

TECHNOLOGIES FOR ORGANIC MANAGEMENT OF CROPS IN NORTHEAST INDIA



ICAR- Agricultural Technology
Application Research Institute,
Umiam, Meghalaya –793103

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(An ISO 9001:2015 certified organization)

Technologies for Organic Management of Crops in Northeast India

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ICAR- Agricultural Technology Application Research Institute, Zone – VII,
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Phone : 0364-2570081

Fax : 0364-2570396, 2570483

Email : icarzcu3@gmail.com

Website : <http://www.icarzcu3.gov.in>

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Concept and Chief Editor

Bidyut C. Deka

Compiled and Edited by

A. K. Singha

Sarah Wahlang

Divya Parisa

Amol K. Bhalerao

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डॉ. अशोक कुमार सिंह
उप महानिर्देशक (कृषि प्रसार)

Dr. A.K. Singh
Deputy Director General
(Agricultural Extension)

भारतीय कृषि अनुसंधान परिषद्
कृषि अनुसंधान भवन-I पुसा, नई दिल्ली 110 012

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
KrishiAnusandhanBhawan, Pusa, New Delhi – 110 012
Ph.:91-11-25843277 (O), Fax : 91-11-25842968
E-mail: aksicar@gmail.com



FOREWORD

Agricultural Extension Division of ICAR, New Delhi through its 11 ATARIs has been pursuing for adaptation of agri-innovations in different farming eco systems.

KVKs of the NEH region are addressing the location specific problems of the respective districts and providing the need based solution to problems through technology assessment, demonstration and capacity development.

Under national initiative, ICAR-ATARI Umiam has conducted cluster demonstration on organic farming under PKVY programme in 800 ha area in 40 districts of 5 NEH states, viz., Manipur, Meghalaya, Mizoram, Nagaland and Tripura in this financial year. I am happy to learn that the Institute is bringing out a publication entitled “Technologies for organic management of crops in Northeast India” by incorporating the technologies developed by the Universities/ ICAR Institutes located in the region. I am sure this publication will be of immense help to all the farmers and KVK experts of the region for bringing out newer innovations in the field of organic farming in the region.

I compliment the Director, ICAR-ATARI, Umiam and the entire team for their effort to bring out this valuable publication.

Dated : 30.10.2019

(A.K. Singh)



भा. कृ. अनु. प.-कृषि प्रौद्योगिकी अनुप्रयोग अनुसंधान संस्थान, अंचल-७

भारतीय कृषि अनुसंधान परिषद

उमियम (बड़ापानी), रि-भोई, मेघालय - ७९३१०३

ICAR-Agricultural Technology Application Research Institute, Zone-VII

Indian Council of Agricultural Research

Umiam (Barapani) Ri-Bhoi, Meghalaya-793103

(An ISO 9001:2015 certified organization)

Phone : 0364-2570081 :: Fax : 0364-2570396, 2570483 :: Email : icarzcu3@gmail.com :: Website : http://www.icarzcu3.gov.in

Preface

Organic farming is the basis for producing healthy food crops for healthy living and it is the natural way of producing food. There is now worldwide awareness about the ill effects of chemical farming and many farmers are now willing to convert from chemical to organic farming. Due to less use of chemical fertilizer, the North Eastern Region of India by and large is considered as a potential area for organic farming. Sikkim has already been declared as an organic state and the states like Meghalaya and Nagaland have initiated various programmes for shifting their cultivation practices into organic. Looking into the potential of organic movement, Govt. of India has launched a Central Sector Scheme entitled Mission Organic Value Chain Development for North Eastern Region (MOVCD-NER). The main objective of this scheme is to ensure safe and healthy food to everyone's plate. Moreover, a nationwide programme on Paramparagat Krishi Vikash Yojana (PVVY) has also been launched for entire country so as to bring sizeable area under organic cultivation.

Looking into the dynamism of the KVK system, the Ministry of Agriculture and Farmers Welfare, Govt. of India has identified more than 500 KVKs for cluster demonstration programme in 20 ha area per KVK in the country for popularizing the suitable technologies for organic management of various crops. Therefore, this document entitled "Technologies for Organic Management of Crops in Northeast India" has been prepared by compiling the technologies developed by ICAR-NOFRI, Tadong; ICAR Research Complex, Umiam; CAU, Imphal and AAU, Jorhat for the benefit of various stakeholders including KVKs of the region. I wish this publication would be of great help for the practicing farmers and other stakeholders.

I express my sincere thanks and gratitude to Dr. T. Mohapatra, Secretary, DARE & DG, ICAR, Govt. of India, Dr. A.K. Singh, DDG (AE), Dr. V.P. Chahal, ADG (AE), Dr. Randhir Singh Poswal, ADG (AE) and all the colleagues of Agricultural Extension Division in the Council HQ for their constant encouragement, guidance and support in executing various programme of the institute. I also thankfully acknowledge the effort made by Miss Sarah Wahlang, SRF in compiling the available information in the region within a stipulated time period.

(Bidyut C. Deka)
Director

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Introduction

Organic farming is a production system which avoids, or largely excludes the use of synthetic fertilizers, pesticides, growth regulators, and livestock feed additives and rely on organic biomass, feed, manure, composts, crop rotation, biological pest control, on farm resources, indigenous technical knowledge, etc. The objectives of environmental, social, and economic sustainability can be met through organic farming. The key characteristics of organic farming include protecting the long-term fertility of soils by maintaining organic matter levels, fostering soil biological activity, nitrogen self-sufficiency by the inclusion of legumes. The effective recycling of organic matter including crop residues and livestock wastes, and weed, disease and pest control rely primarily on crop rotations, natural predators, diversity, organic manuring, and resistant varieties. The soil fertility is maintained by returning all the residues to it through composts, thereby, minimizing the gap between nutrient addition and removal from the soil. The principle of plant nutrition in organic farming is 'feed the soil not the plant'. Pest and disease management in organic farming avoids the use of pesticides and favours a holistic approach through a wide range of cultural practices.

In North Eastern hill region of India, organic farming is a socially acceptable and environmentally sound food production system for the fragile hill ecosystem. Jhum farmers rely on inherent soil fertility due to deposition of nutrients upon decomposition of organic matter and nutrient fixation by various microbes. Farmers in the region have been practicing such cultivation system for the centuries, though with low productivity and income. Organic farming is the basis for producing healthy food crops for healthy living and it is the natural way of producing food. But due to increase in population, the use of chemical fertilizers increased manifold in India. Fortunately the use of chemical fertilizers in the hilly areas of the North Eastern Region remained negligible compared to the plains areas of this region.

There is now worldwide awareness about the ill effects of chemical farming and many farmers are now willing to convert from chemical to organic farming. Further, the growing demands of population, industrialization and globalization leads to a significant need of organic farming in the country. The utmost increasing demands in the sector likely to focus on the North Eastern region for organic agriculture. However,

the major challenges for promotion of organic farming in the region are benchmark survey for identifying the potential areas, research needs for development of appropriate technology, human resource development in organic input production, assistance to farmers in post harvest handling, processing and value addition, reduction of certification cost, creation of infrastructure and marketing of organic produce. North Eastern Region being traditionally an organic hub has tremendous potential for development of organic farming because of its suitable ecosystem on proximity to South East Asia. With little modifications and improvements, along with appropriate packages of organic practices, the upland areas of the North Eastern Region can be utilized for organic farming and an effort in this direction has been initiated by different stakeholders.

