sawani matures about 7 weeks from sowing. The pod picking period is about six to seven weeks depending on cultivar and season. The pods should be harvested when they are still tender before developing fibers.

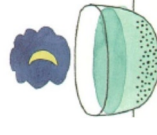
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## 4) Field Management

### ② Planting

#### Seed rate

- The required seed quantity per hectare is 8kg.



#### Field Planting

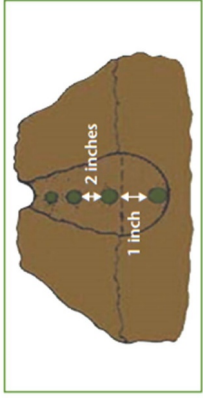
- Planting should be done in well prepared soils with sufficient moisture. Early plantings should be done in pre-irrigated field at a time when sufficient moisture is available and not too wet to hinder planting operations. **Since the seed is naturally hard, prior to planting, soak the seeds in water overnight.**
- Seeds can be drilled or planted by stationing. Seed should not be sown deeper than 2-3cm.
- If the roots is damaged, okra cannot grow very well. Therefore direct sowing is better than seedlings.

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## ② Planting

Plant the okra seeds about 2.5cm deep and 5cm apart in the row. Space the rows at least 3 feet apart.

- 2 inches = 5cm
- 1 inch = 2.5cm



When the okra is up and growing, thin out the plants to about 30 cm apart

- 1 foot = 30 cm
- 3 feet = 90 cm



## Spacing

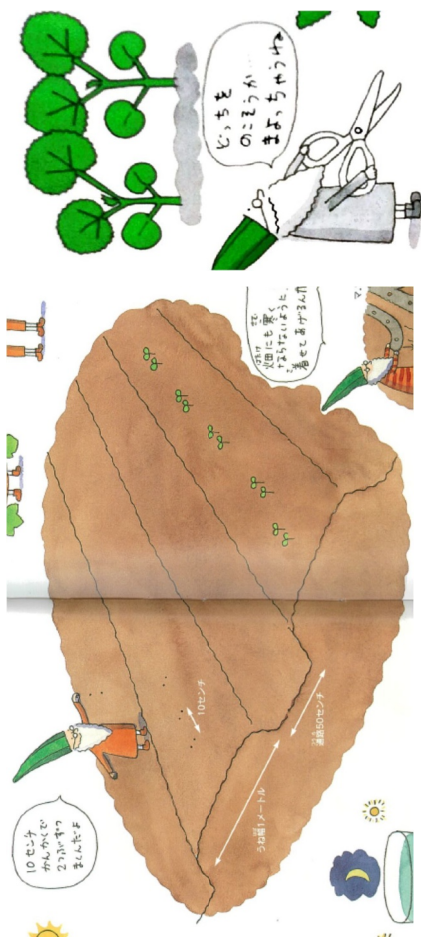
- Sow directly into a moist soil at 20-40 cm within rows and 60-90 cm between rows at a depth of 2-3 cm. after germination, thin out to one plant per stand.

## ② Planting (Reference, sharing Japan's experiences)

- Compare two methods. Top is planting three Okra plants per one stand and bottom is planting only one plant per one stand
- To apply the top method, 5 seeds are sown to one stand and 2 seeds out of the 5 seeds are thinned out later. This enable farmers to maintain same size of okra, easily harvest the fruits, and avoid Okra becomes too big, tough and stringy. Also, productivity per plot may be increased if farmers apply proper soil and water management.
- Staking may be necessary for the former method.
- If you are interested in this way, start it from a small area as experiments or trial at your FFS.



## ② Planting



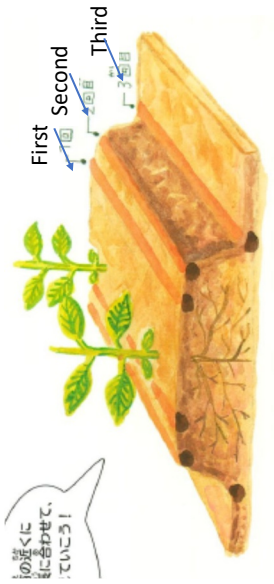
- Or thin out one plant per stand after sowing 2 seeds. Use scissors to thin out and don't pull the unnecessary plant since root of the selected plant will be damaged. After 3 to 4 leaves germinates, thin out the unnecessary one.

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## 4) Field Management (cont'd)

### ⑥ Top-dressing

- Circular band around the stem or Row replacement; the fertilizer is applied in continuous bands on one or both sides of the row
- Top-dressing should be given at the center of roots as the plant grow
- After applying fertilizer, slightly plough the soil and mix fertilizer and soil while weeding

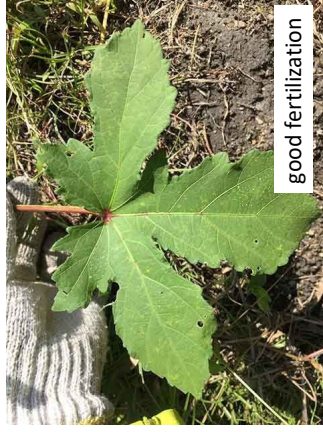


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## 4) Field Management

### ③ Top-dressing

- About 2-3 weeks after emergence, apply 2 x 50kg bag/ha (10g/m<sup>2</sup>) of ammonium nitrate or 75kg bag/ha of Urea (7.5g/m<sup>2</sup>).
- Depending on how the crop appears, apply another 2 x 50kg bag/ha of ammonium nitrate or 75kg/ha urea after 3-4 weeks from the initial ammonium nitrate application.
- Slight earthing up after top-dressing



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### ④ Irrigation

- Irrigate weekly or once in ten days depending upon the soil type and season.
- In hot dry season, a three to four days irrigation interval during hot dry season. In rainy season, it's only rational to supplement in droughty parts of the season.
- Water supply is critical during the flowering and pod formulation stage.

### ⑤ Weed control

- Control weed at all time. Okra is adversely affected by weed infection especially in the initial growth stage.
- Keep the crop clean by inter-cultivation. Inter-cultivate after every top dressing and earth up the crop slightly. Apply herbicides when and where available, and as per recommendations from the specialists (Extension Officers and Stockists)

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## 5) Pest & Disease Control

### Insect Pest

- **Leaf eating caterpillars** may sometimes be a problem and can be controlled by use of chemical insecticides, e.g. Malathion.
- **Pollen beetles** and sucking insects such as **aphids**, **leaf hoppers** and **bugs** (such as red cotton bugs) could seriously damage seed crops resulting in aborted or empty seed.
- Other pests include **fruit borers** and **root-knot nematodes**, **cutworms** also attack the crop occasionally, especially when the crop is still in its early stages.

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## 5) Pest & Disease Control

### Insect Pest

#### Aphids

- Aphids feed on the plant juice and that causes the leaves wrinkling, drooping down and wilting. Aphids also expand the disease.

#### **Control**

- Isolate new crops from an old crops.
- Destroy plants of Okra after harvesting.
- Spray selective aphicide e.g. Primcarb (Pirimor)



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## 5) Pest & Disease Control

### Insect Pest

#### Red Cotton Bugs

- There are red sucking buds with black spots on the back.
- The pest typically sucks the sap from pods, which become distorted in shape. The quality is consequently lowered.

#### **Control**

- Isolate new crops from an old crops.
- Spray with Fastac 1ml/l if infestation is serious.



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## 5) Pest & Disease Control

### Insect Pest

#### Root Knot Nematodes

- There are microscopic worm that affect many vegetable crops.
- They leave and feed in the roots of the plants thereby distributing the flow of water and nutrients. This causes formation of galls on the roots, yellowing of the leaves and stunted growth of affected plants. Nematodes can drastically lower yields. Susceptible crops include Okra, Tomatoes, Eggplants and Melons.



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## 5) Pest & Disease Control

### Insect Pest

#### Root Knot Nematodes: Control

- Apply decomposed manure.
- Break the pest cycle by observing crop radiation and avoiding planting of nematode susceptible crops for at least three years.
- Use certified treated seed.



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## 5) Pest & Disease Control

### Disease

- Diseases include **leaf spots, powdery mildew, and some viral infections**. For powdery mildew, control by applying Sulphur based fungicides. For leaf spots, control by applying fungicides such as Mancozeb (e.g. Dithane M45).
- For viral diseases, control is achieved by removing (roguing) the infected plants from the field. Resistant or tolerant varieties are also recommended.

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## 5) Pest & Disease Control

### Disease

#### **Powdery Mildew**

- Typically affects the leaves, inducing a whitish powdery appearance.
- The disease is common in cool dry weather (April to July)

#### **Control**

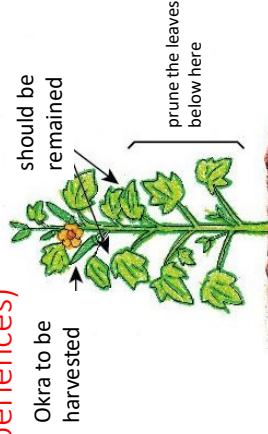
- Look for early signs of the disease and spray with recommended fungicides such as;
  - Benomyl (Benlate) 500-1,000g/ha or 1g/l
  - Chlorothalonil (Bravo) 2-3kg/ha or 2.5ml/l
  - Hexaconazole (Anvil) 2ml/l



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## 6) Harvesting & Storage (Reference, sharing Japan's experiences)

- In Japan, when plant vigorous of Okra is strong, farmers prune the leaves below the harvested okra, but 2 to 5 leaves right below should be remained.
- This promotes fruits growths of okra and reduce incidences of diseases by increasing ventilation.
- If you are interested in this way, start it from a small area as experiments or trial at your FFS.

