

**MANUALS FOR THE SEED PRODUCTION OF**  
**SOME VEGETABLES IN**  
**THAILAND**

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# **Eggplant**

## **Solanum melongena**

### 1. **BOTANICAL DETAILS**

The eggplant belongs to the family of the Solanacea. The tomato, potato, sweet pepper and chillies belong to this family too.

The eggplant is an important tropical vegetable originating from India. The variations of shape, colour, size and taste are enormous. The flower anatomy looks like that of the tomato. The five petals are grown together to over their halves. Pollination is predominantly made by own pollen, but up to 20% of cross-pollination is also made by insects. The seeds are rather weak and germinate at irregular intervals. 1000 seed weight is 3.6 - 4 gr.

The eggplant requires more light and higher temperatures than the tomato.

In general the eggplant is less susceptible to diseases than the tomato.

### 2. **ANATOMICAL DETAILS**

### 3. **GENERAL GROWING INFORMATION**

#### 3.1 **Soil requirements**

Eggplant for seed production can be grown on a wide range of soils, but well-drained, fertile, sandy loam soils with a high organic content are preferred.

The optimum pH is between 5.5 and 7. Very acid soils should be limed to bring the pH within this range.

Stunting layers in the soil will induce some growth inhibition. Choose land after paddy in order to reduce nematode incidence.

#### 3.2 **Manuring**

In most cases the crop benefits from a heavy organic manuring. It increases the porosity of heavy soils which in turn increases water absorption and causes greater aeration. In case of light soils, organic matter will help to keep the soil from becoming too porous.

### 3.3 Crop rotation and preceding crop

It is recommended not to return with Solanacea crops to the same plot more than once within 4-5 years.

Good preceding crops are: rice, maize, wheat, beans, peas, celery, beets, carrots, cabbage, radish, garlic, onion, leek and lettuce.

Moderate preceding crops are: melon, cucumber and squash.

### 3.4 Fertilizing

Commercial fertilizers are added to the soil with the particular purpose of directly increasing the amounts of nutrients available for the plants in order to secure a high yield of good quality. The needs for fertilizer and also the required quantities of fertilizer depend to a great extent on the fertility of the soil and this can best be determined by soil analyses. In respect of what is mentioned above it can be given which have to be adjusted in accordance with local circumstances.

Time of application	Nutrients kg/ha		
	N	P	K
Basal	40	80	60
3 weeks after transplanting	40	0	30
5 weeks after transplanting	40	0	30
Total	120	80	120

#### N

Experiments have proved that N in the form of ammonium is less suitable than N in the form of nitrate.

#### P

Quick available super-phosphate gives an earlier and higher yield.

#### K

Potassium-chloride is unsuitable because the plants can be damaged by the chloride.

### 3.5 Seed requirements

For the production of approx. 10 kg seeds is 10 grs stockseed required or approx. 300 grs per ha.

### 3.6 Sowing date

Direct after early rice approx. first week of November.

### 3.7 Germination

The optimum soil temperature at sowing time is 27<sup>0</sup>C

## 4. SEEDLING PRODUCTION

#### 4.1 Direct sowing in the nursery bed

- A) Choose well drained soil.
- B) Broadcast and incorporate fertilizers at the rate of 40 grs. ammonium sulphate, 50 grs superphosphate, 30 grs potassium sulphate and 2 kgs compost for each m<sup>2</sup> of bed area.
- C) Fumigate soil with methyl bromide to control soil born diseases. Methyl bromide must be applied under a plastic cover according to manufacture's directions.
- D) Prepare beds 15 cm apart, 2.5 cm in the row and 0.5 cm deep (=approx. 2 grs of seed per m<sup>2</sup>).
- E) Cover the bed surface with a thin layer of sand followed by rice-hulls, then mulching with rice straw and covering with a tunnel of a thin mesh screen net to avoid rain or sunshine damage.
- F) Plants are ready for transplanting into the field after 35-40 days from sowing.

#### 4.2 Plant selection on the nursery

Before transplanting the seedlings must be checked on off-types first.

The following off-types should be removed:

- plants with a different leaf type
- plants with a different leaf colour
- damaged and diseased plants

### 5. TRANSPLANTING

- A) About 6-9 days before transplanting, harden seedlings by slightly withholding water and exposing them to strong sunlight by removing the netting. Thoroughly water the field.
- B) The ideal transplant is a seedling with 3-5 true leaves, free from diseases and well-grown, stocky and succulent, and not yet having flower buds or flowers.
- C) Dig a hole for each plant deep enough to bury it so that the first true leave just above the surface.
- D) Press the soil firmly around the root, then top irrigate lightly to settle the soil and help the plant survive. Furrow irrigate the field as soon as possible.
- E) Transplanting should be done late in the afternoon to minimize transplanting shock at high temperatures.
- F) About 7 days after transplanting, replant any missing plants.

### 6. SOIL AND CROP MANAGEMENT

#### 6.1 Soil preparation and planting

- A) If the land is dry, irrigate before land preparation.
- B) Plow furrows to a depth of 20 cm and keep a space of 50 cm between furrows.
- C) Place basal fertilizer into alternate furrows and cover with soil. If there is a shortage of labourers, broadcast the basal fertilizer before plowing.

- D) Form the bed 50 cm wide. Make the bed 30 cm high and leave 50 cm of space between the beds.
- E) Plant seedlings in the middle of the bed.
  - Planting distance between the rows: 100 cm
  - Planting distance in the row: 60 cm
  - Plant population per ha: approx. 16,000
- F) Bank the soil of the bed after the second side dressing.

## 6.2 Mulching

Mulch is very beneficial both in the wet and the dry season. It conserves the soil against erosion, allows water and air to penetrate into the soil, retains the moisture in the soil during the dry season, prevents the growth of weeds and protects the surface roots from excessive temperatures. The mulch should be put in such way, that it never touches the stem. As mulch material can be used: rice straw, dried grass and other crop residues.