CEREAL CROPS

Rice

Rice is the main crop of Northeast as it is the principal food crop of the region. It covers a total area of 3.51 million hectares and the total rice production of NE region is estimated to be around 5.50 million tonnes. There is a very good potential for organic rice production in the region. The use of fertilizers and other agro chemicals are meagre in these hilly areas. Therefore, organic rice cultivation using proper technology would increase the scope for enhancing the yield. The aromatic and sticky rice of the region has got very good export potential. Thus farmers of the region can grow aromatic and slender grain rice to take advantage of the growing international market.



Organic Management Technologies

Seed treatment: Seed inoculation with *Azospirillum*, *Azotobacter* and PSB @ 20 gm/kg seed before sowing.

Organic Nutrient Management

- Application of enriched compost @ 5 t/ha + Biofertilizer (*Azospirillum*, *Azotobacter* and PSB mix. @ 4 kg/ha as seedling root dip).
- Application of FYM @ 10-15 t/ha or mixed compost @ 3-6 t/ha either alone or in combination.
- Application of goat manure/ poultry manure @ 1-2 t/ha as basal dose.

(Source: ICAR-NOFRI, Tadong, Gangtok)

Application of Azolla in rice

Azolla is a free floating water fern which lives in symbiotic association with a N-fixing blue green algae (*Anabaena azollae*) and has potential of providing 30-60 kg N/ha under normal field conditions. Azolla is propagated in pits near the main field to produce enough to inoculate one hectare of rice land.



Azolla Culture

Dual culture of Azolla with rice

Fresh Azolla @ 60-70 kg/bigha is applied one week after rice transplantation. After 3-4 weeks of growth and formation of mat, the Azolla is incorporated in the soil. Again after 7-8 weeks, the Azolla will cover the field and will require second incorporation. With these two incorporations, 2-3 t of Azolla can be supplied in each bigha of rice field with a supplementation of 4-8 kg of Nitrogen through organic source per crop per season.



Azolla in paddy field

Green Manuring In-Situ

The manure, being a bulky one is usually applied as basal dressing before the main crop is raised in the field. The green manure crops are grown and incorporated in the same field and the best stage of incorporation is the flowering stage of the crop. The seeds of green manuring crops @ 5 kg/ha are sown 60 days prior to transplantation of rice and incorporated after about 40 to 45 days growth. After incorporation, 15-20 days is allowed for decomposition to take place and only after this, the rice seedlings are transplanted to the main field. The most common green manuring crops grown under this system are sunhemp (*Crotalaria juncea*), dhaincha (*Sesbania aculeata*) and guar (*Cyamopsis tetragonoloba*).

Green Leaf Manuring

Green leaf manuring is a practice of collecting the green leaves and twigs from various trees, herbs and shrubs elsewhere. The common shrubs and trees used are gliricidia (*Gliricidia maculata*), sesbania (*Sesbania speciosa*), karanj (*Pongamia pinnata*), subabul (*Leucaena leucocephala*), etc.

(Source: AAU, Jorhat)

Plant Protection

Insect Pest

- Planting should be done in time according to the crop duration.
- Clipping of leaf tips to prevent pest infestation from nursery to main field. Field sanitation is important to prevent multiplication of pests.
- **Biocontrol measures against stem borer and leaf folder:** 6-8 releases of *Trichogramma japonicum* and *T. chilonis* @ 50,000/ha/week starting from 30 days after transplanting gives significant good control (30-60% parasitization) of rice stem borer and leaf folder.

- Kamdhenu (mixture of cow urine and neem leaf extract) @ 1 L/250 L of water/ha against insects like caseworm, stem borer, leaf folder and plant hopper.
- Spraying of neem oil @ 3 ml/L at 10 DAT followed by second spray after 20 DAT interval.
- Spraying *Beauveria bassiana* @ 7 gm/L at boot leaf stage to reduce gundhi bug population.
- Installation of pheromone traps @ 16-20 traps/ha for trapping the adult male of yellow stem borer.

Disease

Blast

- Field sanitation and burn straw and stubbles in the field.
- Seed treatment with *Pseudomonas fluorescens* @ 6 gm per kg seed.
- Dry seed treatment with *Pseudomonas fluorescens* talc formulation @ 10 gm/kg.
- Use resistant varieties.
- Use of bael (*Aegle marmelos*) leaves extract @ 2.5 per cent.

Bacterial leaf blight

- Four sprays of biopesticide like Biotime (mixture of *P. fluorescens*, *T. viride* and *M. anisopliae*) @ 2 ml/m² can effectively reduce stem borer incidence both in vegetative and reproductive stage.
- Four sprays of Biogreen @ 2 ml/m² is effective against management of BLB of rice.

Sheath blight

- Spraying of two commercial plant-derived *Cymbopogon* products @ 5 ml/L and neem based fungicide @ 3 ml/L are recommended for management of sheath blight disease of rice. The first spraying should be given as soon as the symptom of the disease is observed in the field followed by the second spraying at 10-12 days interval.

Tungro virus

- Deep summer ploughing.
- Apply neem cake @ 150 kg/ha as basal dose.
- Spray neem oil @ 0.3% or NSKE @ 5% at 15-30 days after transplanting to control vector population (if one jassid is noticed in a plant then three sprays have to be given at 15 days interval).
- Destroy weed hosts of virus and leaf hopper.

(Source: ICAR-NOFRI, Tadong, Gangtok)

Maize

Maize is the second most important crop next to rice in the North Eastern region. Maize production plays a significant role in ensuring food security and is used for direct consumption as well as feed for animals. Maize is grown in almost all the north eastern region. Nagaland is the highest maize producer among the north eastern region.



Organic Management Technologies

Seed treatment: Seed inoculation with *Azospirillum*, *Azotobacter* and PSB @ 20 gm/kg seed before sowing.

Organic Nutrient Management

Apply Dolomite @ 2 t/ha as basal application at 15-20 days prior to sowing followed by conjoint basal application of mixed compost @ 2.5 t/ha and neem cake @ 0.5 t/ha followed by application of vermicompost @ 2.5 t/ha in two equal splits i.e., 1/2 at the time of sowing and the rest amount at the time of earthing up after second weeding.

Plant Protection

Insect Pest

- Spraying of neem formulation (1500ppm) @ 3ml/L or Spinosad 45 SC @ 0.3 ml/L and second spray at 20 days interval to control pest.

(Source: ICAR RC, Umiam)

Disease Management

Turicum leaf blight

- Grow resistant hybrids.
- Remove plant residue from the previous crop.
- Plough the field under the infected crop residue to reduce the inoculums.



Turicum leaf blight in Maize

Downy mildews

- Use resistant varieties.
- Remove infected crop debris.
- Provide proper drainage to avoid water stagnation.