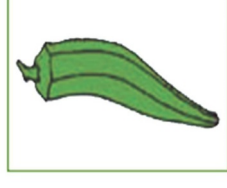


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## 6) Harvesting & Storage

### Harvesting

- Harvest pods while still tender, usually, 5-6 days after flower opening (depends on markets preference).
- Harvest okra 2-3 times/week. Regular picking increases yield. Cut or snap pods from the plant in the cooler parts of the day.
- Pods should be kept in a cool place. Harvested okra should be handled carefully to avoid bruising. Bruised pods will turn black or brown within a few hours. Okra harvesters should always wear cotton gloves when harvesting and handling pods to minimize bruising.



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## References

- <https://agro4africa.com/okra-cultivation-guide/>

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## Module 6: Cultivation Technics for Horticulture Crops (cont'd)

### Popular Crop selected by SHEP Farmers:

## Cabbage Cultivation (Brassica family)



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### 1) Introduction

- Cabbage is a member of the Brassicaceae (Cruciferae) family which includes crops such as Kale, Cauliflower, Broccoli and Radish.
- It is a good source of dietary fiber, antioxidants, vitamin C and Calcium.
- Cabbage has cleansing effect of stomach and intestinal tract if consumed raw without salt due to high sulphur and chlorine content
- **Cabbage can be grown throughout the year with a right choice of a cultivar.**
- During warm weather, the heads do not form properly, and the produce will be of poor flavor and quality.

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### 2) Cultivation Environments

#### Appropriate Temperature

- Normally, cabbage can be cultivated in all season.
- Cabbage prefers the lower temperature.
- The optimal temperature for growth is 15 to 25°C.

#### Soil Condition

- Cabbage may be grown on all types of soils.
- Cabbage does not grow well on a highly acidic soil, say below pH 5.5. But widely accepted slightly acid and alkali soil.
- Require soil with well drainage and sun light

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## 2) Cultivation Environments (cont'd)

### Cultivation Season

- Year-round planting is possible depending on choice of the cultivar.
- Best growing conditions are **during cooler months of April to July**.
- Some Hybrid cultivars can be grown during the summer from August to October and in the rainy season from November to March.

### Crop Rotation

- Avoid planting cabbage on land that has previously been planted to other Brassicas such as Rape, Chomoulier, Cauliflower or Chinese cabbage, for at least a season.

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## 3) Cultivars Choice

### Average yield, Maturation period in Zambia

Cultivar	Days to maturity	Planting Date	Yield (ton/ha)	Remarks
Marcanta F1	105	August-October	54	Cabbage needs ample moisture throughout the growing period especially during head formation.
Drum Head	110	November-March	49	
Gloria F1	103	April-July	56	
Copenhagen	100	April-July	42	
Riana F1	105	August-October November-March	54	

- Cabbage can be grown throughout the year with a right choice of a cultivar. It is a cool season crop which thrives best in a relatively cool and moist climate. Plants can withstand extreme cold and frost.

- During warm weather the heads do not form properly and the produce will be of poor flavor and quality.

- Hybrids such as Riana F, be grown in the rain season because they are tolerant to excessive heat, moisture as well as pests and diseases.

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## 4) Field Management

### ① Land Preparation

(Basal fertilizer, Broadcast Application)

- Apply 16 x 50kg bags/ha (**80g/m<sup>2</sup>**) of compound "D".
- Apply 25-30kg /ha (**2.5g/m<sup>2</sup>**) of Borate.
- 1.5-3.0kg/m<sup>2</sup> of well-decomposed compost or Livestock manure into the soil before planting.
- Manure/compost should be applied at least 1 – 2 weeks before transplanting
- Plough deeper than 30cm

## 4) Field Management

### ① Land Preparation

(Basal fertilizer, Broadcast Application)



Photo: SIEP PLUS



## 4) Field Management

### ① Land Preparation (Basal fertilizer, Band placement)



### ② Nursery establishment and transplanting

#### Seed rate

- The rate is 500-600 g will produce enough seedlings for a hectare.

#### Nursery

- Sow seeds in a nursery bed in well-prepared soil at 0.5-1.0cm depth in spaced 10cm to 20 cm apart. Thin out later to 3-5cm between the seedlings. Protect from pests and disease in the nursery.
- Avoid setting up the nursery in fields previously having a Cabbage crop
- Water thoroughly after transplanting and regularly. However, avoid **over-watering** which can lead to **“Damping-off”** disease
- Start hardening the seedlings **1 – 2 weeks** before transplanting by reducing the frequency of watering and the shade over the nursery
- Mulching is important to provide favorable environment for seedlings

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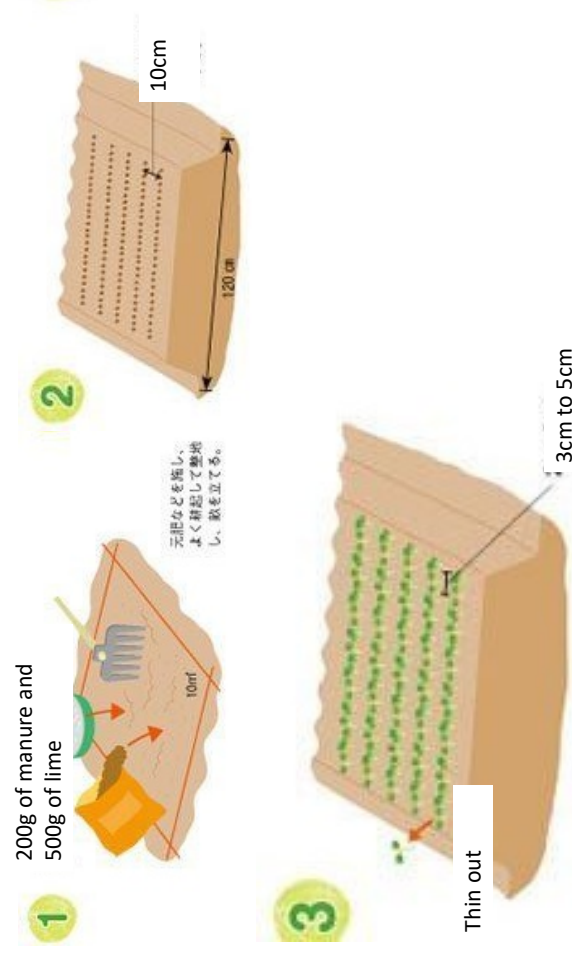
### ② Nursery establishment and transplanting



Photo: SHEEP PLUS

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### ② Nursery establishment and transplanting



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## ②Nursery establishment and transplanting



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## ③Top-dressing

- After 3 weeks from transplanting, apply 4x50kg bag/ha (20g/m<sup>2</sup>) of ammonium nitrate or 3x50kg bag/ha (15g/m<sup>2</sup>) of Urea.



- After 1 month from the 1<sup>st</sup> top-dressing, apply fertilizer same amount as 2<sup>nd</sup> top-dressing at the onset of head formation



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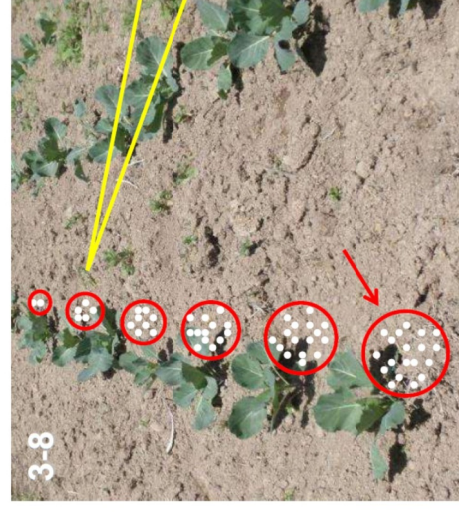
## ②Nursery establishment and transplanting

### Transplanting

- Seedlings are transplanted 30 days after seed germination
- Transplanting should be done either early in the morning or late in the evening
- The recommended spacing is 60 cm between rows and 45 – 60 cm between plants depending on the variety
- Plant population: 11,000 – 14,800 plants/acre
- Give light irrigation to the main field before transplanting.
- The nursery bed also should be irrigated 10-12 hours before pulling out transplants.
- Irrigate immediately after transplanting and do so daily for 5-6 days until seedlings retain their turgidity

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## ③Top-dressing



## Top-dressing using the placement method

After applying fertilizer, slightly plough the soil and mix fertilizer and soil while weeding

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## 4) Field Management (cont'd)

### ④ Irrigation

- Cabbage needs ample moisture throughout the growing period **especially during head formation**.
- Irrigate at regular intervals. Avoid over watering and irregular intervals as this causes bursting of heads. Irrigate continuously so that your crop does not wilt as it establishes itself. **A watering regime of 3 or 4 times a week is more desirable**. The prevailing weather conditions will determine the regime of supply. Watering in rainy season is not as frequent as in dry season.
- After heads are formed and firm and mature, at close to harvest – reduce the amount supplied. This avoids cracked heads.
- ⑤ **Weed control**
- Weeds could be controlled by intercultivation, and application of herbicides. Intercultivate and slightly earth up to keep weeds under control.

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## 5) Pest & Disease Control

### Insect Pest

- There are various insects that attack the crop and cause serious damages. Some of the insects are; **cutworms, aphids, diamond back moth, and cabbage looper**. These could be controlled by application of synthetic insecticides like; Malathion, Monocrotophos, Abamectin, Dimethoate, Pirimor, Aphicides.