## 6.3 Staking

For this crop individual stakes are being used and these are placed at an angle with the ground between the two lateral side shoots. In a later stage when the eggplant carries a lot of fruit, it gets extra support by winding a ribbon round the plant which is tied around the stakes.

## 6.4 Pruning

In order to prevent the plants from becoming too bushy are the plants sometimes pruned. Eggplant is being trained to 2 lateral side shoots. The other shoots which appear in the leaf axil have to be taken away. At the same time old yellow discolored leaves should be removed, so that the crop gets a more open plant habit.

## 6.5 Defoliation

Sometimes defoliation might be necessary especially in damp weather conditions. Ventilation will help to lower the aerial humidity and thus helps to decrease the occurrence of fungus diseases.

Only the bad, discolored leaves at the lower part of the stem are removed. Remove and destroy such leaves, never leave them in the field.

## 6.6 Watering

Do not irrigate abundantly in the beginning, since the plants should go deep with their roots as soon as possible. Always irrigate regularly. In general once a week is sufficient. Too poor or too excessive irrigations can cause several disorders. The roots are sensitive to excessive soil water.

## 7. DISEASE AND INSECT CONTROL

### 7.1 Insect control

For a justified insect control it is necessary to have a thorough knowledge of the life-cycle of the insects which are causing the damage. Control at a stage that the attack is still slight, can prevent rapid spreading. Control of eggs laid by butterflies on the leaves gives an indication when a preventive spraying against caterpillars can be carried out. Sometimes heavy infestations of spider mites and fruit worm attack eggplants, however, their impact on yield is less serious than that of diseases. The most dangerous insects are those that transmit virus diseases:

- aphids (*Myzus persicae*) - leaf roll
- white fly (*Bemisia tabaci*) - leaf curl
- thrips (*Thrips tabaci*) - spotted wilt virus

Most common insects and chemicals:

aphids: pirimicarb, parathion, methomyl, propoxur, heptenofos.

White fly: parathion, malathion, diazinon, dichloorvos, methomyl, mevinfos, permethrin, propoxur.

Thrips: diazinon, dichloorvos, mevinfos, propoxur, methomyl, permethrin, tetrachloorvinfos.

Caterpillars: methomyl, trichloorfon, mevinfos, permethrin.

Leaf miner (*Liriomyza solani*): methomyl, parathion, trichloorfon, mevinfos, dichloorvos, permethrin.

Spider mite (*Tetranychus urticae*): fenbutinoxide, dicofol, parathion, cyhexatin, malathion.

Fruit worm (*Helicoverpa armigera*): methomyl, acephate, mono-crotophos, endosulfan.

## 7.2 Fungi control

In contrast with the insect control which starts when the insects or their damage is observed, fungus control starts already before the disease is observed in the field.

Often, the plants are already attacked in a young stage when they are very susceptible, therefore the application of fungicides should already start in the nursery.

Applications must be repeated at 7-10 days intervals and in wet weather, more frequent applications may be necessary because:

- various fungus diseases develop better during wet or damp weather.
- fungicides may be washed off by the rain.

Most common fungi and fungicides:

Early blight (*Alternaria solani*): mancozeb, captafol, iprodion, metiram-zinc.

Late blight (*Phytophthora infestans*): zineb, maneb, propineb, chloorthalonil, fentin-acetate.

Anthracnose (*Colletotrichum phomoides*): maneb, mancozeb.

Septoria leaf spot (*Septoria lycopersici*): benomyl, carbendazim, chloorthalonil, thiophanate-methyl, zineb.

Gray leaf spot (*Stemphylium solani*): maneb, mancozeb, propineb.

Leaf molds (*Cladosporium fulvum*): benomyl, carbendazim.

Black leaf molds (*Cercospora fuligena*): thiophanate-methyl, iprodion, vinchlozolin, tolylfluanide.

Southern blight (*Sclerotium rolfsii*): benomyl, carbendazim, thiophanate-methyl, iprodion.

Gray mold (*Botrytis cinerea*): tolylfluanide, vinchlozolin, benomyl, carbendazim, thiophanate-methyl, iprodion.

Powdery mildew (Erysiphe polygoni and Leveillula taurica): ditalimfos, dimethirimol.

### 7.3 Virus

Plants infected with virus diseases are frequently stunted and often have distorted, discolored or divided leaves. There is no effective treatment once plants have been infected with virus, they should be up-rooted and burnt immediately. Precaution against infection is the control of insects such as white fly, aphids and thrips, which are known to be responsible for carrying virus diseases from plant to plant. Infection can also be caused very easily during nursing of the crops when working from plant to plant.

### 7.4 Bacteria

Bacteria diseases are often soil borne and are carried from plant to plant by contact. Infected plants should be removed and burned since no real effective control measures are available.

Most destructive in the tropics is Bacterial wilt (*Pseudomonas solanacearum*). Acceptable control has been found by soil-sterilisation with methyl-bromide of the nursery beds. Good crop rotation, field choice (ex paddy fields) and good sanitary prevention will help.

## 8. HARVESTING

When the fruits become dull of colour after the edible stage they should be harvested and given a period of after-ripening under a cover. After approx. 5-7 days the fruits are crushed or macerated by machine or by hand. Directly afterwards the pulp should be trampled with the feet and after that the seed and pulp are separated with water. Finally, the seed should be washed with water for two or three times.

## 9. DRYING

After harvesting, the seeds are being dried in the sun for a short period of time. They must be spread out thinly on a cloth, net sieve or cement floor. When the seeds are dry they should be rubbed by hand to break up the clusters.

## 10. CLEANING

The dry seed usually requires some milling to remove fragments of dried fruit tissue. The required operations depend on the condition of the seed, but in general the cleaning problem at this stage is not difficult.

## 11. STORING

The seed should be stored at a low air humidity and not too high a temperature. It is recommended for temporary storage not to store above a temperature of 20<sup>0</sup>C and at a relative humidity above 55%.