Maydis leaf blight

- Grow resistant varieties.
- Remove infected crop debris.

(Source: ICAR-NOFRI, Tadong, Gangtok)



Maydis leaf blight in Maize

PULSE CROPS

Black gram

Black gram is native to North Eastern India-Myanmar region of Asia. The crop is resistant to adverse climatic conditions and improves the soil fertility by fixing atmospheric nitrogen in the soil. The pulse 'Black gram' plays an important role in Indian diet, as it contains vegetable protein and supplement to cereal based diet. Besides, it is also used as nutritive fodder, especially for milch animals. Moreover, the nutrition demand of this crop is much lesser than any cereals. Hence this crop can be managed organically with lesser cost of production.



Organic Management Technologies

Seed treatment: Pre-sowing/planting treatment of seeds/seedlings with Biofertilizers i.e., *Rhizobium* and PSB @ 3.5 kg/ha.

Organic Nutrient Management

- Basal application of organic sources of nutrient (Compost: 0.83 ton fresh wt./0.56 ton dry wt.; vermicompost: 0.27 ton fresh wt./0.23 ton dry wt.; Mustard oilcake: 0.08 ton fresh wt./ 0.07 ton dry wt.).

(Source: AAU, Jorhat)

- FYM or mixed compost @ 5 t/ha should be applied as basal application prior to sowing followed by goat manure/poultry manure @ 1-2 t/ha as basal dose to overcome micronutrient deficiencies.



Cultivation of Blackgram, KVK Jorhat (Left) and KVK Sonitpur (Right)

Plant Protection

Insect Pest

- Mechanical collection and destruction of blister beetle, bhary caterpillar and *Helicoverpa armigera* are highly effective for management.
- Spraying of entomopathogenic fungi like *Beauveria bassiana* and *Metarhizium anisopliae* @ 5 gm/L.

Disease

Yellow mosaic virus

- Remove and destroy the infected plants.
- Apply neem oil @ 0.3% or NSKE @ 5% to control whitefly.

Urd bean leaf crinkle

- Remove and destroy the infected plants.
- Use disease free seeds.
- Hot water treatment of the seed at 55°C for 30 minutes.

Rust

- Adjust the sowing date to escape from the disease.
- Apply wettable sulphur @ 0.25%.

Powdery Mildew

- Dust sulphur 2-3 times during the cropping season.
- Apply wettable sulphur @ 0.25%.
- Spray NSKE @ 5% or neem oil @ 3% twice at 10 days interval from initial appearance of disease.

(Source: ICAR-NOFRI, Tadong, Gangtok)

Rajma

Rajma, also known as French beans, is a traditional vegetable crop of North Eastern region; its cultivation under organic farming would be a profitable enterprise. Among different vegetables, rajma responds well to organic management practices and most potential crop for organic production in the NEH hills. It is an added advantage that this crop is relatively less prone to pest and disease problems. Appropriate technological backstopping for production of rajma will encourage the farmers to go for organic cultivation.



Organic Management Technologies

Seed treatment: Seed should be inoculated with *Rhizobium* inoculums @ 20 gm/kg seed.

Organic Nutrient Management

- Apply vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha in furrows open for sowing of seeds.

Plant Protection

Insect Pest

- Blister beetle can be managed by spraying of entopathogenic fungi like *Beauveria bassiana* and *Metarhizium anisopliae* @ 5 gm/L.
- Application of *Metarhizium anisopliae* for aphid control in May.
- Spray neem oil @ 5 ml/L to control aphids.
- Spray neem oil 0.5% to control stem borer.
- Use of *Beauveria bassiana*, *Verticillium lecanii* and *Metarhizium anisopliae* @ 10 gm/L at 10 days interval as general insect/pest management.

Disease Management

Powdery mildew: Spray wettable Sulphur @ 0.25% or dust Sulphur @ 25 kg/ha.

Rust: Grow resistant varieties like Arka Anoop.

Anthracnose: Grow resistant varieties like Pant Anupama.

Leaf spot: Use healthy seeds.

Blight: Releases of *Trichoderma harzianum* @ 10 gm/L.

Sclerotina Rot: Spray *T. harzianum* @ 10 gm/L and neem oil @ 5ml/L.

Common mosaic

- Remove and destroy infected plants.
- Use disease free seeds for sowing.
- Spray neem oil @ 0.3%, NSKE @ 5% or petroleum oil-based agro spray @ 1%.

(Source: ICAR-NOFRI, Tadong, Gangtok)

Field/Garden Pea

Pea is the third most important pulse crop at global level. It contains higher amount of protein. The mature seeds are used as whole or split into dal and put to use in various ways for human consumption. Besides vegetable purposes, it is also grown as a forage crop for cattle and cover crop to prevent soil erosion but mainly for matured seed for human consumption.

Organic Management Technologies

Seed treatment: Seed inoculation with *Rhizobium* @ 20 gm/kg mixed in jaggery solution and dried in shade.

Organic Nutrient Management

- Application of vermicompost @ 2.5 t/ha or neem cake @ 1.0 t/ha in furrows open for sowing of the seeds.

Plant Protection

Insect Pest

- Spraying of petroleum oil-based agro spray @ 10 ml/L or neem oil (1500 ppm) @ 3 ml/L to control aphids.

Disease

Wilt and Root Rot

- Early sowing should be avoided to escape from high humidity and high temperature which are congenial for the disease.
- Crop rotation for at least 2-3 years with suitable non leguminous crops should be followed.



Wilting in pea



Rooting rot in pea

Powdery mildew

- Late planting should be avoided.
- Remove and destroy plants after harvest.
- Spraying 10% milk dilution at 10 days interval with effective modification of pH condition.

Rust

- The affected plant trash should be burned after harvest.
- Follow suitable crop rotation with non leguminous crops.
- Grow resistant varieties.

(Source: ICAR-NOFRI, Tadong, Gangtok)



Powdery mildew in pea



Rust in pea

OILSEED CROPS

Rapeseed & Mustard

Rapeseed & Mustard is a major rabi oilseed crops of India. Other cultivars like brown sarson and yellow sarson are under cultivation over a limited area in the North-Eastern States. Rapeseed & mustard is cultivated in an area of 0.46 lakh ha and the average yield is 888 kg/ha in the region. The seed and oil are used as condiment in the preparation of pickles, curries, vegetables, hair oils, medicines and manufacture of greases. The oil cake is used as feed and manure. The leaves of young plants are used as green vegetables and green stem and leaves are a good source of green fodder for cattle. In the tanning industry, mustard oil is used for softening leather.



Organic Management Technologies

Management Practices

- Proper planning of cropping pattern to avoid pest like painted bugs.
- Summer ploughing should be done to kill the residual population of the pest.
- Remove the residue of previous crops to prevent pest like painted bugs.
- Remove the aphid infested twigs at the initial level of the pest attack at flowering stage to stop the further spread of pest.
- Need based and judicious application of *Bacillus thuringiensis* @ 2 gm or ml/L or neem oil 0.15 EC (1500ppm) @ 3 ml/L.
- Spraying of neem formulation @ 3 ml/L or petroleum oil-based spray @ 10 ml/L and second spraying followed by 30 days interval.

