



World Vegetable Center



सत्यमेव जयते
GOVERNMENT OF ASSAM



CULTIVATING CAULIFLOWER IN ASSAM

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



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

Demonstration Area: 0.15 ha [approximately 1 bigha]



**30 – 25
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

25 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



STACKING SEEDLING TRAYS

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



Keeping nursery under protection



Protecting nursery from insect pests



Emerged seedlings



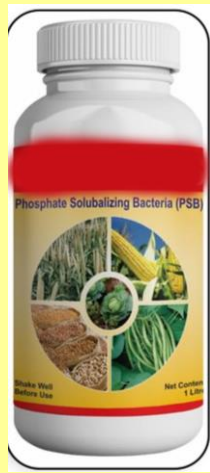
Yellow sticky trap

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.

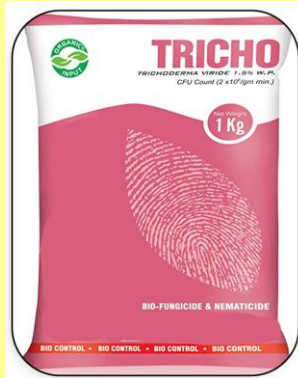
PLACING STICKY TRAPS IN NURSERY

- ❖ 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).

LIMING

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

Enriched
vermi-
compost
incubating
in dark,
protected
place



Enriched
vermi-
compost
covered
for
incubation





Representational Image

**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

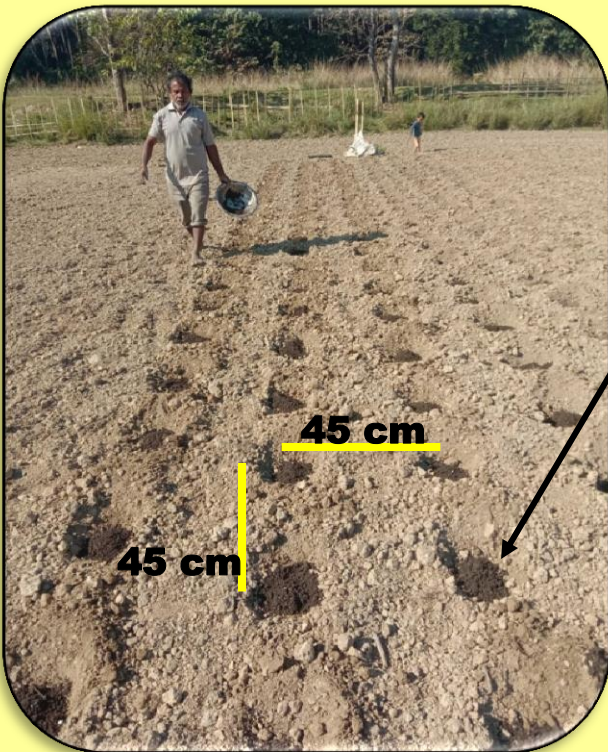


PREPARING TRANSPLANTING MEDIA

- ❖ 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 transplanting media



Transplanting pits with transplanting 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.

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.
- ❖ 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.



Transplanting furrows with transplanting media

DAY OF TRANSPLANTING



Trans-
planting
from
seedling
trays



Representational Image

Trap crops
[in photo:
mustard in
Cole crop]



Inter-
cropping [in
photo: beans
in
cauliflower]



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 cauliflower rows.
- ❖ For uniform seed distribution when using tiny seeds, use fillers.

PLANTING INTERCROPS

- ❖ In case of intercropping: Plant **intercrop** between crop rows.
- ❖ If **coriander** is used as **intercrop**; plant 2 rows at 20-cm-row-spacing, in each inter-row space of cauliflower @ 1 kg 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]

**5 - 10
DAYS
AFTER
TRANSPLANTING**

- ❖ 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).

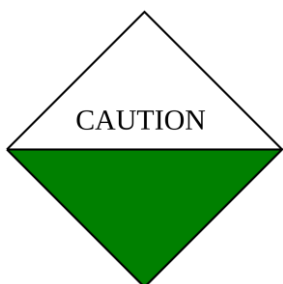
GAP-FILLING

- ❖ Replace seedlings that did not establish.

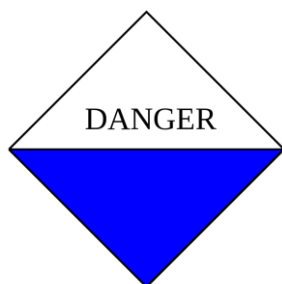
IRRIGATION

- ❖ 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.



Weeding

WEED MANAGEMENT

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

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. Roughly, irrigate at 10-day intervals.
- ❖ Cauliflower is very susceptible to improper irrigation. Keep soil always moist; but ensure water-logging does not occur

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 cauliflower plants.



Earthing-up

FERTILIZER APPLICATION

- ❖ *After weeding*, apply **urea** @ 12 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 cauliflower field 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

[stem 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



Bolting

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.

PHYSIOLOGICAL DISORDERS

[bolting]

- ❖ Occurs due to stress [mainly sudden, drastic changes in temperature] at crucial initial vegetative growth stages.
- ❖ Variety-duration must match length of growing season.
- ❖ Do *not* transplant when weather is too cold.
- ❖ Transplant seedlings at right age.
- ❖ Do *not* let soil dry.



Whiptail

PHYSIOLOGICAL DISORDERS [whiptail]

- ❖ Due to **molybdenum deficiency**.
- ❖ Molybdenum availability in soil can be low if soil is acidic.
- ❖ If whiptail occurs after soil application ensure foliar spray **sodium molybdate @ 5 g per lit of water**



Buttoning

PHYSIOLOGICAL DISORDERS [buttoning]

- ❖ Occurs due to stress at crucial initial vegetative growth stages.
- ❖ 'Early-varieties' are more prone.
- ❖ Buttoning may be induced by:

Transplanting over-age seedlings.

Improper time of planting during the season.

Sudden, drastic or unusual changes in temperature or soil moisture.

Poor nutrient balance and nitrogen availability.

Too much or too little irrigation.

Inappropriate planting density.



Greening

PHYSIOLOGICAL DISORDERS [greening]

- ❖ Due to sudden, drastic increases in temperature; especially during and after curd-formation.
- ❖ Also prevent dry soil conditions.



Browning



**30 - 35
DAYS
AFTER
TRANSPLANTING**

PHYSIOLOGICAL DISORDERS [browning]

- ❖ Due to **boron deficiency**.
- ❖ Foliar spray of **borax @ 2 g** per liter at curd formation stage.
- ❖ Prevent exposure of curd to too much sunlight.
- ❖ Blanch timely, or use self-blanching varieties.



Thumba
[Drona-
pushp]
weed.

WEED MANAGEMENT

- ❖ Perform a shallow inter-row weeding operation.

IRRIGATION

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



Blanching

BLANCHING

- ❖ When curds are approx. 7 – 8 cm in diameter.
- ❖ Cover curds with outer leaves.
- ❖ To protect curds from sunlight. Excessive exposure can cause discoloration and bitter taste.
- ❖ Self-blanching varieties are available, which can naturally cover curds with their inner leaves.

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



A farmer of Cachar district, using for the first time, enriched transplanting media during vegetable transplanting.

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