## 12. YIELD

Depending on type and variety, the yield fluctuates between 2200-500 kg per ha.

### 13. VARIOUS

- Temperatures during flowering: optimum 25<sup>0</sup>C  
maximum 30<sup>0</sup>C  
minimum 15<sup>0</sup>C
- Scheme of the growing period
  - Sowing till transplanting 40 days
  - transplanting till flowering 40 days
  - flowering till harvesting 70-90 days

## **Chillies**

### Capsicum frutescens

#### 1. BOTANICAL DETAILS

The chillies belong to the family of the Solanaceae, to which family also belong tomato, potato, eggplant and sweet pepper. The scientific name for chillies is CAPSICUM FRUTESCENS L.

It is a herbaceous, strongly branching crop and biennial in warmer climates.

The leaf arrangement is alternate. The glabrous leaves are ovate, elliptical and narrow pointed.

The plants are producing clusters of flowers in their leaf axils containing star-shaped, white flowers. The corolla is 5-8 numbered. Each flower contains five stamen and an epigynous ovary and numerous seed ovules, placed sidewise in the flower.

Both self-pollination occur, the latter by insects.

The fruits are small elongated, often wrinkled with a leathery gloomy fruit wall. The fruit wall is green-deep red of colour and very pungent.

The weight per 1000 seeds is approx. 8 grs.

Chillies show an optimum growth and fruit setting at 21- 27<sup>0</sup>C

#### 2. GENERAL GROWING INFORMATION

## 2.1 Soil requirements

Chillies for seed production may be grown on a wide range of soils, but well-drained, fertile, sandy loam soils with a high organic content are preferred.

The optimum pH is between 5.5 and 7. Very acid soils should be limed to bring the pH within this range.

Stunting layers in the soil will induce some growth inhibition. Choose land after paddy in order to reduce soil born pathogens.

## 2.2 Manuring

In most cases, the crop benefits from a heavy organic manuring. It increases the porosity of heavy soils, which in turn increases water absorption and cause greater aeration. In case of light soils, organic matter will help to keep the soil from becoming too porous.

## 2.3 Crop rotation and preceding crop

It is recommended not to return with Solanacea crops to the same plot more than once within 4-5 years.

Good preceding crops are: rice, maize, wheat, beans, peas, celery, beets, carrots, cabbage, radish, garlic, onion, leek and lettuce.

Moderate preceding crops are: melon, cucumber and squash.

## 2.4 Fertilizing

Commercial fertilizers are added to the soil with the particular purpose of directly increasing the amounts of nutrients available for the plants in order to secure a high yield of good quality.

The need for fertilizer and also the required quantities of fertilizer depend to a great extent on the fertility of the soil and this can best be determined by soil analyses. In respect of what is mentioned above it can be concluded that for fertilizing only general guide-lines can be given which have to be adjusted in accordance with local circumstances.

Time of application	Nutrients kg/ha		
	N	P	K
Basal	40	80	60
3 weeks after transplanting	40	0	30
5 weeks after transplanting	40	0	30
Total	120	80	120

### N

Experiments have proved that N in the form of ammonium is less suitable than N in the form of nitrate.

### P

Quick available super-phosphate gives an earlier and higher yield.

## K

Potassium-chloride is unsuitable because the plants can be damaged by the chloride.

### 2.5 Seed requirements

For the production of approx. 10 kg seeds is 10 grs stockseed needed or 1000 grs per ha.

### 2.6 Sowing date

Depending on the earliness of the variety approx. end of October.

### 2.7 Germination

The optimum soil temperature at sowing time is in the range of 24- 28<sup>0</sup>C

## 3. SEEDLING PRODUCTION

### 3.1 Seedlings production by direct sowing onto the nursery bed

- A) Choose well-drained soil.
- B) Broadcast and incorporate fertilizers at the rate of 10 grs ammonium sulfate, 50 grs super-phosphate, 30 grs potassium sulphate and 2 kg of compost for each 1 sqm. of bed area.
- C) Fumigate soil with methyl bromide to control soil borne diseases. Methyl bromide must be applied under a plastic cover according to manufacture's directions.
- D) Prepare beds 15 cm high and 80 cm wide and plant the seeds in rows 5 cm apart, 2.5 cm in the row and 0.5 cm deep = approx. 2 grs of seed per sqm.
- E) Cover the bed surface with a thin layer of sand followed by rice-hulls, then mulching with rice straw and covering with a tunnel of a thin mesh screen netting to avoid rain or sunshine damage.
- F) Plants are ready for transplanting into the field after 30-35 days of sowing.

### 3.2 Plant selection on the nursery

Before transplanting, the seedlings must first be checked on off-types. The following off-types should be removed:

- plants with a different leaf type
- plant with a different leaf colour
- damage and diseased plants

## 4. TRANSPLANTING

- A) About 6-9 days before transplanting, harden seedlings by withholding water slightly and exposing them to strong sunlight by removing the netting. Thoroughly water plants 12 to 14 hours before transplanting to the field.
- B) The ideal transplant is a seedling with 5 to 8 true leaves, disease-free and well-grown, stocky and succulent, and not yet having flowerbuds or flowers.

- C) Dig a hole for each plant deep enough to bury it, so that the first true leaf is just above the soil surface.
- D) Press the soil firmly around the root. Then top irrigate slightly to settle the soil and help the plant survive. Furrow irrigate the field as soon as possible.
- E) Transplanting should be done in the late afternoon to minimize transplanting shock under high temperatures.
- F) About 7 days after transplanting, replant any missing plants.

## 5. SOIL AND CROP MANAGEMENT

### 5.1 Soil preparation and planting

- A) If the land is dry, irrigate before land preparation.
- B) Form the beds 100 cm wide and 20-25 cm high and leave a furrow between the beds, 50 cm wide.
- C) Dig one row to a depth of 10-25 cm in the middle of the bed.
- D) Place basal fertilizers into the row and cover with soil prior to transplanting.
- E) Planting distance between the rows: 60-75 cm  
Planting distance in the row: 40 cm  
Plant population per ha: 30,000
- F) If necessary, the plant may be hilled up slightly a few weeks after transplanting. The plants develop roots from the part of the stem which has been covered with the moist soil.