(Source: ICAR-NOFRI, Tadong, Gangtok)



Painted bugs in Rapeseed Mustard



Aphids infestation of Rapeseed Mustard

HORTICULTURAL CROPS

FRUITS

Banana

Banana is the fourth most important crop after rice, wheat and corn. Its fruit is cheap and can be used by both rich and poor alike considering its nutritive and fruit value, hence, it is considered as poor man's apple.



Organic Management Technologies

Selection of suckers

- Sword suckers of 3-4 months old and disease free healthy clumps should be selected. Suckers should be removed one week after the harvest of the bunch.
- Pseudo stem should be cut back to a length of 15-20 cm from corm and old roots are to be removed. Rhizome weevil (black tunnels) and nematode (darkened lesions) infected portions of corm and roots should also be removed.
- The rhizome should be dipped in hot water (50°C) for 20 minutes to prevent nematode infestation.
- The rhizomes are to be smeared with cow dung solution and ash and dried in the sun for about 3-4 days and stored in shade up to 15 days before planting.
- Soaking the suckers in *Pseudomonas fluorescens* solution (2%) for 30 minutes before planting is beneficial.

Planting

Suckers should be planted upright in the centre of the pits with 5 cm pseudo stem remaining above soil level. Organic manures and *Trichoderma harzianum* (100:1) should be applied in the pits before planting. Soil should be pressed around the suckers to avoid hollow air spaces.

Organic Nutrient Management

- Apply FYM or compost or green leaves @ 10 kg/plant at the time of planting.
- Apply 500 gm of lime in the pit and allow to weather.
- Apply vermicompost @ 2 kg /pit at the time of planting.
- Apply groundnut cake/ neem cake @ 1 kg /pit at the time of planting.
- N, P and K biofertilizer- PGPR mix I/microbial consortium @ 50-100 gm /pit should be applied at the time of planting. The biofertilizer should be mixed with 5 kg FYM. It should be ensured that there is enough moisture in the soil at the time of application.

- Apply Panchagavya 3% as foliar spray three times at 3rd, 6th, and 9th months after planting.
- After planting, sunnhemp/daincha/cowpea should be sown adopting a seed rate of 50kg/ha (20 gm per plant). Incorporate the crop into the soil 40 days after sowing. Repeat sowing of green manure crop and incorporate into the soil 40 days after sowing. Compost made from banana leaves and bunch stalk is rich in potassium content.

Additional nutrient requirement

Apply FYM @ 15 kg, Rock phosphate @ 300 g and ash @ 1.5 kg/plant. It is preferable to apply organic manures in two equal split doses at 2nd and 4th months after planting.

Weed control

Growing cowpea in the interspaces during early stages is highly effective in controlling weeds. Hand weeding by giving 4-5 surface diggings (depending upon weed growth) gives good weed control. Deep digging should be avoided. Soil should not be disturbed after the plants start producing bunches. If green manure crop is grown, weeding operations can be reduced to 1-2 diggings. Mulching is an effective practice for controlling weeds.

Plant protection

Insect Pest

Banana pseudo stem weevil (*Odoiporus longicollis*)

- Field sanitation—All dried hanging leaves of the pseudo stem should be removed.
- Severely infested plants with rhizome weevils, in full should be removed and destroyed by burning the life stages of the insect.
- Pseudo stem of harvested plants should be destroyed.
- Loose dry sheaths of the pseudo stem of plants from 5th month onwards should be removed and any of the following methods should be followed.
- **Swabbing mud slurry around the pseudo stem:** If infestation is noticed, neem oil emulsion @ 3% is to be mixed in the mud slurry (30 ml/L) and then used it for swabbing.



Pseudo stem weevil
(*Odoiporus longicollis*)

- Neemazal (1% EC) may be sprayed on the pseudo stem and the leaf axil is to be filled at monthly intervals starting from 5th month onwards. Application on the pseudo stem by spraying and leaf axil by filling with entomopathogens, namely, *Beauveria bassiana* based bioformulation like Org-Beauverijal or *Metarhizium anisopliae* based bioformulation like Org-Metajal @ 15 ml/L.
- Spraying of entomopathogenic nematode (EPN) @ one billion/ha over the pseudo stem or place three cadavers containing EPNs in alternate leaf axils at fortnightly intervals.
- Split pseudo stem pieces of 2 ft long can be placed in the ground when plants are 5 months old. Weevils in the traps are to be collected and destroyed daily.

Banana Rhizome Weevil (*Cosmopolites sordidus*)

- Only healthy, pest free planting material should be selected.
- The land should be deep ploughed so as to remove old rhizomes and exposed inner soil layer to sun.
- Outer layer of rhizome (paring) are to be cut and removed so as to remove eggs and young ones of weevils. Suckers are to be dipped in slurry made of cow dung and ash and dried in shade.
- Split pseudo stem pieces of 2 ft long can be placed in the ground when plants are 5 months old. Weevils in the trap are to be collected and destroyed daily.
- Pheromone trap should be used with Cosmolure/ Cosmolure + (an aggregation pheromone) to attract both sexes of weevil. The trap is to be kept throughout the year and change the site when the number of weevils collected is reduced. Pheromone sachet is to be changed every 45 days.
- Soil around plants should be drenched or the plants are to be sprayed with entomopathogens like *Beauveria bassiana* or (dosage same as for pseudo stem weevil). The quantity needed will depend on stage of the crop.
- Crushed neem seed should be applied to the pit @ 1 kg/plant.



Rhizome Weevil
(*Cosmopolites sordidus*)



Aphids
(*Pentalonia nigronervosa*)

Aphids (*Pentalonia nigronervosa*)

- *V. lecanii* @ 1×10^7 spores/ml should be sprayed whenever aphid population is noticed.

Nematodes

Major nematode species attacking banana are burrowing nematode (*Radopholus spp*), root knot nematode (*Meloidogyne incognita*), root lesion nematode (*Pratylenchus coffeae*) and cyst nematode (*Heterodera oryzicola*). Reduction in the number of leaves, bunch weight and number of fingers are the symptoms.

Management

- Paring the rhizomes and dipping in hot water at 45-50°C for 20 minutes will control nematodes.
- Neem cake @ 1 kg/plant is to be applied at the time of planting.
- Intercropping banana with sunnhemp or marigold also reduces nematode population.

Diseases

Sigatoka leaf spot (*Mycosphaerella sp.*)

- All severely affected leaves are to be cut and burned.
- Need based sprayings are to be given depending upon the severity of the disease.
- 1% Bordeaux mixture is to be sprayed soon after the appearance of the initial symptoms of the disease. The disease appears with the commencement of southwest monsoon.
- Poweroil (mineral oil) 1% emulsion is effective in controlling the disease.
- Bioagents like *Pseudomonas fluorescens* @ 20 gm/L (2%) or *Bacillus subtilis* @ 5 gm/L is effective against sigatoka leaf spot disease.
- Growing of resistant/less susceptible varieties.