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## 5) Pest & Disease Control

### Insect Pest

#### Aphids

- Aphids feed on the plant juice and that causes the leaves wrinkling, drooping down and wilting. Aphids also expand the disease.
- Suck the sap from leaves, inducing stunting on young plants. This may lower the quality of the cabbage.



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## 5) Pest & Disease Control

### Insect Pest

#### Aphids : Control

- Control of this problem is by isolating the new crop from infested crop, using appropriate insecticides like doom, Uthane M-45 and planting according to specified time.
- Hand picking of insects



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## 5) Pest & Disease Control

### Insect Pest

#### Diamond back moth

- It feeds on leaves, succulent growing point may also be attacked and this results in deformed leaves.



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## 5) Pest & Disease Control

### Disease

#### Black Rot

- This is a Bacterial disease. Symptoms include; Yellow brown patches from leaf margins.
- Severely attacks the crop. The whole leaf becomes yellowish with black veins.
- This disease tolerates dry conditions and survives in seeds and in dried infected plant tissues for one year.
- **Debris of infected plants in soil may be the major source of infection.**
- The pathogen is mainly carried by rain splash.



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## 5) Pest & Disease Control

### Insect Pest

#### Diamond back moth : **Control**

- Destroy plants of all Brassicas after harvest. Avoid destruction of parasitic wasps and other natural enemies through fixed sprays with synthetic pesticides.
- Spray with insecticides such as Karate at 1ml/liter or with neem extracts.
- Hand picking of insects



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## 5) Pest & Disease Control

### Disease

#### Black Rot : **Control**

- Roguing out (identifying and removing) of infected plants. Control by good hygiene and practicing crop rotation.
- Avoidance of continuous cropping of cruciferous vegetables and spray of fungicide including copper oxychloride (oxychlorure de quivre) such as FUGURAN before wide spread of the disease are effective.
- Immediate removal of infected crops is also effective to prevent the infection to other crops.



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## 5) Pest & Disease Control

### Disease

#### **Bacterial Soft Rot**

- Bacterial soft rot that causes severe loss in cabbage. It is a Bacterial disease.
- The first symptom of the disease is wilting of young leaves followed by wilting of the entire plant.
- This disease often affects the crop in the rainy season.
- Affected parts become water soaked and develop a soft rot with a distinctive foul smell.



## 5) Pest & Disease Control

### Disease

#### **Bacterial Soft Rot : Control**

- Control is through improving drainage in the field and removing infected plants.
- Crop rotation with Gramineaceous crops (maize and sorghum) and legume crops (French bean) is effective for the control.
- Spray of fungicide including copper oxychloride (oxychloride de quivre) such as FUGURAN at the early stage of head formation and after heavy rain is also recommended.



## 6) Harvesting & Storage

### Harvesting

- The crop is ready for harvesting 3 to 4 months later after transplanting. Harvest by cutting lowest sprouts with knife.
- Harvest compact headed cabbage and avoid removal of outside leaves to keep freshness.



## 6) Harvesting & Storage

### Storage

- Harvested cabbage should be stored under cool, dry conditions without removing the leaves.



Use of appropriate crates in post-harvest handling



## Module 6: Cultivation Technics for Horticulture Crops (cont'd)

### Popular Crop selected by SHEP Farmers:

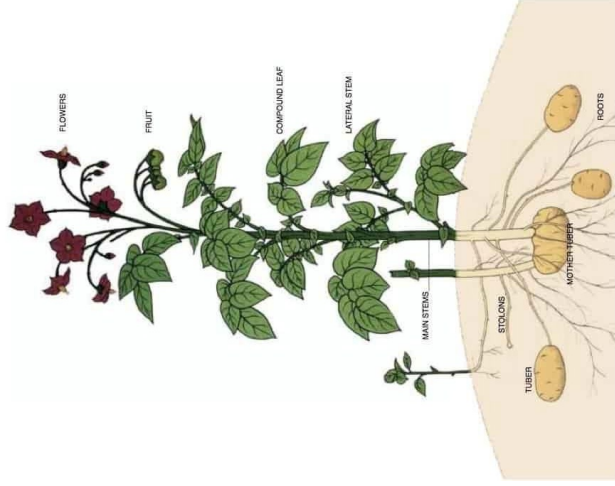
### Potato Cultivation



1

## 1) Introduction

- The crop is botanically called, *Solanaum tuberosum*. It belongs to the botanical family known as Solanaceae.
- Potato is a stem tuber crop. There are many types of cooking or preparing Irish potatoes that includes; boiling, frying and chip making types.
- It's a good source of vitamin C, B6, Potassium and antioxidants.
- Differences exist in tuber shapes, size, flesh color and coat color.
- Rich in starch that it ranks as the world's fourth most important food crop, after maize, wheat and rice.



## Contents

- 1) Introduction
- 2) Cultivation Environments
- 3) Cultivars Choice
- 4) Field Management
- 5) Pest and Disease Control
- 6) Harvesting and Storage

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## 1) Introduction

- **Sprout development:** Sprout develop from the eyes using energy from the seed
- **Vegetative growth:** Development of leaves, branches and stolons (Right time for earthing-up). Growth stage 1 and 2 takes roughly **4 – 10 weeks** depending on environmental conditions, physiological age of the tubers & kind of variety
- **Tuber initiation:** Tubers begin to form at the stolon tips but with little enlargement. Flowering starts at the end of this stage and takes **2 weeks**
- **Tuber bulking:** Tuber enlargement caused by accumulation of water, nutrients & carbohydrates. Critical stage for yield & quality. This stage is the longest and can last **up to 3 months**



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## 2) Cultivation Environments Appropriate Temperature

- Potato is a **cool season crop** that grows within temperature ranges of 15 to 24 Celsius.
- In the tropics, it can be grown throughout the year, preferably in the cool months between April to July.

### Soil Condition

- The soils should be **well-drained sandy or silty loams**.
- **Good drainage avoids** sugary tubers that keep/store badly.
- There is a high possibility of the crop rotting whilst in the soil, if the drainage is poor.
- Soil pH should fall within pH 5.5 – 7.5.
- To prevent the build-up of pathogens in the soil, farmers **avoid growing potato on the same land from year to year**. Instead, they grow potato in rotations of three or more years, alternating with other, dissimilar crops, such as maize, beans and alfalfa. **Continuous cropping with Solanaceae such as tomato and eggplant should be avoided**.

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## 3) Cultivars Choice

### Average yield, Maturation period in Zambia

Cultivar	Days to maturity	Planting Date	Yield (ton/ha)	Remarks
Arka	115-125	Year round	20-30	All purpose, susceptible to Late Blight
Baraka	125-130	Year round	20-30	All purpose, drought tolerant. Resistant to Late Blight
Pentland Dell	115-125	Year round	20-30	All purpose, resistant to Late Blight, Low cooking quality
Pimpernel	130-140	Year round	20-30	Resistant to Late Blight and drought
Up-To-Date	115-125	Year round	20-30	Susceptible to Early Blight, fairly resistant to Late Blight.

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## 2) Cultivation Environments (cont'd) Cultivation Season

- The crop can be grown all the year round but best under cool condition.
- Irish potatoes should not be planted in areas **prone to night frost** during the months of May and June.
- Tuber growth is sharply inhibited in temperatures below 10° C and above 30° C, while optimum yields are obtained where mean daily temperatures are in the 18 to 20° C range.

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## 4) Field Management

### ① Preparation of Seed Seed rate

- 2 – 2.5 tons/ha or 1.0 – 1.5 tons/ha depending on variety and size of the tubers. **Avoid using split tubers (setts) in the tropics** due to losses arising from soft rots and soil fungi. During sprouting of seed potato, any rotten tubers must be removed.

### Pre-sprout

- For best results **seed potatoes (tubers selected for planting) should be pre-sprouted before planting**.
- To pre-sprout, **spread tubers in a single layer on the floor or on a shelf in a humid evenly lighted room**.
- Shade from direct sunlight but do not keep in darkness.
- Check tubers daily and remove diseased or damaged tubers.
- Plant after short sprouts (1- 2 cm) has developed.
- When planting, ensure that sprouts point upwards..

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## ①Preparation of Seed (Sharing Japan's experience) Sun light treatment for potato seed tuber

- **Sun-light treatment is the process of exposing the seed tubers on the sun-light for 20-30 days under the condition of 10-20 degree Celsius** before the plantation for getting the healthy, strong and uniform 4-8 sprouts from each of all potato.
- The seed tuber with young 4-8 sprouts that are 0.5-1 cm long, strong, healthy and green emerged from every eye is better for plantation.
- In case of using such light treated seed tuber, the plants will grow strongly and easily during the initial stage for good seed tuber production.
- Potato plants grow fast and give stronger tubers from such sun treated seed tuber potatoes.