### 5.2 Mulching

Mulch is very beneficial both in wet and the dry season. It conserves the soil against erosion, allows water and air to penetrate into the soil, retains the moisture in the soil during the dry season, prevents the growth of weeds and protects the surface roots from excessive temperatures. The mulch should be put in such way that it never touches the stem. As much material can be used: rice straw, dried grass and other crop residues.

### 5.3 Staking

For this crop individual stakes can be used. They must be placed under an angle with the ground between two lateral shoots. In a later stage the plants can be extra supported by winding a ribbon round the plants which is tied around the stakes.

### 5.4 Roguing

In case of off-types, plants with fruits of a different shape, size, etc. Should be removed.

### 5.5 Watering

Do not irrigate abundantly in the beginning, since the plants should go deep with their roots as soon as possible. Always irrigate regularly. Too poor or too excessive irrigations can cause several disorders. Irrigation once a week is in general sufficient, depending on soil type and weather conditions.

## 6. DISEASE AND INSECT CONTROL

### 6.1 Insect control

For a justified insect control, it is necessary to have a thorough knowledge of the life-cycle of the insects which are causing the damage. Control at a stage that the attack is still slight, can prevent rapid spreading. Control of eggs laid by butterflies on the leaves gives an indication when a preventive spraying against caterpillars can be carried out. Sometimes heavy infestations of spider mites can attack chillies. The most dangerous insect enemies of chillies are those that transmit virus diseases:

- aphid (*Myzus persicae*)
- white fly (*Bemisia tabaci*)
- thrips (*Thrips tabaci*)
- leaf roll
- leaf curl
- spotted wilt virus

Most common insects and insecticides:

Aphids: pirimicarb, parathion, methomyl, propoxur, heptenofos.

White fly: parathion, malathion, diazinon, dichloorvos, methomyl, mevinfos, permethrin, propoxur.

Thrips: diazinon, dichloorvos, mevinfos, propoxur, methomyl, permethrin, tetrachloorinfos

caterpillar: methomyl, trichloorfon, mevinfos, permethrin.

Leaf miner (*Liriomyza solani*): methomyl, parathion, trichloorfon, mevinfos, dichloorvos, permethrin.

Spider mite (*Tetranychus urticae*): fenbutinoxide, dicofol, parathion, cyhexatin, malathion.

Fruit worm (*Heliocoverpa armigera*): methomyl, acephate, monocrotophos, endosulfan.

A number of the same insecticides can be used for the control of different insects, thus the control can be done by one spraying, providing that the proper insecticide is chosen. It is recommendable to change regularly the insecticides to prevent immunity of the insects.

### 6.2 Fungi control

In contrast with the insect control, which starts when the insects or their damage is observed, fungi control starts already before the disease is observed in the field. Often, the plants are already attacked in a young stage when they are very susceptible, therefore the application of fungicides should already start in the nursery. Applications must be repeated at 7-10 days intervals and in wet weather, more frequent applications may be necessary because:

- various fungi diseases develop better during wet or damp weather
- fungicides may be washed off by the rain.

Most common fungi and chemicals:

Early blight (*Alternaria solani*): propineb, mancozeb, captafol iprodion, metiram-zinc.

Late blight, Phytophthora blight (*Phytophthora infestans*, *Phytophthora capsici*): tolylfluamide, zineb, maneb, propineb, chloorthalonil, fentin-acetate.

Antracnose (*Colletotricum phomides*): maneb, mancozeb.

Septoria leaf spot (*Septoria lycopersici*): benomyl, carbendazim, chloorthalonil, thiophanate-methyl, zineb.

Gray leaf spot (*Stemphylium solani*): maneb, mancozeb, propineb.

Leaf molds, black leaf molds (*Cladosporium fulvum*, *Cercospora fuligena*): benomyl, carbendazim, thiophanate-methyl, iprodion, vinchlozolin, tolyfluanide.

Southern blight (*Sclerotium rolfsii*): Vinchlozolin, benomyl, carbendazim, thiophanate-methyl, iprodion.

Powdery mildew (*Erysiphe polygoni* and *Leveillula taurica*): ditalimfos, dimethirimol.

### 6.3 Bacteria

Bacterial diseases are often soil borne and are transferred from plant to plant by contact.

Once infected plants should be removed and burned since no real effective control measures are available. Most destructive in the tropics is Bacterial Wilt (*Pseudomonas solanacearum*). Acceptable control has been found by soil sterilisation with methyl bromide of the nursery beds. Good crop rotation, field choice (ex paddy fields) and good sanitary prevention will help.

### 7. HARVESTING

The pods have to be dried in the sun or artificial. The temperature applied should not exceed 35<sup>0</sup>C until the pods are dry enough for threshing can be done by flailing the pods in half filled bags and that is less irrigating, with a special designed thresher with a good dust sucking and dust isolation equipment.

### 8. DRYING

After harvesting it could be necessary to dry the seeds in the sun for a short period of time. They must be spread out thinly on the cloth, net sieve or cement floor.

When the seeds are dry, they should be rubbed by hand to break up the clusters.

### 9. CLEANING

After the seed is dry, it may require cleaning to remove fragments of dried fruit which are still present in the seed.

### 10. STORING

The seed should be stored at a low air humidity and not too high a temperature. It is recommended for temporary storage not to store above a temperature of 20<sup>0</sup>C and at a relative humidity above 55%.

### 11. YIELD

Depending on type and variety, the yield fluctuates between 50-150kg per ha.

### 12. VARIOUS

- temperatures during flowering: optimum 21-27<sup>0</sup>C  
maximum 28-32<sup>0</sup>C  
minimum 15-18<sup>0</sup>C

- scheme of the growing period:  
sowing till transplanting 30-40 days

transplanting till flowering	30-35 days
flowering till harvesting	45-60 days.