Sigatoka leaf spot
(*Mycosphaerella sp.*)

Panama Wilt (*Fusarium oxysporum. sp. cubense*)

- Affected clumps along with corms are to be removed and destroyed.
- Lime @ 500 gm to be applied per pit and allowed to weather.
- Neem cake @ 1 kg per pit can be applied at the time of planting followed by irrigation.



Panama Wilt
(*Fusarium oxysporum. sp. cubense*)

- Application of soil based inoculums of AMF 500 gm (soil based inoculums containing 40 spores/gm of soil), *Trichoderma harzianum* (50gm) and *Pseudomonas fluorescens* (50gm) or PGPR mix 1 is effective.
- The planting materials are to be dipped in 2% *Pseudomonas* before planting.

Bunchy top disease

- Use disease free suckers for planting.
- Eradication of disease affected plants.
- Spraying neem based insecticide on the pseudo stem to control the vector.
- Spraying of *Verticillium lecanii* based bioformulation like Org-Vertijal or Metarhizium based bioformulation Org-Metajal @ 5 ml/l of water whenever aphid population is noticed.



Bunchy top disease

Banana Bract Mosaic Disease (*Kokkan disease*)

- Use disease free healthy suckers for planting.
- Eradication of disease affected plants as and when noticed.
- Spraying of neem based insecticide to control the vector.



Banana Bract Mosaic Disease (Kokkan disease)

Infectious Chlorosis (Cucumber Mosaic Disease)

- Use disease free suckers for planting.
- Eradication of infected plants.
- Use neem based insecticide to control the insect vector.
- Growing of cucurbitaceous vegetables as intercrop should be avoided in banana.

(Source: AAU, Jorhat)

Pineapple

Pineapple is the second most important fruit crop of north eastern region of India both in terms of area and production. Manipur stands first in production while Meghalaya has the largest area under pineapple cultivation and is second in production. It is followed by Assam, Tripura, Arunachal Pradesh, Mizoram and Nagaland. Organic production of pineapple and its processing will go a long way in boosting the economy of the region.



Organic Management Technologies

Organic Nutrient Management

Pineapple removes large amount of soil nutrients. Repeated cultivation of this crop in the same land leads to drastic reduction in yield after few years due to exhaustion of nutrients in soil. Therefore, application of FYM @ 7.5 t/ha, vermicompost @ 2.0 t/ha, neem cake @ 2.5 t/ha or neem cake powder @ 25 gm/pit (enriched with *Azotobacter*, *Azospirillum* & *Trichoderma harzianum*) should be carried out.

Cultural operation

Earthing up

It is an essential operation in pineapple cultivation to provide better anchorage to the plants. After application of biofertilizers, earthing up should be carried out. The roots of pineapple are very shallow; the plants eventually lodge under high rainfall areas. Lodging of plants at the time of fruit development results in lopsided growth, uneven development and premature ripening of fruits. High density planting minimizes the risk of lodging as the plants prop each other.

Weed management

Weeds are serious menace in pineapple gardens. Periodical weeding is must to ensure better performance of crop. Weeding done manually increases the cost of production. Mulching with any organic materials like paddy



Mulching in Pineapple

straw, pineapple trash, saw dust or black polythene sheets is essential particularly under rain-fed condition to reduce the growth of weeds and conserve soil moisture.

Removal of suckers slips and crowns

Suckers start growing with the emergence of inflorescence while slips grow with the development of fruits. With the increase number of suckers, fruit size increases but the fruit maturity is delayed with the increase in number of slips. If slips are not required for further planting then it should be removed as early as possible. Crowns are not removed as this will affect the appearance of fruit.

(Source: AAU, Jorhat)

Insect-Pest

- Spray of neem oil 2% to control insect pest.

(Source: ICAR RC, Umiam)



Pineapple mealy bug



Scale insect



Thrips



Pineapple fruit borer

Citrus (Khasi Mandarin)

Citrus is an important fruit of north eastern region and it comes third in terms of area and production. This region is known as one of the centres of origin of various Citrus species. Among the Citrus crops available in the region, Khasi mandarin is the most economically important one and plays a vital role in the socio-economic development of the people. It is well known for its quality, fruit colour, unique sugar-acid blend and shelf life which make it the most popular citrus cultivar.



Organic Management Technologies

Seed treatment: Seedling root dip treatment with *Trichoderma* @ 10 gm/L of water.

Organic Nutrient Management

Soil application of FYM mixed with tricho, neem cake and spray neem oil 0.5%.

Rejuvenation Practices

- Cleaning of orchard followed by pruning of dead, diseased and overlapping branches immediately after harvest.
- Treatment of pruned ends with 1% Bordeaux paste (1 kg lime dissolved in 5 L of water in the bucket, do not use plastic & Iron, dissolve 1 kg copper sulphate in another 5 L of water, mixed the solution well).
- Cut the wither parts and destroy them.
- Orchard phytosanitation and basin preparation by light working of the soil without root injury.
- Sow intercrops like french bean, chilli or leguminous crops.
- Irrigation by double ring method/ drip and provide proper drainage.
- Application of Bordeaux paste on the tree trunk twice a year before monsoon and after monsoon.



Insect Pest

- Locate trunk borer and plug the holes with mud after plugging cotton soaked in petrol/kerosene.
- Shaking of tree to kill the adult trunk borers manually.
- Install light trap to catch trunk borer adults or hand picks.
- Kill the grubs of trunk borer by hooking by spike.
- Cut and burn dried parts of the plants as they harbor grubs and pupae.
- Generate smoke in the orchard for 2-3 hours after night fall to control fruit piercing moth.
- Dispose the fallen fruits which attract the moth.

Disease Management

Gummosis or Foot Rot

- Proper drainage to avoid water stagnation around the plants.
- Scrapping of affected portions and pasting of Bordeaux paste.

Root Rot

- Removal of soil around the trunk and drenching the roots with 1% Bordeaux mixture.

(CAU, Arunachal Pradesh)



Citrus Gummosis



Citrus Root Rot

Assam Lemon

Assam lemon is another important commercial citrus cultivars grown in North East India. It is native to Assam. It is grown in an area of 13,000 ha in Assam with a productivity of 7.00 tonnes per ha.



Organic Management Technologies

Organic Nutrient Management

- Apply vermicompost @ 4 kg/plant before flowering.
- Apply wood ash @ 5 kg/plant before flowering.
- Apply neemcake @ 3 kg/plant in two splits March/April and September/October.
- **Green manuring with dhaincha:** Dhaincha seeds are to be sown between the rows of Assam lemon plants and incorporated into the soil after sufficient growth.

Plant Protection

Insect Pest

Aphids and whiteflies : 4 kg tobacco leaves + twigs boiled in 40 L of water for 40 minutes. On cooling 1 kg of soap is mixed well. This stock is to be diluted 7-8 times and sprayed.

Leaf miner : Spray neem oil @ 10 ml/L of water at bud burst stage and repeat after 10 days. If infestation is severe then prune the infected branches. Spraying of Biotime (mixture of *P.fluorescens*, *T. viride* and *M. anisopliae*) @ 0.2% is also effective against citrus leaf miner.

