



World Vegetable Center



GOVERNMENT OF ASSAM



Assam Rural Infrastructure and Agricultural Services Society

CULTIVATING CABBAGE IN ASSAM

An Illustrated Manual of the
WorldVeg Improved Production Guide [IPG]



WorldVeg Guidelines *for* Cabbage Production *for* Farmers and Extension Agents *in the* APART Project Demonstrations

Demonstration Area: 0.15 ha [approximately 1 bigha]



**35 – 30
DAYS
BEFORE
TRANSPLANTING**

Coco-peat
bricks

PREPARING COCO-PEAT

- ❖ Place 30 kg of **coco-peat** blocks or bricks in 300 liters of water for 24 hours.
- ❖ Attempt to break them down a few times.
- ❖ After complete expansion, fluff up and powder the **coco-peat** blocks.
- ❖ Then, drain excess water.
- ❖ This process removes salt present in the **coco-peat**.
- ❖ Prepared **coco-peat**, when squeezed, should *not* expel water.



Powdered
coco-peat



'Squeeze-
testing'
coco-peat

WEEDING NURSERY AREA

- ❖ Remove **weeds** within and around the nursery area.
- ❖ **Weeds** can serve as alternate hosts to diseases and insect pests. In this way, **weeds** can enhance pest incidence.



Weeding

30 DAYS BEFORE TRANSPLANTING



Preparing
potting
mixture



Checking
for well-
formed
holes



Filling
seedling
trays with
potting
mixture



PREPARING POTTING MIXTURE

- ❖ Uniformly mix the **prepared coco-peat**, 40 kg **well-matured vermi-compost** and 40 kg **charred [not ash] rice husk**, along with 100 grams *each* of **phosphorus solubilizing bacteria (PSB)**, *Azotobacter*, *Azospirillum*, *Pseudomonas* and *Trichoderma* formulations. Use coco-peat, vermi-compost and husk at approx. 3:1:1 by weight.

FILLING SEEDLING TRAYS

- ❖ Check **seedling trays** for presence of well-made holes at bottoms of plugs, to ensure proper drainage.
- ❖ If mono-cropping, fill 83 **seedling trays** of 98 plugs [holes] each; for approx. 8000 seedlings. If intercropping, fill 62 **seedling trays** of 98 plugs each; for approx. 6000 seedlings.
- ❖ Heap **potting mixture** over **seedling trays**; then, move a straight, flat object [such as a **wooden plank**] over the top, from one end to the other, to remove excess **potting mixture**.
- ❖ Do *not* compress **potting mixture** while filling; do *not* tamp down.

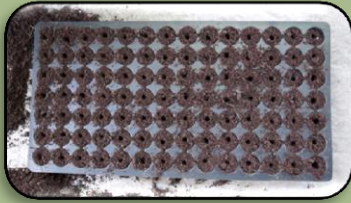
SEED TREATMENT

- ❖ Uniformly mix **seeds** with 2 grams of *Trichoderma* formulation.

SOWING SEEDS

- ❖ After filling **seedling trays**, make 1.5 cm-deep holes in the center of each plug, using a **pencil** or similar object.
- ❖ Sow only a single **seed** into each hole/plug.
- ❖ Cover holes with **potting mixture**; again, making sure *not* to compress the **potting mixture**. Follow same process as before to fill.

Making holes for sowing



IRRIGATING SEEDLING TRAYS

- ❖ Immediately after sowing, *lightly* **water** the **seedling trays** if moisture in **potting mixture** is insufficient.
- ❖ Do *not* apply **water** excessively.
- ❖ Use a device that applies **water** gently; and does *not* displace **potting mixture** during irrigation.
- ❖ To prevent displacement of **potting mixture** during the first irrigation, cover trays with newspaper or cloth and apply water *gently* through this layer.
- ❖ **Seedling trays** can be typically irrigated once daily; but, apply water as required. *Never* apply water forcefully or excessively.

Sowing



Watering seedling trays



STACKING SEEDLING TRAYS

- ❖ To enhance speed and uniformity of germination, for 3 – 4 days *only*, stack seedling trays in a zig-zag manner.