## **Chinese radish**

### **Raphanus sativus sub var. longipinnatus**

#### 1. **GENERAL**

Chinese radish is an annual plant with a swollen white, round, cylindrical tap root with a mild flavor. The flower colour can variate between white and lilac. Radish is a cross- pollinator. Pollen transport occurs by insects (bees). Bolting date approx. 55 days after sowing.

In trials it has been found that long day condition or light can act supplementary effect to low temperature in vernalization.

Chinese radish will probably better produce seeds than Japanese varieties.

The pod is one to three inches long with a pithy interior. It has an extended beak but lack entirely any exterior longitudinal groove.

#### 2. **CLIMATE**

Best suited in the cooler parts of the dry season. Radish can stand better less humid climates than many other crucifers. Long hot dry periods are not suitable. Temperatures of 32<sup>0</sup>C or higher can cause bad seed set, because of too dry stigma and reduced germination of the pollen. Winter varieties should be grown on the highlands (above 1000 meter) and summer varieties should be grown on the low lands.

3. SOIL

Fertile loam. Sandy soils are possible but only then when well manured. Can grow under slightly acid soil conditions. Optimum pH 5.5 - 6.8. Radish is little salt tolerant.

4. CROP ROTATION

Avoid a crucifer crop before. In Europe they use an 8 years interval between radish, but 4 years are acceptable.

5. ISOLATION

Isolation distance minimum 100 meter between sativus types and 1500 meter between hybrids. Radish can cross-pollinate with *Raphanus raphanistrum*, *maritimus*, *landra* and *rostatu*.

6. NUTRITION

During land preparation	- N	50 kg/ha
	P	100 kg/ha
	K	80 kg/ha

Just before bolting a side-dressing with 30 kg Nitrate per ha.

7. SOIL PREPARATION

Prepare the soil till it has a fine texture. Depending on the local circumstances and irrigation needs it may be better to produce beds of ca. 100 cm wide.

8. SOWING

Direct sowing.

Date: 1 th of November.

Stockseed: 2-3 kg/ha

Distance between the rows 50 cm. Per meter row 10 plants.

9. TRANSPLANTING

Only for stockseed production. Transplanting from the nursery ca. mid of December.

10. IRRIGATION

Can withstand drought well. When necessary furrow-irrigation, only at the end of the day. Irrigation is important during flowering.

11. ROGUING

Important stages: - before flowering, when stem elongation starts

- begin of flowering

12. WEED CONTROL

a) by hand

b) by the use of herbicides

- before sowing 2 liter Trifluraline per ha, which should be incorporated 5-8 cm into the soil.

- after sowing, before germination: 7 kg Propachlore per ha.

13. INSECT CONTROL

Thrips

Phyllotreta

- Parathion powder

Psylliodes chrysocephala

ceuthorrhynchus spp.

- Cyper/delta/permethrin

Do not spray during flowering.

14. PATHOGEN CONTROL

leaf spot

- Alternaria spp.

iprodion or vinchlozolin

White blight

- Sclerotinia sclerotiorum

damping off

- Rhizoctonia solani

- seed treatment thiram

bottom rot

- iprodion or vinchlozolin

black leg

- Phoma lingam

- seed treatment with

thiram

yellow

- Fusarium oxysporum

- crop rotation

downy mildew

- Peronospora parasitica

- maneb, zineb, metalaxyl

white rust

- Albugo candida

black rot

- Xanthomonas campestris - seed-borne

hot water treatment

15. HARVESTING

Crop starts to mature when the pods are changing from yellow to brown. At the same time the seeds are turning brown too. Radish pods do not dehisce. After approx. 2 weeks the crop can be harvested.

Threshing is sometimes troublesome if the plants are too dry or too humid. Radish is sensible to mechanical damage. Advice when an ordinary thresher is used to reduce the drumspeed to 20 m.p.s. The use of a belt-thresher will give the best threshing results. Threshing by fail is natural also possible.

Front opening concave cylinder 10 mm

Back opening concave cylinder 4 mm

Size return screen 7 mm

Size bottom screen 5 mm

Harvest date approx. end of March

16. YIELD  
800 kg/ha

17. DRYING  
Dry down directly after harvest till min. 9 %

## **Chinese Cabbage**

Brassica campestris var. Chinensis (pak-choi)

Brassica campestris var. Pekinensis (pe-tsai)

### 1. GENERAL

Chinese cabbage is an annual long day plant ...production is much simpler than with Brassica smaller pods and seeds are similar to olerate is cross- pollinated. Bees are the primary age nation. There are approx. 100 seeds per gram.

### 2. CLIMATE

Moderate temperatures combined with a short day length are favorable to head formation (g possibilities). The best time to grow seed the dry winter season on the low lands. High ... give insufficient vegetative development.

### 3. SOIL

Adapted to a wide range of soils but good seed and water supply essential. Optimum pH 6.0 - ... for Plasmodiophora brassicae (club root). This .. low pH soils.

### 4. CROP ROTATION

3-4 years to prevent building up of soil-borne

### 5. ISOLATION

Isolation distance minimum 1000 meter. Can crop with:

- Brassica perviridis (tendergreen mustard)
- Brassica rapa (turnips)

### 6. NUTRITION

N 100 kg/ha

P 80 kg/ha

K 60 kg/ha

Sometimes risk for Ca and Bo deficiency.

### 7. SOIL PREPARATION

Beds of 100 cm width. Distance between the beds.

8. SOWING

Direct sowing approx. 2 kg stockseed per ha.

By transplanting 0,40 kg per ha.

Sowing date beginning/mid of November.

Distance between the rows 30-40 cm, in the row

Depth 1-1.5 cm.

Pekinensis needs more space than chinensis.

9. IRRIGATION

When necessary furrow irrigation at the end of the days.