Bark eating caterpillar

- Apply Bordeaux paste on the trunk up to a height of 60 cm during winter and early summer.
- Insert cotton soaked in kerosene or petrol in the tunnel and plug with mud.
- Keep the trunk clean.

Disease

Citrus Canker

- Prune and destroy infected twigs.
- Spray Biotime (mixture of *P.fluorescens*, *T. viride* and *M. anisopliae*) @ 0.2 per cent.

(Source: AAU, Jorhat)



Citrus canker in Assam lemon



Leaf damaged by leaf miner

VEGETABLES

Cabbage

Cabbage is one of the most popular and widely grown vegetables in the NEH region and has occupied second position in production after potato. It is a rich source of vitamin A, C and minerals including potassium, calcium, sodium and iron. Cabbage juice is said to be a remedy against poisonous mushrooms and is also used as gargle against hoarseness.



Organic Management Technologies

Seedbed preparation, seedling raising and transplanting

- Before sowing, seed bed should be mixed thoroughly with 250 gm neem cake powder, 50 gm *Trichoderma viride* and 25 gm *Pseudomonas fluorescens*.
- Seeds treated with *Pseudomonas fluorescens* powder @ 5 gm with 100 gm of seeds along with little amount of water followed by shade drying.
- Releases of *T. chilonis* @ 50,000/ha for 4-5 times at 5-7 days interval to control lepidopteran pest.
- The seedbed should be watered lightly and then seeds should be covered with a mixture of dried sieved cowdung and *Trichoderma viride* (mixture 10 gm of *Trichoderma* powder with 1 kg of cowdung powder). This will reduce the soil borne plant pathogen.
- Seedlings are to be transplanted to the main field after 25-30 days of sowing. Before transplanting seedling roots are dipped in a slurry of *Azotobacter* (AZB) and Phosphorus Solubilizing Bacteria (PSB) mixture for 30 minutes (slurry is prepared by mixing 75 gm AZB and 75 gm PSB for 1000 no. of seedlings).
- Application of Rock phosphate @ 375 kg/ha and vermicompost @ 5 t/ha before transplanting of seedlings.

Plant protection techniques

- Follow crop rotation with non cruciferous crops.
- Deep summer ploughing helps in exposing resting stages of pests.
- Use of resistant varieties against black rot.
- Destruction of crop residues after harvest and phytosanitation measures are to be adopted.

- **Pheromone traps:** Pheromone traps with lures are commercially available for pests like *H. armigera* and *S. litura*. Install 5 traps with lures for each pest. Traps should be installed in the field in such a way that the position of the lure is always 6-12 inches above the crop canopy. Replace the lures once in 15-25 days depending upon the weather conditions. The trapped moths should be collected and killed daily. ETL for *H. armigera* is 8 to 10 moths per day per trap.
- **Yellow sticky traps:** Set up yellow sticky traps @ 10 traps/ha for monitoring whiteflies, thrips, etc. Locally available empty tins can be painted yellow, coated with vaseline/castor oil on outer surface which may also be used as yellow sticky traps.
- Release of *T. chilonis*, *T. priteosum* @ 50,000/ha for 4-5 times at 5-7 days interval help in controlling DBM and other lepidopteran pests.
- Neem bases (e.g. pestoneem or neemax) @ 20 ml/10 L and judicious application of insecticides are effective for conservation of natural enemies at an interval of 15 days whenever necessary.
- Treat the seeds with *Trichoderma harzianum* based bioformulation like Org-Trichoal @ 5 gm/L of water + CMC @ 0.02% for 1 hour followed by shade dry for 2 hours prior to sowing can reduce the soil borne disease like damping off.
- **Use of trap crop:** Two rows are to be sown with mustard as trap crop at the beginning and after 25 cabbage rows. Bold seeded mustard is more suited. Mustard is to be sown twice; first sowing is at 15 days prior to cabbage transplanting while the second one is at 25 days after transplanting. Thick sowing of mustard i.e., 50-60 plants/m row is usually recommended, the intercropped cabbage is free from infection during early stages. However, there may be some incidence at later stages. For this apply 5% NSKE.
- Erect bird percher @ 50 nos./ha help to keep away the insect larvae.
- 1% lemon juice as a foliar spray for controlling DBM is also found effective.

(Source: AAU, Jorhat)



Leaf webber in cabbage



Diamond back moth



Cabbage damaged by
Lepidopteran pest

Cauliflower

Cauliflower is a cool season vegetable grown for its white and tender curd. The curd contains a good amount of vitamin B and protein. It is also rich source of minerals mainly phosphorus and sodium.



Organic Management Technologies

Seedbed preparation, seedling raising and transplanting

- Selected land for seedbed preparation should be solarized with thin transparent polythene sheet (100 gauge) for one month before sowing of seeds. Before covering the beds with polythene sheet, well dried rotten cowdung and sand (in case of clay soil) @ 40 kg each per 5m² should be mixed. Bed should be moistened before covering and sides of the polythene sheet should be properly covered with soil to restrict the entry of air.
- Before sowing of seeds, the seed bed should be mixed thoroughly with 250 gm neem cake powder, 50 gm *Trichoderma viride* and 25 gm *Pseudomonas fluorescens*.
- Seeds are treated with *Pseudomonas fluorescens* powder @ 5 gm with 100 gm of seed along with little amount of water. Seeds should be dried in shade before sowing. After sowing, the seedbed should be watered lightly and then seeds are covered with a mixture of dried sieved cowdung and *Trichoderma viride* (mixture 10 gm of *Trichoderma* powder with 1 kg of cowdung powder).
- Neem based insecticides such as pestoneem (2 ml/L water) is to be sprayed to the young seedlings whenever necessary.
- Seedlings are to be transplanted to the main field after 25-30 days of sowing. Before transplanting, seedling roots are dipped in a slurry of *Azotobacter* (AZB) and Phosphorus Solubilising Bacteria (PSB) mixture for 30 minutes (slurry is prepared by mixing 75 gm AZB and 75 gm PSB for 1000 no. of seedlings).

Application of manure and biofertilizers

- Rock phosphate @ 375 kg/ha and vermicompost @ 5 t/ha should be applied before transplanting of seedlings.
- Before planting of seedlings in the main field, microbial consortium is to be mixed with 2.5 t enriched compost at a ratio of 1:100 and mixed properly. Water is to be sprinkled and heaped. The heaps are to be covered with gunny bag. After 8-10 days the mixture should be added to the pits meant for planting the seedlings. Wood ash and banana pseudo stem ash are to be applied along with the organic manure.

Plant protection techniques

- Follow crop rotation with non cruciferous crops.