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## 4) Field Management

### ①Land Preparation

- Before spading, remove the rocks, trash, and large sticks from the soil. Prepare the soil by deep ploughing (20cm deep) to loose soil, followed by harrowing.
- Growing potatoes involves **extensive ground preparation**. The soil needs to be harrowed until completely free of weed roots. In most cases, **three ploughings**, along with frequent harrowing and rolling, are needed before the soil reaches a suitable condition: soft, well-drained and well-aerated.
- Irish potatoes should be planted into moist but not wet soil. **Planting on the flat and then earthing-up is recommended.**

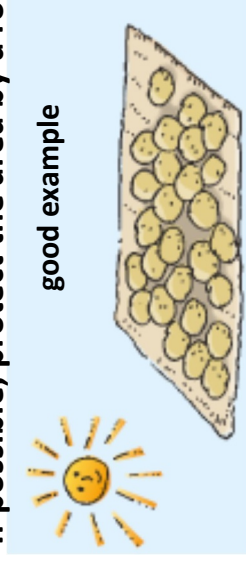
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## ①Preparation of Seed

### Sun light treatment for potato seed tuber



If possible, protect the area by a roof



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## 4) Field Management

### ①Land Preparation

#### Spacing of Potatoes

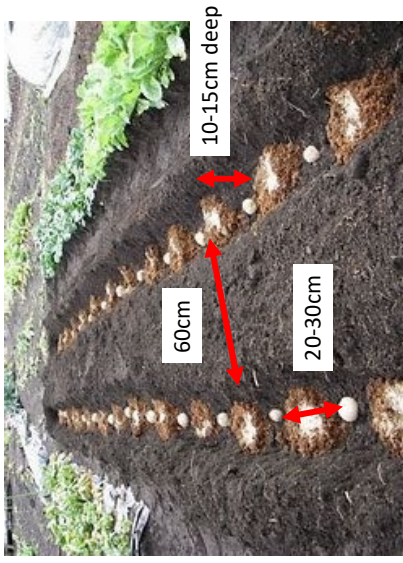
- The size of potato seeds determine the spacing that one uses.
- For small tubers (3-4cm), recommended spacing is 70-90cm by 30cm.
- Medium tubers(4-5cm), recommended spacing is 80-90cm by 30cm.
- Large tubers(5-6cm), recommended spacing is 90cm by 45cm.

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## ② Planting with Basal Fertilizer

- Prepare ridges spaced at 60cms.
- Plant the tubers on the side of ridges 10cm to 15cm deep and 20cm to 30cm between tubers depending upon the size of the tuber.
- Apply basal dressing as a side landing **without contact the tuber** (30gms/m<sup>2</sup> compound D and manure) and cover the tubers and irrigate to facilitate sprouting the tubers.



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## ① Planting with Basal Fertilizer (EXAMPLE 1)

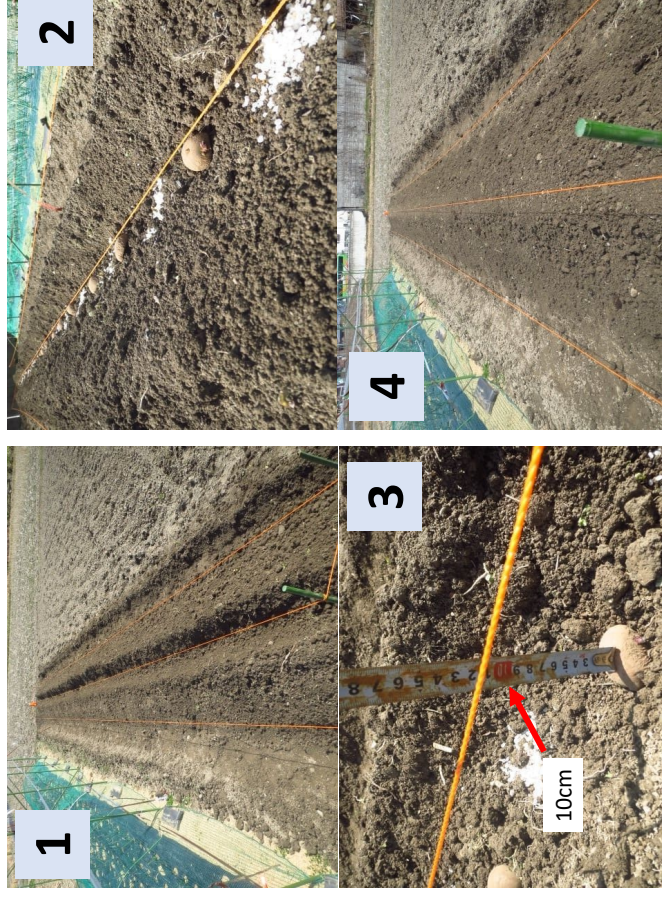


## ① Planting with Basal Fertilizer (EXAMPLE 1)



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## ① Planting with Basal Fertilizer (EXAMPLE 2)



## 4) Field Management

### ③ Top-dressing

- For top dressing, apply Ammonium Nitrate at the rate of 100kg/ha (10g/m<sup>2</sup>) at 5 Weeks after Planting.
- Applying the Ammonium Nitrate around the plant
- And mix it with soil and earthing-up the soil (please refer next slide about earthing-up)



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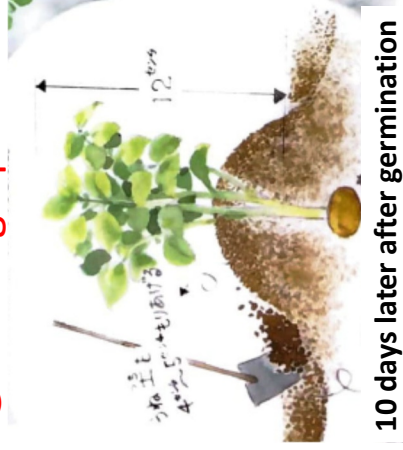
## 4) Field Management

### ④ Earthing-up (Ridging)

- Earthing-up consists of mounding the soil from between the rows around the main stem of the potato plant. Earthing-up keeps the plants upright and the soil loose, prevents insect pests such a tuber moth from reaching the tubers; and helps prevent the growth of weeds.
- Earthing-up should be done two or three times at an interval of 15 to 20 days. The first should be done when the plants are **about 15-25 cm high**; the second is often done to cover the growing tubers.
- Do Not earth-up when the soil is wet to avoid compaction

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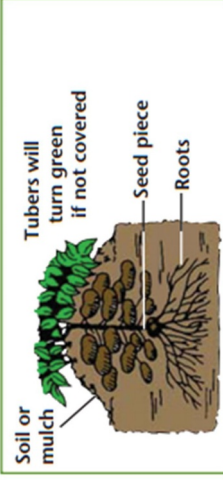
### ④ Earthing-up



10 days later after germination



20 days later after germination



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### ④ Earthing-up

## Bad Example of Earthing up



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## ④ Earthing-up



## Potato crop that has been earthed up /ridged properly

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## ⑥ Irrigation

- Drip irrigation and flood irrigation is more appropriate. Do not use sprinkler or overhead irrigation as it might encourage blight (early blight and late blight) multiplication.
- If irrigation or suitable dambo sites are available, planting may be carried out throughout the year. To reduce Early and Late Blight disease, when using irrigation, avoid wetting leaves and stems. Use of sprinkler irrigation is not recommended.

### WATER MANAGEMENT(irrigated)

Season/Soil	Light soil	Heavy soil
First week after planting	15 liters (1 bucket) everyday	per m2
Cool season	Every 3 – 4 days	Every 4 days
Hot season	Every 2 days	Every 3 days

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## 4) Field Management

### ⑤ Weed control

- During the development of the potato canopy, which takes about four weeks, weeds must be controlled in order to give the crop a "competitive advantage". If the weeds are large, they must be removed before ridging operations begin.
- Weed shelters insects and disease.
- After earthing up, weeds between the growing plants and at the top of the ridge are removed mechanically or using herbicides.

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## 5) Pest & Disease Control

### Insect Pest

- The most notable insect and other pests are; **nematodes (root knot), potato tuber moth, aphids, ladybird beetles, red spider mites and cutworms.**
- Use systemic insecticides for most these except for the red spider mites.
- In the case of the red spider mites could best be controlled by applying acaricides such as Abamectin.

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## 5) Pest & Disease Control

### Insect Pest

#### Nematode

- Neoplasm will appear with different shapes and volumes on the root system.
- Some neoplasms are full of warts and dark brown spots are inside tubers.



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## 5) Pest & Disease Control

### Insect Pest

#### Nematode : Control

- Utilization of animal dung, green manure and compost in soil.
- Crop rotation with ground nut, maize, sorghum and guinea grass to prevent nematode damage.
- Mix planting or crop rotation with marigold.



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African marigold

## 5) Pest & Disease Control

### Insect Pest

#### Aphids

- Aphids are one of the serious insects that infect the potato because it transfers the Virus to potato.
- Preventive control is necessary as the adult aphid is a main vector of "potato leaf roll virus" and "Y virus" for potato.



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## 5) Pest & Disease Control

### Insect Pest

#### Aphids : Control

- Apply the recommended pesticide below when finding an aphid on the plant.
- Both sides of leaves should be sprayed very well.

Pesticide	Amount
Agri-flex 18.56% SC	240 cm <sup>3</sup> /100 litres of water
Actara 25% WG	20 gm/ 100 litres of water
Actellic 50% EC	375 cm <sup>3</sup> / 100 litres of water
Imidazed 20% SC	50 cm <sup>3</sup> / 100 litres of water
Blanch 48% SC	30 cm <sup>3</sup> / 100 litres of water
Gaucho (Imidacloprid) 70% WS	150 gm/ ton of seeds

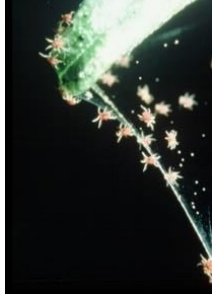
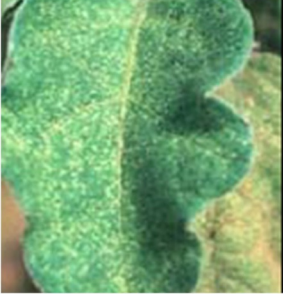
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## 5) Pest & Disease Control

### Insect Pest

#### Red Spider Mites

- Yellow color plants appear in the cultivation field.
- Yellow or brown color spots increase the number and the size on the surface of the leaves.
- The yellowish leaves become rough surface. It increases during hot season.
- Red spider mite feeds on the plant juice from the lower surface of leaves.
- In case of severe attack, leaves will dry and fall and we will be able to see the spider net on the lower surface of leaves or between plants. It also may get around buds causing its death.