Stacking seedling trays





Keeping nursery under protection



Protecting nursery from pests



Emerged seedlings



Yellow sticky trap

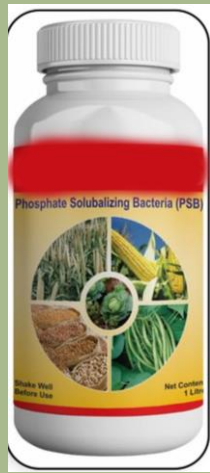
MAINTAINING SEEDLING TRAYS IN NURSERY

- ❖ In cool weather, to improve germination, cover **seedling trays** with **black plastic sheet** for a few days following sowing; and keep them under shade.
- ❖ Do *not* maintain this cover after seedling emergence.
- ❖ After emergence, spread **seedling trays** on an open, protected area.
- ❖ Protect **seedling trays** from rain or hail by keeping them under a **shade net** or removable **plastic sheet**.
- ❖ To reduce pest damage, keep nursery completely covered with insect-proof net.
- ❖ Place **seedling trays** on **concrete floor** or on **plastic sheet**; so that roots do *not* come into contact/penetrate soil underneath.
- ❖ Nursery must *not* be in a shaded or damp area. Well-aerated and sunlight conditions are important for seedling health.

PLACING STICKY TRAPS IN NURSERY

- ❖ At the center of the nursery, place 1 **yellow** and 1 **blue sticky trap**, [individual sheet size: 22 cm x 30 cm] approx. 15 cm above the **seedling trays**.

20 - 15 DAYS BEFORE TRANSPLANTING



Microbial
bio-
fertilizers
and bio-
control
agents



PREPARING ENRICHED VERMI-COMPOST

- ❖ Uniformly mix 250 kg of **well-matured vermi-compost** with 400 grams *each* of **PSB**, *Azotobacter*, *Azospirillum*, *Pseudomonas* and *Trichoderma* formulations. | Do *not* mix synthetic chemicals with bio-agents.
- ❖ Ensure that **vermi-compost** does *not* dry out after inoculation; keep moist, but, do *not* wet excessively.
- ❖ Cover with a **sheet** after inoculation; and store under protection, away from sunlight.

Enriching
vermi-
compost



Advisory
Coco-peat, potting mixture, enriched vermi-compost and transplanting media, upon preparation, must be moist and easy-flowing; but *not* dry or sticky.

PLANT PROTECTION

- ❖ Apply **neem oil** [against sucking pests] over seedlings [at 2 - 3 leaf stage] and on the floor of the protected nursery, @ 0.4 mL per 10 m² @ 500 mL spray volume (i.e. 0.8 mL per liter of water ; i.e., 2 teaspoons in 10 liters of water).

Enriched
vermi-
compost
incubating
in dark,
protected
place



PLANT PROTECTION

- ❖ If cropping system permits, apply **lime** as required from soil testing. | Shallowly incorporate to increase efficacy.
- ❖ Use finely powdered **lime**.

Enriched
vermi-
compost
covered
for
incubation



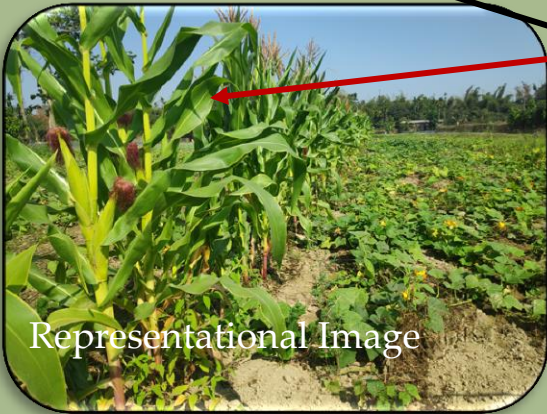


**10
DAYS
BEFORE
TRANSPLANTING**

Border
crops

PLANTING BORDER CROPS

- ❖ Plant 3 rows of **maize** along the border at 30 cm row-spacing and 20 cm plant-to-plant spacing.
- ❖ Plant into 5 cm-deep furrows and cover with soil.