- Deep summer ploughing helps in exposing resting stages of pests.
- Use of resistant varieties against black rot.
- Destruction of crop residues after harvest and phytosanitation measures is to be adopted.
- **Pheromone traps:** Pheromone traps with lures are commercially available for pests like *H. armigera*, *S. litura*. Install 5 traps with lures for each pest. Traps should be installed in the field in such a way that the position of the lure is always 6-12 inches above the crop canopy. Replace the lures once in 15-25 days depending upon the weather conditions. The trapped moths should be collected and killed daily. ETL for *H. armigera* is 8 to 10 moths per day per trap.
- **Yellow sticky traps:** Set up yellow sticky traps @ 10 traps/ha for monitoring whiteflies, thrips, etc. Locally available empty tins can be painted yellow, coated with vaseline/ castor oil on outer surface which may also be used as yellow sticky traps.
- Release of *T. chilonis*, *T. priteosum* @ 50,000/ha for 4-5 times at 5-7 days interval help in controlling DBM and other lepidopteran pests .
- Neem bases (e.g. pestoneem or neemax) @ 20 mL/10 L and judicious application of insecticides are effective for conservation of natural enemies at an interval of 15 days whenever necessary.
- Treat the seeds with *Trichoderma harzianum* based bioformulation like Org-Trichojal @ 5 gm/L of water + CMC @ 0.02% for 1 hour followed by shade dry for 2 hours prior to sowing can reduce the soil borne disease like damping off.
- **Use of trap crop:** Two rows are to be sown with mustard as trap crop at the beginning and after 25 cauliflower rows. Bold seeded mustard is more suited. Mustard is to be sown twice; first sowing is at 15 days prior to cauliflower transplanting, while the second one is at 25 days after transplanting. Thick sowing of mustard i.e., 50-60 plants/m row is usually recommended, the intercropped cauliflower is free from infection during early stages. However, there may be some incidence at later stages. For this apply 5% NSKE.
- Erect bird percher @ 50 nos./ha help to keep away the insect larvae.
- 1% Lemon juice as a foliar spray for controlling DBM is also found effective.

(Source: AAU, Jorhat)



Cauliflower cultivation in Mawphlang, Meghalaya

Carrot

Carrot is one of the most important and major root vegetable. It is a rich source of *beta-carotene*, which is precursor of vitamin A. Carrot is a heavy feeder of nutrients and removes 100 kg N, 50 kg P₂O₅ and 180 kg K₂O per hectare. Therefore, judicious and proper use of organic manures and biofertilizers are very essential not only for obtaining higher yield and quality produce but also to maintain soil health and sustainability for longer period.



Organic Management Technologies

Soil selection and land preparation

Deep summer ploughing is advisable. Well drained sandy loam to clay loam soil is suitable for carrot cultivation. Before sowing of seeds the land has to be ploughed and seeds of green manuring crops like dhaincha or sunnhemp are sown in the month of May. After one and half or two months of sowing, young green manure plants are cut and incorporated with the soil by ploughing. Liming @ 10-12 q/ha should be done to raise soil pH depending upon the soil test result and mixed with the soil at least one month before sowing of seeds.

Seed treatment

Prior to sowing, the seed should be well rubbed to remove the fine hairs. The seeds should be treated with a mixture of AZB and PSB @ 7.5 gm each with 100 gm seeds.

Application of manure and biofertilizers

Rock phosphate @ 30 kg/ha and enriched compost @ 5 t/ha should be applied before sowing of seed. If enriched compost is not available, well decomposed FYM @ 10 t/ha can also be used.

Plant protection

- Deep summer ploughing helps in exposing resting stages of pests.
- Destruction of crop residues after harvest and phytosanitation measures are to be adopted.
- **Use of repellent:** 4% garlic juice should be sprayed whenever required.
- Neem based insecticides @ 2 ml/1 L to be applied against any leaf cutting insects whenever required.
- Neem cake enriched with *Psuedomonas fluorecens* applied at 10 gm/m² increases root colonization and significantly increases the yield of carrot.

(Source: AAU, Jorhat)

Tomato

Tomato is a nutritious and popular vegetable all over the world. It is one of the most important vegetable crops supporting the livelihood and improving the living standard of many vegetables growers in the north eastern region. It is used as a vegetable, salad, pickle, soup, ketchup, sauce, etc. It is good source of vitamin A,B and C.



Organic Management Technologies

Seed treatment: Seed treatment with *Trichoderma viride* @ 10 gm/kg of seed.

Organic Nutrient Management

- Application of FYM @ 10 t or vermicompost @ 1-1.5 t per acre.
- Green manuring is recommended for areas with assured rainfall and also for irrigated crop.

Nursery Development

Soils are exposed to high temperatures, to prevent possible pests and diseases attack in the plants. After the beds are prepared, 20 to 25 kg of FYM along with 1.2 kg neem cake is applied per bed. After necessary application of water, the beds are covered with thin white plastic sheets for raising the temperature without loss of moisture. Such practice will further eradicate harmful bacteria and pests.

Plant protection

- To prevent the attack of soil borne plant pathogen, compost can be enriched with *Trichoderma harzianum* based bioformulation and FYM can be treated with *T. harzianum* based at the rate of 500 gm per tractor load of manure. After mixing the required amount of *Trichoderma* the manure should be allowed to remain in a heap covered with wet gunny bag for proper culturing.
- Crop rotation with french bean reduces the bacterial wilt disease incidence.
- Crop rotation with cereals, sesame, mustard and marigold to reduce nematode infestation.
- Deep summer ploughing helps in exposing resting stages of pests.
- Use of resistant varieties towards nematodes and bacterial wilt.



- Destruction of crop residues after harvest and phytosanitation measures are to be adopted.
- **Pheromone traps:** Pheromone traps with lure are commercially available for pests like fruit borer and tobacco caterpillar. Install 5 traps per hectare with lures for each pest. Traps should be installed in the field in such a way that the position of the lure is always 6-12 inches above the crop canopy. Replace the lures once in 15-25 days depending upon the weather conditions. The trapped moths should be collected and killed daily. ETL for fruit borer is 8 to 10 moths per day per trap.
- **Yellow sticky traps:** Set up yellow sticky traps @ 10 traps per ha for monitoring whiteflies, thrips, etc. Locally available empty tins can be painted yellow, coated with vaseline/castor oil on outer surface which may also be used as yellow sticky traps.
- Intercropping a tall variety of marigold as a trap crop after every 16 rows of tomato can be practiced to control fruit borer. Raising of marigold nursery should be 15 days prior to tomato nursery, so that 25 and 40 days old tomato and marigold seedlings can be transplanted to main field. Maximum eggs laying is observed on marigold flowers. Eggs and larvae are removed from field along with the flowers. This trap cropping system also helps in reducing the root knot nematode infestation.
- Inundative release of *T. brasiliensis*, *T. chilonis* or *T. priteosum* @ 50,000/ha starting from formation stage for 6 times at weekly interval.
- Neem based insecticide can be applied @ 20 ml/100 L and judicious application of insecticides are effective for conservation of natural enemies at an interval of 7 days.
- Grow cowpea or pulses on the border area of main crop to build up natural enemy fauna.



Intercultural operation

Organic weed control can be achieved by using organic matter as mulches as these restrict weed growth. Crop rotation, mulching, sanitation, and shallow tilling also help in controlling the weeds. Use of black mulch (50 micron) between the rows will help to control weeds and also conserve soil moisture.

(Source: AAU, Jorhat)

King Chilli

King Chilli/Bhut Jalokia is a perennial plant, having an economic span of 3-5 years under shade house. Fruits are extremely pungent and aromatic, with persistent pungency when eaten. The fruit is a large berry, consisting of a pericarp, placenta, seed and dry cavity.