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## 5) Pest & Disease Control

### Disease

- The diseases which usually attack the crop include;
  - 1) Early blight (*Alternaria solani*),
  - 2) Late blight (*Phytophthora infestans*),
  - 3) Septoria leaf spot,
  - 4) Powdery mildew, and
  - 5) Soft rot.
- All these could be controlled by application of fungicides, such as Mancozeb, Benlate, etc.

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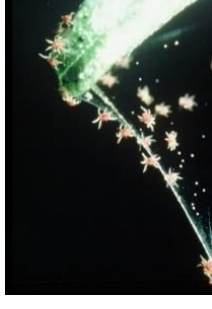
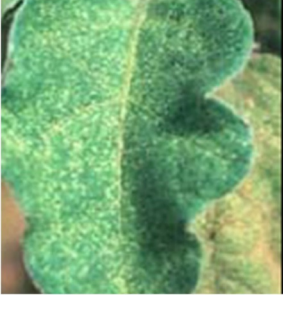
## 5) Pest & Disease Control

### Insect Pest

#### Red Spider Mites : Control

- Removing weeds and dry leaves.
- Apply the irrigation during high temperature period.
- Apply the potassium fertilization and the balanced fertilization.
- Spray the recommended pesticides below when it appears more than 5 on one leaf.

Pesticide	Amount
Abalone 1.8% EC	40 cm <sup>3</sup> / 100 litres of water
Sniper 24% SC	60 cm <sup>3</sup> / 100 litres of water
Gold 1.8% EC	40 cm <sup>3</sup> / 100 litres of water
Challenger Super 24% SC	60 cm <sup>3</sup> / 100 litres of water
Vertimec (Abamectin 1.8%)	40 cm <sup>3</sup> / 100 litres of water



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## 5) Pest & Disease Control

### Disease

#### Early Blight

- Black spots appear on the old leaves of small plants.
- Spots extend and circle loops start to appear around its center, these spots look like an eye.
- Tissues around spots turn into yellow color.
- The high temperature (25-30°C) and humidity condition expand the disease easily.
- Similar spots on leaves also appear on the stem, and it may cause crown rot.



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## 5) Pest & Disease Control Disease

### Early Blight : Control

- Apply cropping pattern, without repeating of tomato or same crop family of tomato, e.g. Eggplant, Pepper and Irish Potato.
- Pick up the infected plants and burn it out of the field.
- Start spraying when plants are 20 cm high.
- Spray weekly with Dithane M45 (500g/lima) in the rainy season.
- Spray the following recommended pesticides every 15 days:

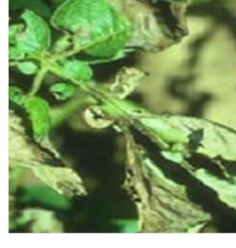
Pesticide	Amount
Equation pro 52.5%	40 gm/ 100 litres of water
Anadrol 80% WP	250 gm/ 100 litres of water
Index 77% WP	250 gm/ 100 litres of water
Optima 25% EC	50 cm <sup>3</sup> / 100 litres of water
Proxani/45% SC	250 cm <sup>3</sup> / 100 litres of water
Profile NT 35% SC	500 cm <sup>3</sup> / 100 litres of water
Polyram DF 80%	200 gm/ 100 litres of water
Tazolen 72% WP	250 gm/ 100 litres of water
Toledo 43% SC	35 cm <sup>3</sup> / 100 litres of water
Gardens 25% EC	50 cm <sup>3</sup> / 100 litres of water



## 5) Pest & Disease Control Disease

### Late Blight

- Late blight damage increase under the cold weather and high humidity condition.
- Fungus can infect all parts of the plant.
- Small watery-black spots appear on leaves.
- Spots spread fast, and white rot appears on the edges of the bottom surface of leaves.
- During 48 hours the color of leaves and stem change into brown.
- Big black spots cover the infected tissues on the fruit surface.



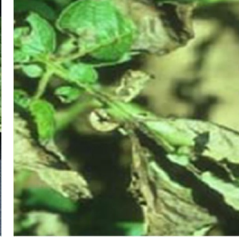
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## 5) Pest & Disease Control Disease

### Late Blight : Control

- Use the resistant variety and apply cropping pattern. Tomato and potato cannot be cultivated consecutive because of injury of continuous cropping.
- Start spraying when plants are 20 cm high.
- Spray weekly with Dithane M45 (500g/lima) in the rainy season.
- Spray the recommended pesticide both side on the leaf:

Pesticide	Amount
Acrobat Mancozeb 69% WG	250 gm/ 100 litres of water
Acrobat Copper 73.2% WP	250 gm/ 100 litres of water
Equation pro 52.5%	40 gm/ 100 litres of water
RIDOMIL Gold Plus 42.5% WP	200 gm/ 100 litres of water
RIDOMIL Gold MZ 68% WG	200 gm/ 100 litres of water



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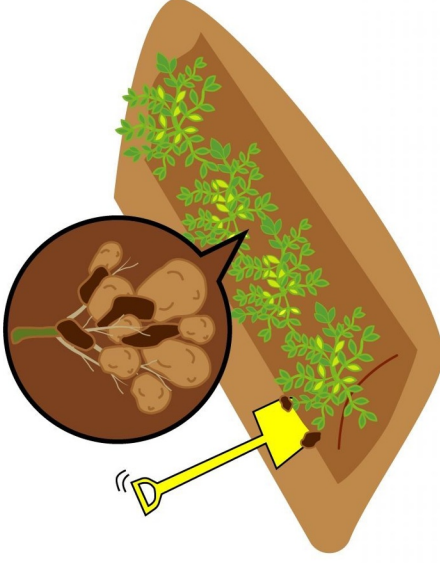
## 6) Harvesting & Storage Harvesting

- Harvesting is done within 3-4 months of planting. Potatoes are ready to harvest when the tops begin to die, and the potato skin becomes firm.
- The skin is set when it does not scrape easily when rubbed with the thumb. Skin set can be speeded by cutting back the tops of the plants. To facilitate harvesting, the potato vines can be removed two weeks before the potatoes are dug up.
- For earlier harvesting (while the stems are still green), assess the stage of maturity by checking tuber size and harvest as required. You can harvest small “new potatoes” during the growing season by carefully digging beside the plants with your fingers.

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## 6) Harvesting & Storage

- To harvest potatoes, dig under the plants with a shovel or spading fork. Keep the pitchfork 20 to 30 cm away from the plant to prevent cutting the potatoes. Raise the plants and shake away the soil. Pull the potatoes from the vines and handle them carefully to prevent damage; damaged potatoes do not store well.



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## 6) Harvesting & Storage

### Harvesting

- Potatoes should be dug **when the soil is moist**. If it is too wet, the soil will stick to the potatoes. If too dry, dirt clods will bruise the potatoes.
- Avoid damaging the tubers. If not selling all at once or storage facilities are poor, just harvest enough leaving the rest in soil.
- If the potatoes are to be stored rather than consumed immediately, they are left in the soil to allow their skins to thicken - thick skins prevent storage diseases and shrinkage due to water loss. However, leaving tubers for too long in the ground increases their exposure to a fungal incrustation called black scurf.

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## 6) Harvesting & Storage

### Storage

- Allow the potatoes to dry; **then store them in a single layer in a cool, dark, well-ventilated place.**
- Remove rotting or damaged tubers as quickly as possible.
- Clean them and spray them with a sprout depressant such as Fusarex.
- Package them in 30kg bags for sale.
- After the potatoes are dug, place **the tops in the compost pile.**

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## Tips for potato farmers

### Analysis of risk and opportunity on Irish potato

	Risk	Opportunity
Dry season	<ul style="list-style-type: none"><li>• Inadequate market due to high competition</li><li>• Water shortage</li></ul>	<ul style="list-style-type: none"><li>• Available market</li><li>• Cool favorable weather</li><li>• Adequate labour</li></ul>
Rainy season	<ul style="list-style-type: none"><li>• Lack of market</li><li>• Lack of labour</li><li>• High disease infestation</li></ul>	<ul style="list-style-type: none"><li>• High demand</li><li>• High price</li><li>• Abundant water</li></ul>

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# Tips for potato farmers

## Ideal technical extension approach on Irish potato

It grows all year round, preferably in the cool months between April to July.



- **Basic step: Planting in cool season**
- **Advanced step:**  
**Rainfed production with careful planning and risk management**





**E-COBSI**

Expansion of **Community-Based Smallholder**  
Irrigation Development Project



## Module 6: Cultivation Technics for Horticulture Crops (cont'd)

### Popular Crop selected by SHEP Farmers:

## Watermelon Cultivation



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## Contents

- 1) Introduction
- 2) Cultivation Environments
- 3) Cultivars Choice
- 4) Field Management
- 5) Pest and Disease Control
- 6) Physiological Disorders
- 7) Harvesting and Handling

2

## 1) Introduction

- The crop is botanically called, *Citrullus lanatus*. It belongs to the botanical family known as Cucurbitaceae.
- Watermelon are consumed as fresh fruit, snack and in “sweet courses”. It is a very good source of vitamin A, C, B5, Potassium and Copper. It **contains some of the most important antioxidants in nature- e.g. Lycopene**
- Watermelon seeds are edible and in some cultures they’re even more valued than the fruit. Watermelon seeds are also a rich source of protein, fat, folate, niacin, thiamin, copper, iron, magnesium, manganese, phosphorous, potassium, and zinc. It can be cooked by frying and remove the black parts.
- Japanese also eat the white part of watermelon by making a pickles with salt



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## 1) Introduction

- Watermelons range in shape from round to oblong.
- The plant requires **warm dry weather** to perform well since it is **originally from Southern Africa**.
- It is thus usually recommended to **plant watermelons at the end of the cool dry season**.