Representational Image

**5
DAYS
BEFORE
TRANSPLANTING**

PREPARING THE FIELD

- ❖ Plow field, harrow cross-wise using multi-row disks or regular cultivators; then, level using a shallow leveling implement.
- ❖ In case of zero-till production: Avoid tillage operations.
In case of strip-till production: Chisel-plow *only* along where crop will be planted. Do *not* perform other tillage operations.
- ❖ **Mulch** with **rice-straw**, **arecanut-husk**, or similar material. If intercropping, **mulch** after **intercrop** harvest; if using on-field [**rice-straw**] residue, keep **mulch** within in-row space until **intercrop** harvest.



Zero-tillage method with rice-straw mulch

HARDENING TRANSPLANTS

- ❖ Reduce the quantity of water applied to seedlings. Be careful *not* to let seedlings wilt.
- ❖ Also, remove **seedling trays** from protected nursery to expose them to outside conditions.

Keeping seedling trays outside for hardening



PLANT PROTECTION

[*Spodoptera*]

- ❖ If *Spodoptera* is a serious problem: Flood field to reduce population of pupae in soil.

1 DAY BEFORE TRANSPLANTING



PREPARING TRANSPLANTING MEDIA

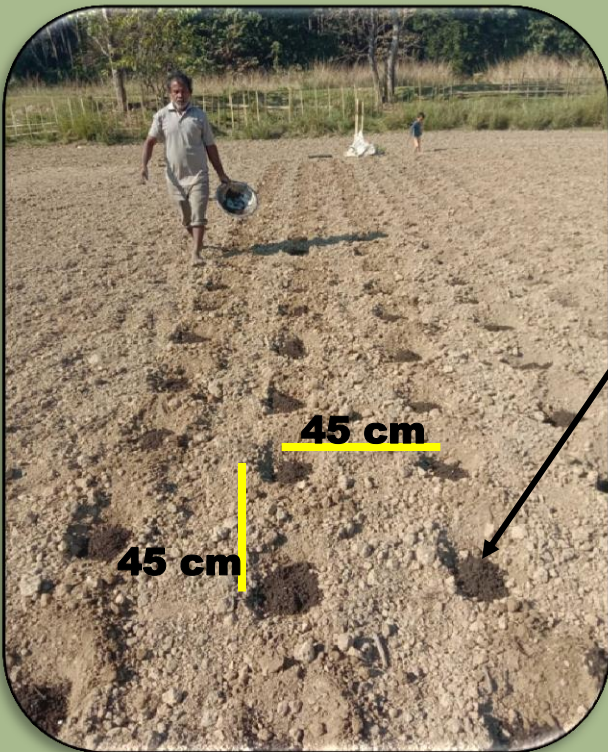
- ❖ Uniformly mix 15 kg diammonium phosphate (DAP), 12 kg muriate of potash (MOP), 500 g Borax, 100 g Ammonium molybdate, 250 kg enriched vermi-compost and 1000 kg farmyard manure (FYM).
- ❖ To mix uniformly: Spread FYM on an open area; then, distribute DAP, MOP and enriched vermi-compost evenly over FYM in different layers; then, mix in from sides.



Preparing trans-planting media

PLANT PROTECTION [damping-off]

- ❖ If damping-off is a serious problem: Drench seedling roots in a solution of chlorothalonil 75 WG formulation @ 2 g per liter of water or Fosetyl Al 80% WP @ 3 g per liter of water.



Trans-planting pits with trans-planting media

PREPARING TRANSPLANTING PITS

- ❖ Make 15-cm-deep and 10-cm-wide **transplanting pits**, at 45-cm-row and 45-cm-plant-to-plant spacing [or, 30 cm and 30 cm] [where seedlings will be transplanted]
If intercropping, use 60-cm-row and 45-cm-plant-to-plant spacing.



Trans-planting furrows with trans-planting media

- ❖ Alternatively, if easier, 15-cm-deep and 10-cm-wide **transplanting furrows** may be made; then, **transplanting media**, and seedlings can be placed according to plant-to-plant spacing.

DAY OF TRANSPLANTING



Trans-planting from seedling trays



Trap crops [in photo: mustard in cabbage]

Representational Image



Inter-cropping [in photo: beans in Cole crops]



Irrigating trans-planted seedlings

TRANSPLANTING

- ❖ Put 150 grams **transplanting media** in each **transplanting pit** [250 grams if intercropping].
- ❖ Fix seedlings into the media @ 1 seedling per pit. Cover pits with original top soil and tamp down to anchor transplants firmly.
- ❖ Seedlings must be planted deep enough that they are *not* poorly anchored and leaning on the soil surface; they must remain erect. Leaves must *not* have soil contact.
- ❖ Transplant when weather is cool, without intense sunlight [early morning or late afternoon].