10. WEED CONTROL

a) by hand/ machine

b) chemicals - profam 5-7 liter/ha direct after sowing

11. INSECT CONTROL

Chinese cabbage is very attractive for insects such as aphids, caterpillars etc. It means also a risk for virus diseases such as Turnip Mosaic Virus.

12. PATHOGEN CONTROL

Stockseed must be treated with thiram.

Leaf spot - *Alternaria brassica*

gray mold - *Botrytis cinerea* iprodion or vinchlozolin

white rot - *Sclerotinia sclerotiorum*

bottom/head rot - *Rhizoctonia solani*

black leg - *Phoma lingam* - seed treatment with thiram

yellows - *Fusarium oxysporum*

bact. soft rot - *Erwinia carotovora*

black rot - *Xanthomonas campestris* - hot water treatment

13. During the heading stage on off-types. Approx. end of December.

14. HARVESTING

End of February/beginning of March when the first pods of the dried-out plants start to shatter can the plants harvested directly. More practical is to swath/ up-root first before threshing.

Threshing by flail or by ordinary thresher. Drumspeed max 20 m/sec. Front opening concave-cylinder 20 mm and the back opening 6 mm. Use a return screen of 7 mm and a bottom screen of 3 mm.

15. YIELD

600 kg/ha

16. DRYING

Should be dried down after harvest to min 8 %

## **Chinese kale (Kai-lan)**

### **Brassica oleracea var. alboglabra**

1. GENERAL

Chinese kale is one of the popular brassica greens in the S-E Asian countries, because of its tolerance to heat and humidity of the tropics.

Chinese kale will produce easily seeds under Thai conditions. It is possible to produce seeds from the top harvested plants. Chinese kale is white flowering.

The weight of 1000 seeds is approx. 3.3- 5.0 gram.

2. SOWING

Direct sowing - sowing rate 1 kg stockseed by nursery and 2 kg by direct sowing.

a) only seed production - sowing date mid October

b) first crop harvest, stumps are used for seed production - sowing date 1 th of October

3. SPACING  
40 X 30 CM
4. ROGUING  
Just before marketable stage. Depending of the sowing period method - begin/ end of December.
5. YIELD  
500-600 kg/ha
6. OTHER CROP INFO  
See broccoli and chinese cabbage.

## **Broccoli**

### Brassica oleracea var. Italica

1. GENERAL  
Broccoli is a biennial, days neutral plant. The curd is not compact and mostly green of colour. Broccoli is more heat tolerant than cauliflower, but the higher the temperature the lower the seed yield.  
Broccoli is a cross- pollinator (bees)  
there are approx. 250-350 seeds per gram.

2. CLIMATE

The crop will perform well between 18 - 27<sup>0</sup>C during day-time and with a mean of 20<sup>0</sup>C. For a good seed production we advice to grow on the highland during the dry winter season.

3. SOIL

Can stand many types of soil. Prefers sandy clay or fertile loam with a high organic content. Optimum pH 6.5 or higher.

4. CROP ROTATION

4 years also with chenopodiacea.

5. ISOLATION

Isolation distance minimum 1000 meter between oleracea types and 1500 meter between hybrids. Be ware of Kailan.

6. NUTRITION

N 100 kg/ha (incl. 20 Kg side-dressing)

P 80 kg/ha

K 80 kg/ha

Side-dressing just before flowering with Nitrate.

7. SOIL PREPARATION

Beds of 100 cm with a fine texture.

8. SOWING

The seedlings should be raised in the nursery. Sowing can be done directly into the nursery-bed. Distance between the rows 20 cm and in the row 2.5 cm. Sowing time end of September. Depth 1 cm. 300 grs stockseed per ha.

9. TRANSPLANTING

Date: 1 th of November (4 weeks after sowing).

Depth: deep as possible.

10. IRRIGATION

When the necessary furrow-irrigation, only at the end of the days and specially direct after planting and during flowering and seed-set.

11. WEED CONTROL

a) by hand/ machine

b) chemicals - direct after transplanting 7 kg/ha propachlore (Ramrod)

12. INSECT CONTROL

Aphids - pirimicarb  
Soil-insects - prevent attack in the nursery by soil treatment with an insecticide e.g. tri-chloronate or aldicarb.  
Ceuthorrhynchus spp. -Cyper-, delta- or permethrin.  
Do not spray during flowering time.

### 13. PATHOGEN CONTROL

Leaf spot	- Alternaria brassica	
gray mold	- Botrytis cinerea	iprodion or vinchlozolin
white rot	- Sclerotinia sclerotiorum	
bottom/head rot	- Rhizoctonia solani	
black leg	- Phoma lingam	- seed treatment with thiram
yellows	- Fusarium oxysporum	
bact. soft rot	- Erwinia carotovora	
black rot	- Xanthomonas campestris	- hot water treatment

### 14. ROGUING

- At the marketable stage just before flowering. Period from heading time is approx. end of December.  
- Flowering time - this is approx. mid/end of January.

### 15. HARVESTING

Crop is mature when the pods are yellow/brown. The seeds are browning and the lower pods are shattering. This is the stage to swath or up-root the plants. After approx. 7 days the crop can be threshed by flail or by an ordinary thresher. Drumspeed max. 20 m/sec.

- Front opening concave cylinder 20 mm
- Back opening concave cylinder 8 mm
- return screen 7 mm
- bottom screen 5 mm

Harvest period approx. begin/mid of March.

### 16. YIELD

Approx. 600 kg/ha

### 17. DRYING

Dry down after harvest till min. 8 %.

# **Cucumber**

## **Cucumis sativus**

### 1. **GENERAL**

Annual, day-neutral, trailing vine type with a main stem from which develop several main branches. It will have a vigorous growth under warm conditions. It has male and female flowers on the same plant. Fruits can have white or black spines or hairs. A plant will carry under outdoor production not more than 5 fruits.

Period from sowing till harvesting approx. 100 days.

### 2. **CLIMATE**

Optimum temperature 28 - 30°C. Grows the best in the dry season with a low humidity and with irrigation.