Photo: <https://www.royalsoced.biz/water-melon.php>



Photo: <https://awhalley.com/seeds/vegetables/watermelon/sweet-dakota-rose-usda-organic>

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## 2) Cultivation Environments

### Temperature

It needs a long, warm growing periods

- Bright, hot days (27 –35 °C)
- Warm nights (16 –21 °C)
- Cool Temp & Excessive Rain Fall: Delay germination, Slows growth, poor fruit setting, hollow fruit
- High humidity: Susceptible to various diseases & Reduce the flowering
- Even though some cultivars can be grown under the humid conditions of the rainy season, incidence of diseases is high at this time of the year.

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## 3) Cultivars Choice

- Watermelons range in shape from round to oblong.
- Rind colors can be light to dark green with or without stripes. Watermelons are grouped according to fruit shape, rind color or pattern, and size.
- Watermelon varieties fall into three broad classes based on how the seed were developed: **open-pollinated, F1 hybrid, and triploid or seedless.**
- For example, oblong melons with dark stripes on a light background in the 10 to 15 kg range are called **Jubilee** types
- Melons of similar shape and size as **Jubilee** but with a light green rind are called **Charleston Gray types,**

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## 2) Cultivation Environments (cont'd)

### Soil Condition

- Sandy or sandy loam, deep and well drained soil
- Soils have not been in cucurbit (cucumber, squash, etc.)
- Rich in organic
- Heavy soils with a lot of clay often cause small, weak plants that produce fewer melons.
- Soil pH: 6 –7
- Apply lime if soil pH is too low
- **Watermelons are vining crops that require a lot of space**

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## 3) Cultivars Choice

- Round melons in the range of 8 to 12kgs with a striped rind are called **Crimson Sweet** types
- Because varieties are constantly being changed and market trends are also changing, selecting varieties acceptable for your market is important.

### Examples of varieties available at the market:



### 3) Cultivars Choice



#### “Crimson Sweet”

- Has a light green rind with broad dark green stripes
- Has blocky oval shaped with brilliant red flesh
- **Maturity Period: 90 – 120 days**
- **Average fruit weight: 7 – 9 kg**
- **Yield potential: 25 – 30 tons/acre**
- Good shipping quality and resistant to extreme heat and Root-knot Nematodes



#### “Sweet Rose F1”

- Vigorous with good adaptability
- Fruits are oval to round
- Good keeping quality
- Flesh is deep crimson red with good texture
- **Maturity Period: 80 – 90 days** after transplanting
- **Average fruit weight: 10 – 12 kg**

#### “Sweet Rose”

### 3) Cultivars Choice



#### “Charleston Grey”

- Very elongated and oblong
- Light green striped variety with red flesh and hard rind
- At maturity, rind color turns to light green
- Fruits are sweet, juicy and crunchy
- Ideal for fresh market
- Tolerant to *Fusarium* and *Anthraxnose*
- **Drought resistant**
- **Maturity Period: 80 – 85 days**
- **Average fruit weight: 8 – 10 kg**
- Able to withstand long transportation

#### “Charleston Gray”

### 4) Field Management

#### ① Land Preparation

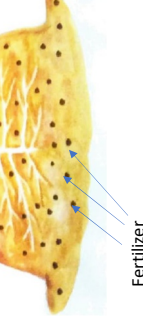
Land preparation involves one or more tillage operations performed:

- To make the soil more suitable for seeding and seedling (or transplant) establishment,
- To enhance productivity by providing the best soil structure for subsequent root growth and development,
- To help control some disease problems.

- Watermelons respond favorably to warm soils.
- Raised beds tend to warm quickly and are particularly desirable for early season production.
- Raised beds will facilitate drainage in heavy soils but are more prone to drying;
- Therefore, particular care should be taken with watering, especially during the first two weeks after emergence.
- Root growth can be severely restricted by compacted soil. Proper land preparation should eliminate or significantly reduce soil compaction.

#### ① Land Preparation (Basal fertilizer, Broadcast Application)

i. After application of lime and manure, land should be ploughed. Then, fertilizer will be broadcasted.



iii) Make a ridge (bed) after one to two weeks



ii) Mix soil with fertilizer



iv) level the ridge (bed) and finish



④表面をならして  
てきあがり!

#### Basal Fertilizer

- 8 × 50kg bags of compound “D” per ha (40g/m<sup>2</sup>)
- Well decomposed livestock manure or compost at 2 kg per station

## 4) Field Management

### ② Planting

**Seed rate;** 250 – 300 grams per lima

**Single row system:**

- Row spacing: 2.0 -2.5 meters
- Plant spacing: 60 cm

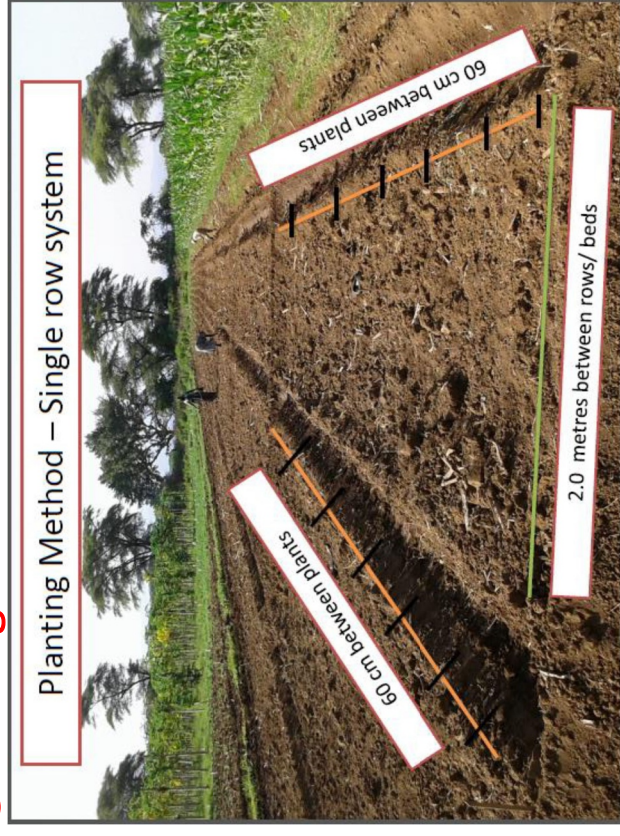
**Double row system:**

- Row spacing: 3.5 –4.0 meters
- Plant spacing: 60 cm

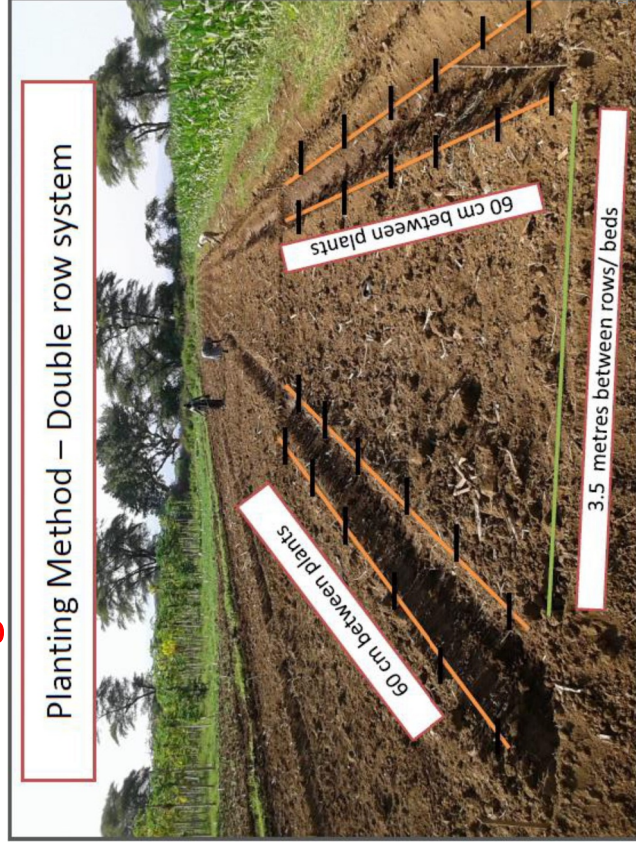
Seed should be planted approximately 2.5 cm deep.

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### ② Planting



### ② Planting



### ③ Top-dressing

- 2 × 50kg bags of ammonium nitrate or 2 × 50kg bags of Urea per hectare

- **Or CAN (Calcium Ammonium Nitrate)** top dressing fertilizer is applied in 2 splits

- 1st split application: when the plants start to run (40 kg per acre)
- 2nd split application: when plants are about to flower (80 kg per acre)

- Watermelons are a relatively long-season crop; therefore, applying fertilizer in small amounts several times throughout the season will maximize production. Don't put too much fertilizer as basal application.

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### ③ Top-dressing



- Top-dressing using the placement method

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## 4) Field Management

### ④ Irrigation

- A ripe watermelon consists of more than 90 percent water (a 15kg watermelon contains more than 10litres of water). Thus, an adequate water supply is critical to optimizing yield and quality of this crop.
- Watermelons are **potentially deep rooted** (1.2 to 1.8 meter); however actual rooting depth will vary considerably depending on soil conditions and cultural practices.
- Water deficits during the establishment of watermelons delay maturity and may cause gaps in production.
- Water stress in the early vegetative stage results in reduced leaf area and reduced yield.
- The most serious yield reductions result from water stress during flowering and fruit development.