PLANTING TRAP CROPS

- ❖ Plant one row of **mustard** at intervals of 10 cabbage rows.
- ❖ For uniform seed distribution when using tiny seeds, use fillers.

PLANTING INTERCROPS

- ❖ In case of intercropping: Plant **intercrop** between crop rows.
- ❖ If **amaranth** is used as **intercrop**; plant 2 rows at 20-cm-row-spacing, in each inter-row space of cauliflower @ 200 g per 0.15 ha. For uniform seed distribution when using tiny seeds, use fillers.
- ❖ Plant **intercrop** seeds in furrows. Do *not* broadcast **intercrop** seeds.

IRRIGATION

- ❖ Immediately *after* the planting operations, irrigate *lightly*.



**1 - 5
DAYS
AFTER
TRANSPLANTING**

Cut-worms

PLANT PROTECTION
[cut-worms]

- ❖ Cut-worms snip the tender stems of newly transplanted seedlings.
- ❖ If severe: Spray **flubendiamide 48 SC** formulation @ 35 mL per 0.15 ha @ 75 liters spray volume (i.e. 0.5 mL per liter of water) or **Emamectin benzoate 5% SG** @ 112 g per 0.15 ha @ 75 liters spray volume (i.e. 1.5 g per liter of water).



Damping-off

PLANT PROTECTION
[damping-off]

- ❖ If severe, apply **chlorothalonil 75 WG** formulation @ 150 g per 0.15 ha @ 75 liters spray volume (i.e. 2 g per liter of water) or **Fosetyl Al 80% WP** @ 225 g per 0.15 ha @ 75 liters spray volume (i.e. 3 g per liter of water).

**5 - 10
DAYS
AFTER
TRANSPLANTING**

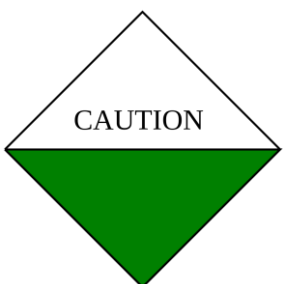
GAP-FILLING

- ❖ Replace seedlings that did not establish.

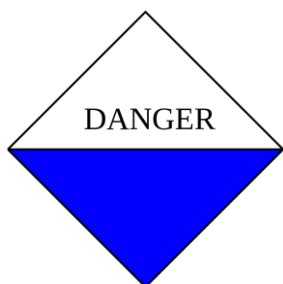
IRRIGATION

- ❖ Irrigate *after* gap-filling [*lightly* if soil moisture is not low].

COLOR CODING ON PESTICIDE CONTAINERS FOR TOXICITY-LEVEL



Green
Slightly toxic



Blue
Moderately toxic

Refrain from using **RED**-labelled pesticides. Use **RED** and **YELLOW** only if absolutely necessary.



Yellow
Highly toxic



Red
Extremely toxic

10 - 15 DAYS AFTER TRANSPLANTING



Yellow and blue sticky traps

PLACING STICKY TRAPS

- ❖ Place 6 **yellow** and 6 **blue sticky traps** [individual sheet size: 22 cm x 30 cm] uniformly across the 0.15 ha field, at crop canopy height.
- ❖ Replace every 3 – 4-weeks.



Water-based pheromone trap

PLACING PHEROMONE TRAPS

- ❖ Place 15 water-based **pheromone traps** uniformly across the 0.15 ha field; 30 cm above crop canopy.
- ❖ Use **pheromone lures** against diamondback moth. [If necessary, use Spodo lures with 6 funnel-type traps against *Spodoptera*.]
- ❖ Replace **lures** every 6 – 7 weeks.



Funnel type pheromone trap

PLACING BIRD PERCHES

- ❖ Place T-shaped **bird perches** made of bamboo, approx. 2-m-tall and 1-m-wide @ approx. 10 **perches** per 0.15 ha.
- ❖ **Bird perches** can facilitate feeding of birds on caterpillars and other insect pests.