### 3. **SOIL**

Preferable high fertile soils e.g. silt, clay loam, sandy loam. Optimum pH is 6.5 - 7.5.

### 4. **CROP ROTATION**

4 years including solanaceae.

### 5. **ISOLATION**

Predominantly cross-pollinated (bees).

Isolation distance minimum 1000 meter and with hybrids minimum 1500 meter.

### 6. **NUTRITION**

N 80 kg/ha (partly as side dressing)

P 40 kg/ha

K 80 kg/ha

### 7. **SOIL PREPARATION**

Raised beds, width 100 cm, height 20 - 25 cm, furrow 40 - 50 cm.

### 8. **SOWING**

Date: first week of December. Earlier sowing not advisable because of risk for high virus infection.

A) Direct sowing on raised beds. 4 kg stockseed per ha.

Sowing distance 70 x 50 cm. Plant 3 seeds per station.

The station must be thinned out after germination to one plant.

B) The use of transplants. Mostly sown in pots or plastic perforated bags. 1 kg stockseed per ha.

#### 9. TRANSPLANTING

Transplanting stage: 1-2 leaves.

Distance between the rows 70 - 80 cm and in the row 50 cm.

#### 10. STAKING

Crop can be grown with and without stakes. Staked crop will deliver a better quality and quantity of seeds. Use only the main stem for seed production with a staked crop - cut the side branches off till the 7 th internode. Stakes can be placed a week after transplanting - stake length 2.5 meter.

#### 11. IRRIGATION

Use furrow irrigation. Cucumbers need regular irrigation, specially during flowering. The crop will not stand water logging.

#### 12. ROGUING

- direct after first fruit set (staked crop)

- before harvest when the fruits are mature.

#### 13. WEED CONTROL

Hoeing. Important during the early growth.

#### 14. INSECT CONTROL

Aphids, cucumber beetle, fruit flies, caterpillars, spider mites, white fly. Attack of the mentioned insects sometimes troublesome.

#### 15. PATHOGEN CONTROL

Root rot	- Fusarium solani
Downy mildew	- Pseudoperenospora cubensis
Powdery mildew	- Erysiphe cichoracearum
Angular leaf spot	- Pseudomonas lachrymans
Antracnose	- Colletotrichum lagenarium
Bacterial wilt	- Erwinia tracheiphila
CMV	- Cucumber mosaic virus
Stem	- Sclerotinia sclerotiorum

## 16. HARVESTING

During the month of March. The fruits are mature when they are yellow (depending of the type also white, orange, pale yellow-green) and when the seeds are not longer attached to the flesh.

- a) By hand - cut the fruit lengthwise and scrape the seeds out.
- b) With a vine-crop-harvester.

We can separate the seeds from the pulp by: fermentation 2 days followed by washing with clean water or first 7 % HCL during 30 minutes followed with many washes of clean water.

During washing the light seeds can be poored off.

## 17. YIELD

300 kg/ha

## 18. DRYING

The best results are obtained with a rotor-dryer, but the use of screen bottom trays is also possible. Dry down till 8 % moisture content.

# Watermelon

## Citrullus lanatus

### 1. GENERAL

Watermelon is a day neutral annual plant. The trailing individual stems extend as much as 3.5 - 5.5 m. It requires a relative long hot season for good fruit development.

Most varieties are monoecious and have hermaphrodite, male and female flowers on the same plant. It matures seed in 90 - 110 days, depending on variety and place. The weight of 1000 seeds is approx. 150 grams.

### 2. CLIMATE

Watermelons prefer the hot drier areas with abundant sunshine. It needs a main temperature of above 20<sup>0</sup>C. It will not germinate under 20<sup>0</sup>C. It needs for a good fruit set a temperature of minimum 20<sup>0</sup>C. It can stand a high air-humidity but the seed and fruit set is sometimes poor in the humid tropics. Elevations in the tropics above 1000 meter produce satisfactory crops.

3. SOIL

Will grow on a wide range of well drained soils. Tolerates a lower soil fertility than most other vine crops.

The best soil for watermelon is sandy loam.

Minimum pH is 5.

4. CROP ROTATION

5 years

5. ISOLATION

Partly self and cross pollinated. Cross pollination by insects (bees).

Isolation distance minimum 1000 meter.

6. NUTRITION

React well on organic manure.

N 60 kg/ha

P 100 kg/ha

K 60 kg/ha

7. SOIL PREPARATION

Well cultivated fairly loose soil is essential.

Prefer ridges, specially when furrow irrigation is used.

8. SOWING

Date: December

Sow on the spot 2 seeds on a distance of 1.80 x 0.90 meter.

After the first true leaf stage every station must be thinned out to 1 plant.

Sowing depth: 2.5 cm.

9. IRRIGATION

The crop is fairly drought resistant. Will not stand water-logging. Regular irrigation is required in the dry season.

10. ROGUING

Stage: when the fruit shape and colour can be determined (marketable stage).

11. WEED CONTROL

By hand/hoeing.

12. INSECT CONTROL

- |                  |                     |
|------------------|---------------------|
| Cucumber beetles | - Diabrotica spp.   |
| Caterpillars     | - Margarania indica |
| Fruit flies      | - Daucus spp.       |
| etc.             |                     |

13. PATHOGEN

- |                   |                              |
|-------------------|------------------------------|
| Wilt              | - Fusarium spp.              |
| Antracnose        | - Colletotrichum lagenarium  |
| Gummy stem blight | - Didymella bryoniae         |
| Powdery mildew    | - Erysiphe cichoracearum     |
| Downy mildew      | - Pseudoperonospora cubensis |
| WMV               | - Watermelon mosaic virus    |

14. HARVESTING

Approx. April.

Harvesting stage normally at least a week after the fruit has reached the edible stage.

Cut the fruit open by hand, scrape the seed cut and wash it over a screen with clean water. It is also possible to use the mechanical method which is used by cucumber.

Fermentation is not advisable because of seed colour and viability.