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## 4) Field Management

### ④ Irrigation

- Where evaporation is high and rainfall is low, frequent irrigation with an interval **from 6 to 8 days** may be necessary.
- Irrigation under dry conditions must be scheduled at the start of the growing period (pre-irrigation), during the late vegetative period (vine development, 1), the flowering period (2) and the yield formation period (3). In these periods soil water depletion must not exceed 50 percent.
- During the ripening period (4) relatively dry soils are preferred to increase sugar content and to avoid the flesh becoming more fibrous and less juicy.

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### ④ Irrigation

- Furrow Irrigation



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## ⑤ Weed control

- Watermelon has a shallow root system therefore care should be taken to avoid bruising the roots during weeding
- The frequency of weeding depends on weed infestation; generally keep the field weed-free as much as possible to avoid competition for **nutrients, sunlight** and **moisture**
- This can be done through use of appropriate weeding tools
- Weeding watermelon field when the soil is wet can increase the spread of some bacterial (**Bacterial Wilt**) and fungal (**Fusarium Wilt**) diseases
- Watermelons, as with most crops, **require early season weed control to ensure a quality crop.**
- In addition, **the spreading nature of this crop makes weed control difficult once the vines begin to form.**

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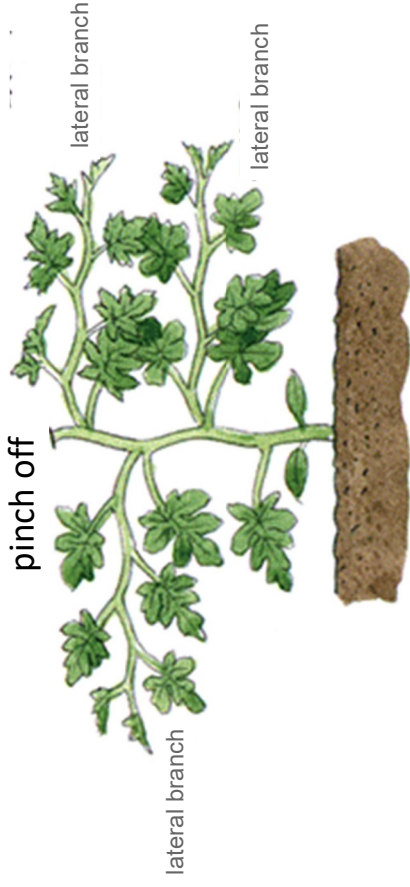
## 5) Pest & Disease Control

### Insect Pest

- Watermelons are subject to attack by a variety of insect pests.
- These attacks do not always result in economic injury, so certain insect management practices can be used to ensure cost-effective control decisions.
- Indiscriminate use of insecticides often creates more favorable conditions for the development of harder-to-control insect pests, thus increasing the cost of production.
- Insects cause injury to the leaves, stems, roots and melons.
- The developmental stage of the plant at the time of attack often governs the plant part injured by different insect pests.

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## ⑤ Pruning



- Control the number of fruits per plants if market demands larger fruits.
- Remove any dead, diseased, yellowing or infested leaves or shoots at the joint where they are connected to the main stem
- Remove deformed and blossom-end rot fruits
- Maintain 2-3 vines and remove extra vines
- If market demands larger melons leave 3-4 well shaped melons per plant
- Do not prune when vines are wet

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## 5) Pest & Disease Control

### Insect Pest

#### Root-knot Nematodes

- Most cucurbits are extremely susceptible to Root-knot Nematodes
- **Stunting, general unthriftiness**
- (Weak/unhealthy), **premature wilting**, and slow recovery to improved soil moisture conditions
- Root symptoms cause **swollen areas (galls)** on the roots of infected plants which result from exposure to multiple and repeated infections
- Leaf **chlorosis (yellowing)**



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## 5) Pest & Disease Control

### Insect Pest

#### Root-knot Nematodes: Control

- **Cultural Control:** Crop rotation of less susceptible crops or resistant varieties
- Use of resistant varieties e.g.) Crimson Sweet
- Use adequate amount of manure
- **Chemical Control:** Use of Ethoprophos (MOCAP GR10®), Azadirachtin (NIMBECIDINE EC®)



## 5) Pest & Disease Control

### Insect Pest

#### Cucumber Beetles

- The beetles have been responsible for most economic damage.
- Beetles feed on the stems and foliage of the plant.
- Feeding begins on the undersides of the cotyledons or true leaves.
- Occasionally, larvae cause direct damage to the melon.
- The damage consists of small trail-like canals eaten into the surface of the rind.
- Cucumber beetles can be controlled with foliar applications of insecticides when 10 percent or more of the seedlings are infested.
- The natural feeding behavior of cucumber beetles leads to their avoidance of insecticidal sprays, so thorough spray coverage is imperative.



## 5) Pest & Disease Control

### Insect Pest

#### Melon Fly

- This is the major pest of watermelon.
- The damage by maggots results in rotting of young and ripened fruits or drying and shriveling of fruits before maturity.
- Maggots of this fly causes severe damage to young developing fruits.
- Fruit flies are usually a problem as soon as female flower initiation takes place.

#### Control

- The affected fruits should be regularly pinched off and buried in a pit.
- Spray: Deltamethrin, Lambda-cyhalothrin, Alphacypermethrin



## 5) Pest & Disease Control

### Insect Pest

#### Aphids

#### Identification:

- Colonies of green to blackish aphids are found on tender shoots
- Excretion of honeydew

#### Damages:

- Attacked leaves are curled and twisted

#### • Sooty moulds

#### Control:

- Ensure plants are not water stressed
- Use of pesticides, such as
- Azadirachtin (Nimbecidine®)
- Deltamethrin (Decis 2.5EC®)



**Aphids on Watermelon leaves and damaged leaves**

## 5) Pest & Disease Control

### Insect Pest

#### Spider Mites

#### Identification:

- Mites are tiny spider like pests which spin silk threads for anchoring to the plant
- Their bodies are yellow-green to reddish brown in color
- They flourish at low humidity and high temperature (hot dry conditions)

#### Damage:

- Attacked leaves show white to yellow speckling
- Where there is high infestation, plant is covered with orange cloud of mites and webs

#### Control:

- Adequate irrigation
- Mulching to conserve water
- Predatory mite (Phytotech®)
- Spray with miticides, such as Bifenthrin (Brigade 25EC®)

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## 5) Pest & Disease Control

### Insect Pest

#### White Flies

#### Identification:

- Small soft bodied insects with wings covered with white powdery wax
- Presence of honeydew and sooty mould

#### Damage:

- Sucking sap
- Vector of viral diseases (Cucurbit Yellow Stunting Disorder)

#### Control:

- Use of pesticides such as
  - Lambda-cyhalothrin (Karate 2.5WG®)
  - Thiamethoxam (Actara 25WG®)

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## 5) Pest & Disease Control

### Insect Pest

#### Spider Mites

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- Spray with miticides, such as Bifenthrin (Brigade 25EC®)

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## 5) Pest & Disease Control

### Insect Pest



Cutworm

Thrips



Rind worms

### Disease

- Disease infection leads to reduction in quality and quantity of produce
- Certain diseases have destroyed entire watermelon crops in some areas when weather conditions favored their development.
- If disease control practices are not followed, some loss can be expected every year from foliage and stem diseases.
- Disease-causing fungi can live from year to year on un decayed vines of watermelon, cucumber, citrons, gourds and pumpkins.

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## 5) Pest & Disease Control

### Disease

#### Damping-off

- The amount of damping-off is usually directly related to litter from the previous crop and to environmental conditions.
- In some years, seedling diseases reduce stands by 50 percent; in other years, seed-ling diseases are rare.
- Good cultural practices and seed treatment are essential in preventing damping-off of young watermelon seedlings.
- Basically, conditions unfavorable for rapid emergence, which involves cool, wet weather, are usually most favorable for damping-off



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## 5) Pest & Disease Control

### Disease

#### Downey mildew

- This fungus attacks only the leaves of watermelons.
- Lesions first appear on the oldest crown leaves as yellow, mottled spots with indefinite borders blending gradually into healthy portions of the leaf.
- Older lesions are dark brown with a slight yellow border. As the disease progresses, brown areas coalesce, causing leaves to curl inward toward midribs.

#### Control

- Remove old plant debris.
- Do not overcrowd plants; avoid overhead irrigation, water plants through furrows.
- Spray: Triadimefon, Tebuconazole, Propineb + Cymoxanil, Azoxystobin



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## 5) Pest & Disease Control

### Disease

#### Fusarium wilt

- Infected plants develop wilt symptoms on one or more runners, usually beginning at their tips.
  - The vascular tissue in the lower stem and roots develops a light brown discoloration.
  - In severe cases, the entire root may become dark brown and a soft rot develops near the crown.
  - Several varieties are considered somewhat resistant to this disease
- #### Control
- Plant in well-draining soils and avoid water logging;
  - Crop rotation.
  - Avoid using urea and ammonia based fertilizers,
  - Nitrate is recommended.
  - Soil solarization and fumigation



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### Disease

#### Bacterial Fruit Blotch

- The fruit blotch bacterium can cause seedling blight, leaf lesions and fruit symptoms.
- First symptoms in watermelon seedlings appear as dark water soaking of the lower surface of cotyledons and leaves followed by necrotic lesions, which frequently have chlorotic halos.
- In young seedlings, lesions can occur in the hypocotyls, resulting in collapse and death of the plant.
- Symptoms on the surface of fruit begin as small, greasy appearing water-soaked areas a few millimeters in diameter.
- These enlarge rapidly to become dark-green, water-soaked lesions several centimeters in diameter with irregular margins.
- Fruit blotch bacteria may be introduced into a field by infested seed, infected transplants, contaminated volunteer watermelons or infected wild cucurbits

#### Control

- Rotate crops; Avoid the use of overhead irrigation.
- Spray: Mancozeb + Copper or tebuconazole + copper



## Disease



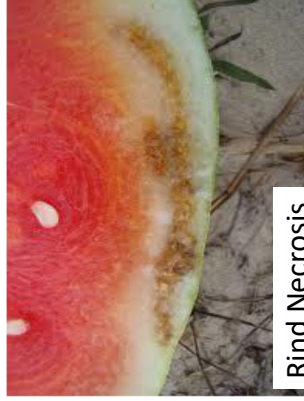
Gummy Stem Blight



Powdery Mildew



Anthracnose



Rind Necrosis

## Disease

Watermelon Mosaic Virus



Alternaria Leaf Blight



## 6) Physiological Disorders

- Physiological disorders are caused by non-pathogenic agents that affect fruit quality.
- The cause can be either one or a combination of environmental, genetic or nutritional factors.