WEED MANAGEMENT

- ❖ Perform shallow weeding around cabbage plants.
- ❖ Always perform weeding when weeds are small, because at this stage, weeding is easier and provides better control.



Weeding

15 DAYS AFTER TRANSPLANTING TO HARVEST



Irrigation



Pest-affected plants that must be removed



IRRIGATION

- ❖ After weeding, irrigate.
- ❖ Continue irrigation according to soil moisture conditions. Keep soil always moist.
- ❖ As a rough recommendation, irrigate at 10-day intervals, or after each harvest operation.

PLANT PROTECTION

- ❖ Frequently remove plant parts [leaves, fruits, etc.] affected by diseases or insect pests.
- ❖ Discard [and burn] these far away from cropped areas. Do *not* discard within field.

PLANT PROTECTION

- ❖ If insect pest population is noticed, and is low; spray *Beauveria* or *Metarhizium* formulations @ 250 g per 0.15 ha @ 75 liters spray volume (i.e. 3 g per liter of water).
- ❖ Before applying *Beauveria* or *Metarhizium*, apply **neem oil** approx. 3 days prior; in order to weaken insect pests.

PLANT PROTECTION

- ❖ If sucking insect pests are noticed, spray salts of fatty acids such as **Lastraw®** @ 375 mL per 0.15 ha @ 75 liters spray volume (i.e. 5 mL per liter of water).
- ❖ Non-chemical mode of action; from Pest Control India Ltd.

20 - 25 DAYS AFTER TRANSPLANTING



PLANT PROTECTION

- ❖ As preventive measure, spray **neem oil** @ 150 mL per 0.15 ha @ 75 liters spray volume (i.e. 2 mL per liter of water).
- ❖ Spray during early-morning, or late-afternoon [preferred] so as to reduce degradation by UV light.

INTERCROP HARVEST

- ❖ Harvest **intercrop** during this period when it is of marketable size and quality.

WEED MANAGEMENT + EARTHING-UP

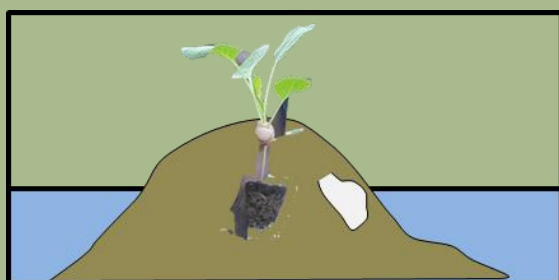
- ❖ *After **intercrop** harvest*, perform shallow weeding + earthing-up.
- ❖ Heap soil from inter-row space at the base of cabbage plants.



Earthing-up

FERTILIZER APPLICATION

- ❖ *After weeding*, apply **urea** @ 22 kg per 0.15 ha uniformly at the base of each plant.
- ❖ Place **urea** at a height [from ground] that will allow it to come into contact with irrigation-water.



Urea
[white]
placement
in
reference
to water
level
[blue]

FERTILIZER APPLICATION

- ❖ *After weeding*, spray **micronutrient mixture** formulation.



Mulched Cole crop with yellow and blue sticky traps, and funnel-type pheromone traps.



Mulching with rice-straw [top] and arecanut-husk [bottom]



IRRIGATION

- ❖ Irrigate *after* fertilization [*lightly* if soil moisture is not low].

MULCHING

- ❖ If off-farm **mulch** material is used, *after* weeding, cover soil surface with a thick layer of **mulch** such as **rice-straw** or **arecanut-husk**.
- ❖ If in situ [**rice straw**] crop residue is used as **mulch**, distribute the residue in the inter-row space.
- ❖ **Mulching** can conserve soil [reduce erosion] and soil moisture, suppress weed growth, and improve overall soil health.

**20
DAYS
AFTER
TRANSPLANTING
TO
HARVEST**



Whitefly



Aphids


PLANT PROTECTION


[whitefly, aphids]


❖ If whitefly (ETL 5-10 flies /leaf) or aphids (ETL 30 aphids/ plant) are noticed, spray **neem oil** @ 150 mL per 0.15 ha @ 75 liters spray volume (i.e. approx. 2 mL per liter of water).