15. YIELD

200 - 250 kg/ha

16. DRYING

Direct after harvesting/washing till 10 % moisture content.

## **Sugar pea, snap pea**

### **Pisum sativum**

#### 1. **GENERAL**

Pea is an annual day-neutral/ long day plant with a trailing climbing or dwarf habit. The climbing types can grow up to 2.50 meter high. The leaves have three leaflets. The plant has leaf tendrils and produces white, pink or red flowers. The pods are different from other peas types. The difference is that in the pod no parchment (fibre) is present.

Growing period from sowing till seed-harvest approx. 3 months. 1000 seeds weight is approx. 125 - 250 grams.

#### 2. **CLIMATE**

Can be grown on the low-land during the cool season (20 - 30<sup>0</sup>C), but the seed harvest will be better on the higher altitudes (1000 - 1500 meter) will temperatures between 15 - 30<sup>0</sup>C.

Optimum temperature is 21<sup>0</sup>C with cool nights.

#### 3. **SOIL**

Well drained clay-loams with a good content of organic material. Optimum pH 6.0 - 7.7.

#### 4. **CROP ROTATION**

5 years.

#### 5. **ISOLATION**

Pea is largely self-pollinated.

Minimum distance 50 meter.

#### 6. **NUTRITION**

N 20 kg

P 70 kg

K 60 kg

#### 7. **SOIL PREPARATION**

Deep cultivation and a seed-bed with a fine tilth.

#### 8. **SOWING**

50 - 150 kg stockseed per ha depending of the variety =  
$$\frac{\text{plants per m}^2 \times 1000 \text{ seeds weight}}{\text{field germination}}$$

Sowing method: on the flat or on ridges.

Sowing depth: 3 - 5 cm.

Distance between the rows on the flat: 10 - 20 cm.

Distance between the rows on the ridges: 50 cm.

9. STAKING

Only for the tall growing varieties. Stake length ca. 1.50 meter.

10. IRRIGATION

Furrow irrigation, specially during flowering time. Late irrigation during end of flowering must be avoided because of risk for sun-scalding and diseases.

11. ROGUING (OF STOCKSEED PLOTS)

- When the plants are ca. 8 - 10 cm high - remove the tall/early ones.

- just before flowering - remove the higher plants and the ones with a different colour

- during flowering - remove the higher plants, plants with a different plant colour and plants with a different flower colour.

- During maturing when the pods are visible on - big types, late ones, different pods, peas in snap peas and sterile types.

12. WEED CONTROL

- by hand

- by chemical

a) direct after sowing                      - Tribunil (methabenzthiazuron)  
3 -4 kg/ha

b) after germination till 5 leaves            - DNBP (dinoseb)  
6 - 8 liter/ha.

13. INSECT CONTROL

eelworm    - crop rotation

aphids    - 0.50 kg pirimimicarb per ha.

Pea weevils/thrips/etc.                        - several insecticides available

14. PATHOGEN CONTROL

Ascochyta blight                                - Ascochyta spp.

Gray mold                                         - Botrytis cinerea

Wilt     - Fusarium spp.

Sclerotinia disease                            - Sclerotinia sclerotiorum

Powdery mildew                                - Erysiphe polygoni

Bacterial blight - Pseudomonas pisi  
Virus - crop rotation and insect (aphids) control.

15. HARVEST

A) by swathing - stage is when the seed splits during rubbing and no visible moisture is available.

Threshing 14 days after.

B) Direct

Optimum moisture content of the seed during threshing is ca. 18%. Maximum speed concave cylinder is 400 r.p.m.

**Cow pea, Yard long bean - climbing type**

Vigna sinensis

1. GENERAL

Vigna sinensis is a short-days annual with trailing stems, warm weather plant and very sensitive to frost. Slightly more drought resistant than soya bean. The roots are well developed with a surface root system arising from branches of the top root. The plant has long, slender, pendent, cylindrical pods. (Pole type)

1000 seeds weight approx. 140 grams.

2. CLIMATE

Grow well in humid and hot areas. Poor seed set under dry conditions. Culture above 1000 m not successful.

The best growing season is from September till December. Also considering virus diseases and the worse maturing of the seeds in the cool season.

3. SOIL

Adapted to a wide range of soils - even relative acid - but strongly acid or alkaline are not recommended. Grows best on sandy loam soil with a pH in the range of 5.6 - 6.5.

4. CROP ROTATION

At least 2 years.

5. ISOLATION

The crop is self- pollinated. Cross-pollination can occur. Min. distance between varieties 200m.

6. NUTRITION

N 0 - 30 kg depending on the soil fertility

P 60 kg

K 40 kg

7. SOIL PREPARATION

Well prepared seed bed necessary. Beds approx. 100 cm. Width. Crop must be stake length ca. 2m.

8. SOWING

Usually on beds. Distance between the rows 75 cm. Distance in the row 25 cm. Stockseed approx. 15 kg/ha. Plant two seeds per hole. Sowing date beginning of September.

9. IRRIGATION

Furrow irrigation must suitable. Irrigation during flowering benefits the production/seed set.

10. WEED CONTROL

Hoeing and weeding

11. INSECT CONTROL

Caterpillars

Bean fly - *Agromyza phaseoli*

12. PATHOGEN CONTROL

Root rots, wilt - *Fusarium solani*, *Fusarium oxysporum*,

- *Sclerotinia sclerotiorum*

Leaf spot - *Ascochyta* spp.

Downy mildew - *Peronospora viciae*

Powdery mildew - *Erysiphe pisi*

Anthraxnose - *Colletotrichum lindemuthianum*

13. ROGUING

Mature stage of the pods is the best moment to detect and to remove the off-types.

14. HARVESTING

From mid till the end of November when 50 - 67% of the pods are brown (mature) plants can be cut by hand. Threshing by flail or thresher (drum speed reduced to 500 r.p.m).

15. YIELD

Approx. 700 kg/ha

16. DRYING

Dry down to min. 13%.

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