### Bottle Necks

Bottle necks or otherwise mis-shaped fruit can be caused by poor pollination & fluctuations in watering (**Moisture Stress**). Low temperatures can also cause mis-shaped fruits.



## 6) Physiological Disorders

### Blossom End rot

This is caused by calcium deficiency or moisture stress or both. Excessive nitrogen fertilizer also can contribute BER by promoting vigorous vine growth and depleting available calcium in the soil.

### Fruit Cracking

Cracking is caused by cool temperatures during early fruit-filling pe-riod. Excess nitrogen, low boron levels, or heavy infrequent watering at fruit filling stage.



## 6) Physiological Disorders

### White Heart

This is caused by excessive moisture and probably too much nitrogen during fruit maturation.



### Sunscald

Sunscald is damage to the melons caused by intense sunlight.



## 7) Harvesting And Handling

### Main harvesting stages:

- Mature but before full ripeness for distant markets
- Mature and ripe for nearby markets

### Notes:

- Watermelons don't ripen after they are picked so harvest time is important
- If harvested immature, red color will develop but sugar content does not increase after harvest
- Mature fruits have sweet flavor, crisp texture and deep red color
- Sugar content (measured as soluble solids by use of hand held refractometer) of 10 % or more in the flesh near the center of the melon

## 7) Harvesting and Handling

### Harvesting Indices

- Tendrils near fruit stem have changed color from **green to brown**
- Ground spot on the belly of the melon has changed from **white to yellow**
- The fruits when thumped with the hand produce muffled dull tone (immature fruits produce clear metallic ringing tone)
- Harvesting should be done by cutting the vine and **NOT** pulling, twisting or breaking off the vines. Leave the stalk attached to the fruit
- Cutters should take care not to skin or scuff melons with their knives. These areas provide an entrance for decay-causing pathogens.
- Harvesting only when melons are dry can reduce abrasions caused by sand on the melon surface at harvest.



## 7) Harvesting and Handling

- **Handling** should **minimize fruit injury** which may be caused by impact or abrasion
- **Shading** is necessary in order to **protect Watermelon from direct sunlight** which causes sunburn
- Watermelons are handled as bulk shipment or packed into cartons
- For bulk shipments in trucks a layer of straw on the floor and between melons and the side walls of the truck needs to be put in place
- Can store for 2 weeks beyond which they lose crispness and colour
- A drop of only 20 cm can result in severe internal bruising; a 30 cm drop can crack the flesh internally or split the melon open.

## 7) Harvesting and Handling

### Grading

- Watermelons shall be of similar varietal characteristics that are mature, but not overripe, and fairly well formed.
- They must be free from anthracnose, decay, sunscald and from damage caused by other diseases, sun-burn, hail, scars, insects, hollow heart, whiteheart or mechanical injury.
- Watermelons are sorted to remove insect damaged, blossom-end rot, cracked, discolored, without stalk attached
- Retail merchandising programs require watermelons to be packed according to specific weight sizes:
  - ✓ small, less than 3kgs;
  - ✓ medium, 3 to 10kgs;
  - ✓ and large, greater than 10kgs

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THANK YOU



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## Module 6: Cultivation Technics for Horticulture Crops (cont'd)

# NURSERY PREPARATION

Steps Taken In Preparations

1

## Materials Required cont.

- Digging forks
- Digging spade
- Dibble
- Plastic

3

## Nursery Bed Preparation

Materials Required

- Hoe and Rake
- Livestock Manure or Compost
- Compound Fertiliser D
- Mulch
- Fire wood or dry twigs/ Transparent plastic
- Wire mesh
- Seeds

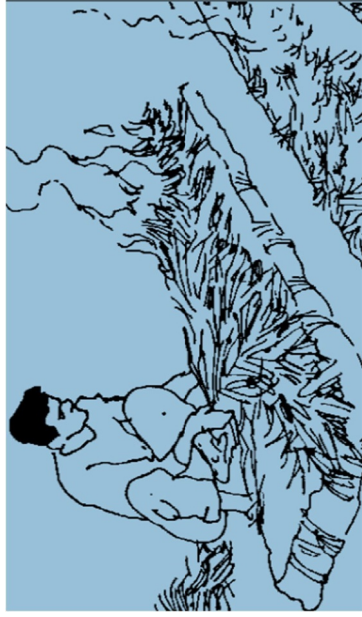
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## Procedure

- After site selection ,clear the land
- Measure 1 m-1.2m wide of any convenient length
- Dig it well to the depth of 0.3–0.45m so that the stones and roots lying underneath outside the nursery
- Carry out soil sterilization to kill non- beneficial micro-organism.

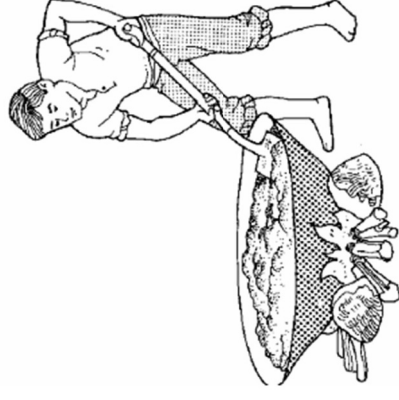
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## Sterilization-Burning of twigs



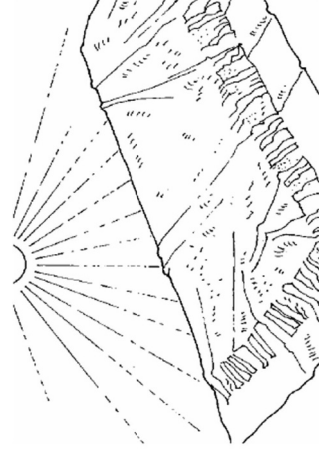
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## Hot plate sterilisation



6

## Sterilization-Solarisation



7

### Preparation of a sunken bed

- Dig a trench of 1.2m wide and 10-15cm deep
- Keep 45-60 cm for operation
- Add 5-10kg of manure and 100g of Compound D
- Break the soil clods into small structures
- Mix it with a garden fork and level with rake



**Fig. No.3.2.3.1: Sunken nursery bed (For hot & dry season bed)**

Source: JICA Project Team

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## Raised Nursery Bed

1m wide and  
15 cm raised



Fig. No. 3.2.1.1: Raised bed

Source: JICA Project Team

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## Flat beds

The bed is  
prepared at  
ground level



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## Sowing in nursery

- Use a dibble/ stick to make straight lines for sowing
- Planting depth should not exceed 2 cm
- Spacing between lines should be not less 5cm
- Water the bed to field capacity before transplanting
- Drill the seeds in the lines made, burry them gently
- Add mulch on top of the soil for moisture conservation and constant soil temperature

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## Nursery Bed Making Steps

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**Step:1 Preparing the Nursery Bed**



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**Step:2 Compost and Fertilizer Application**



**Step:3 Leveling using a Wooden Pole**



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**Step:4 Making Sowing Ditches using a Wooden Pole**

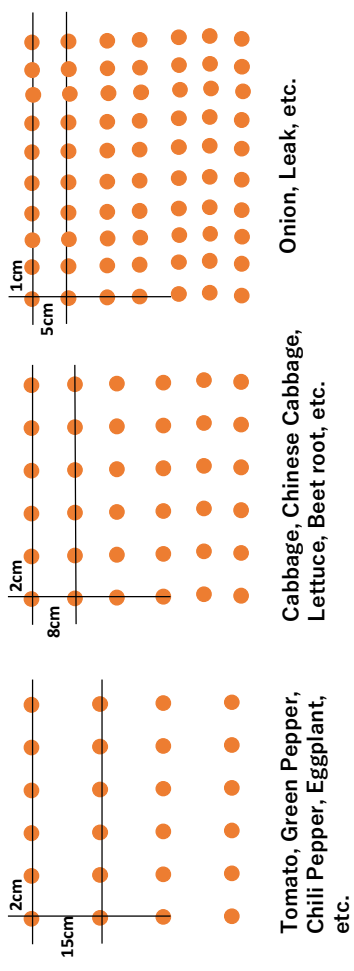




Step:5 Sowing keeping Proper Space



Step:5 Sowing keeping Proper Space



Step:6 Covering the seeds by soil



Step:7 Covering with Mulching materials



**Step:8 Gently Applying Water**



**Step:9 After Germination... Making a roof for protecting the seedlings from strong sunlight**



Lets go and  
Practice Now

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