❖ If pest population is high:

Spray **Lastraw®** @ 375 mL per 0.15 ha @ 75 liters spray volume (i.e. 5 mL per liter of water). Apply 2 – 3 times at weekly intervals.

Spray **acetamiprid 20 SP**  formulation @ 75 g per 0.15 ha @ 75 liters spray volume (i.e. 1 g per liter of water) against whitefly.

Spray **thiamethoxam 25 WG**  formulation @ 30 g per 0.15 ha @ 75 liters spray volume (i.e. 0.4 g per liter of water) against whitefly.

Spray **chlorantraniliprole 18.5 SC**  formulation @ 35 mL per 0.15 ha @ 75 liters spray volume (i.e. 0.5 mL per liter of water) against soft-bodied larval pests.

❖ Maintain 10 – 15-day intervals between consecutive pesticide (spray) applications.



Diamond-back moth larvae and damage



Diamond-back moth symptom



Diamond-back moth adult [left] and pupa [right]



Cabbage butterfly larva [left] and eggs [right]



Alternaria [black] leaf spot

PLANT PROTECTION

[caterpillars: diamondback moth, *Spodoptera*, cabbage butterfly]

- ❖ If these pests are noticed (**ETL 10 larvae/plant**), spray *Beauveria* OR *Metarhizium* formulations @ 250 g per 0.15 ha @ 75 liters spray volume (i.e. 3 g per liter of water).
- ❖ Spray **neem oil** @ 150 mL per 0.15 ha @ 75 liters spray volume (i.e. 2 mL per liter of water).

❖ If pest population is high:

Spray **spinosad 48 SC** formulation @ 45 mL per 0.15 ha @ 75 liters spray volume (0.6 mL per liter of water)

OR **flubendiamide 48 SC** formulation @ 35 mL per 0.15 ha @ 75 liters spray volume (i.e. 0.5 mL per liter of water).

- ❖ Rotate with **chlorantraniliprole 18.5 SC** formulation @ 35 mL per 0.15 ha @ 75 liters spray volume (i.e. 0.5 mL per liter of water)

OR **emamectin benzoate 5 SG** formulation @ 112 g per 0.15 ha @ 75 liters spray volume (i.e. 1.5 g per liter of water).

- ❖ Maintain 10 – 15-day intervals between consecutive pesticide (spray) applications.

PLANT PROTECTION

[head rot, alternaria leaf spot, club root]

- ❖ Spray **chlorothalonil 75 WG** formulation @ 150 g per 0.15 ha @ 75 liters spray volume (i.e. 2 g per liter of water) or **Propineb 70% WP** @ 150 g per 0.15 ha @ 75 liters spray volume (i.e. 2 g per liter of water).



Bacterial soft rot



Bacterial black rot

PLANT PROTECTION

[bacterial soft rot, bacterial black rot]

- ❖ As preventive measure against these, drench base of plants with *Trichoderma* and *Pseudomonas* formulations @ 10 g per liter of water.

In case of organic farming:

Drench base of plants with a mixture of **asafetida** @ 75 + **turmeric** @ 375 g in 750 liters of water for 0.15 ha (i.e. 0.1 g **asafetida** and 0.5 g **turmeric** per liter of water).

- ❖ Drench @ 100 mL per plant.

**30 - 35
DAYS
AFTER
TRANSPLANTING**



Thumba
[Drona-
pushp]
weed.

WEED MANAGEMENT

- ❖ Perform a shallow inter-row weeding operation.

IRRIGATION

- ❖ Irrigate *after* weeding [*lightly* if soil moisture is not low].

Personal Protection Equipment [PPE] for Pesticide Applications



Advisory for Pesticide Applications

- Apply uniformly.
- Use safety equipment.
- Do *not* apply if windy.
- Use cone-type nozzles for pesticides.
- Use flat-fan type nozzles for herbicides and fertilizers.
- Avoid spraying before impending rain events.
- Strictly follow label instructions.
- Be aware of pre-harvest [residue] intervals, for application and harvest at proper times.
- Be aware of field re-entry intervals after application.

HARVEST

- ❖ Harvest when heads are firm, and of marketable size and quality.
- ❖ Harvest along with a few wrapper leaves for protection.



Mr. Sankaranada Sharma of Cachar district; using for the first time, seedling trays to produce vegetable seedlings.

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