Organic Management Technologies

Organic Nutrient Management

- FYM @ 1.3 t/bigha (10 t per ha) to be applied at final land preparation and mixed well. The FYM should be applied @ 1 kg/pit.
- Application of enriched compost @ 10 t/ha or 5 t/ha + biofertilizer.
- The pits should be prepared 30 days ahead of transplanting. Apply *Azotobacter* @ 5 gm, PSB @ 5 gm and Biofor Pf @ 100 gm/pit within 7 days of transplanting.

Intercultural Operation

- Mulching with organic material can also be practiced for suppression of weeds. Mulching should be done with shredded organic materials for conservation of soil moisture, suppression of weeds and increase in soil organic matter. Staking may be required to provide mechanical support to the plants.

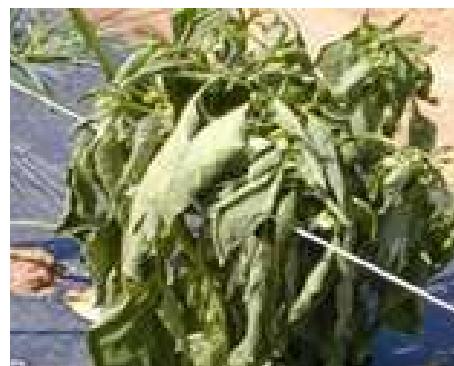
Plant Protection

Disease

Damping-off/Collar rot: Adopt proper nursery raising technique. Apply Biozium (*T. harzianum*) @ 20 ml/kg against *Paphanidermatum*. Seed treatment with *Trichoderma harzianum* based bioformulation like Org-TrichoJal @ 5 ml/kg of seed against *Rhizoctonia solani* and *Fusarium spp.*

Bacterial wilt: Soil application of *Trichoderma viride* based bioformulation like Bioveer @ 2 kg/m² or *Pseudomonas fluorescens* based bioformulation like Biofor Pf-2 @ 2 kg/m². Follow three years crop rotation in infested soil by including non-host crops like crucifers, maize, etc. Apply biocontrol agents formulation like Biofor Pf, etc. Infected plants must be discarded as soon as possible.

Leaf curl and Little leaf: Remove all the infected plants and weeds. Grow seedlings in netted nursery. Use 2-3 rows of trap crops like cotton, marigold along the border. Sow the border crop at least 60 days before transplanting of seedlings.



Bacterial Wilt

(Source: AAU, Jorhat)

Chilli

Chilli is one of the most popular and widely grown vegetable crops in north eastern region especially in hilly areas. It is highly suitable and economical under poly house condition. Its cultivation in rice fallow has been commercialized in the region. It is constituent of many food additives and adds flavour, colour, vitamin C and pungency to food items.

Organic Management Technologies

Management Practices

- Seed treatment with *Trichoderma harzianum* @ 10 gm/L, *Pseudomonas fluorescens* @ 10 gm/L to prevent rhizome rot.
- After sowing the seeds, mulch with green leaves and irrigate daily in the morning.
- Remove the mulch immediately after germination of the seeds. Addition of diluted (25 gm/L) cowdung slurry or cow urine (diluted 8 times) increases the vigour of the seedlings.
- Broadcasting of *Beauveria bassiana*, *Verticillium lecanii*, *Metarhizium anisopliae* 10 gm/L each.

Manuring

- Apply lime @ 500 kg/ha based on the acidity of soil at 15 days before transplanting.
- Apply FYM or compost @ 25 t/ha as basal dose to which *Trichoderma* and PGPR mix I each @ 2.5 kg /ha are mixed and kept for 15 days in shade.
- Apply *Pseudomonas* and AMF at the time of transplanting.
- Apply poultry or powdered goat manure @ 1 t/ha instead of FYM.
- Dip the roots in 2% *Pseudomonas* or PGPR mix I before transplanting to the field.

Top dressing

Top dressing can be done at 7-10 days interval with any one of the following:

- Soil application of fresh cow dung slurry @ 1 kg/10 L (50 kg/ha).
- Soil application of biogas slurry @ 1 kg/10 L (50 kg/ha).
- Soil application of cow's urine @ 500 L/ha (8 times dilution).
- Soil application of vermiwash @ 500 L/ha (8 times dilution).
- Soil application of vermicompost / poultry / powdered goat manure @ 1 t /ha.
- Soil application of groundnut cake @ 1 kg/10 L (50 kg/ha).
- Foliar spray can be given with cow dung slurry / vermiwash / cow's urine.

After cultivation

- Give pre-transplanting irrigation, if the soil is not moist enough.
- Irrigate at two or three days interval during summer.
- Stake the plants if necessary.

- Weeding followed by organic manure application and earthing up may be done at one and two months after transplanting.
- Provide mulch in the field throughout the crop growth period with materials like green leaves, plant residues, decomposed coir pith, coconut husk, straw, etc.

Plant Protection

Insect Pest

Chilli Aphids: Spray tobacco decoction or neem oil-garlic emulsion (2%) or *Nattapoochedi* (*Hyptis suaveolens*) emulsion (10%). Spray *Verticillium lecanii* like Org-Vertijal @ 5 ml/L or *Metarhizium anisopliae* based bioformulation like Org-Metajal @ 5 ml/L. Release green lacewing bugs @ 50,000 eggs/ha.

Jassids: Spray neem oil-garlic emulsion (2%) or lemon grass/ ginger extracts (10%).

Thrips: Spray Kiriya (*Andrographis paniculata*) extract (10%).

Mite: Apply neem oil 5% or neem oil + garlic emulsion 2%. Spray diluted rice water once in 10 days against mite.

Chilli White fly : Spray *Verticillium lecanii* based bioformulation like Org-Vertijal (10^{10} conidia/L) or garlic emulsion (2%). Place sticky yellow traps.

Chilli Nematode : Apply Eupatorium and neem leaves, neem cake, rice husk, wood shavings, castor cake @ 100 gm/m². Apply VAM, Plant Growth Promoting Rhizo bacteria, Paccilomyces to soil @ 2 kg/ha. Seed treatment with *Bacillus macerans* @ 3% W/W (2.5 kg/ha) and drenching with *B. macerans* @ 3% solution at 30 days after sowing.



Aphids



Jassids



Chilli thrips

Disease

Damping off: Sow the seeds in raised bed prepared in open area during summer months. Pre-inoculation of AMF in furrows @ 200 gm/m². Apply lime in nursery bed. Use *Trichoderma*, *Pseudomonas fluorescens* and PGPR mix II @ 20 gm/L. Neem cake can be applied @ 250 kg/ha to reduce soil inoculants or apply Biozium (*T. harzianum*) @ 20 ml/kg against damping-off causing pathogen (*P. aphanidermatum*).



Leaf spot

Leaf spot: Spray *Pseudomonas fluorescens* (2%). Spray Bordeaux mixture (1%).

Bacterial wilt: Soil application of *Trichoderma viride* based bioformulation like Bioveer @ 2 kg/m² or *Pseudomonas fluorescens* based bioformulation like Biofor Pf-2 @ 2 kg/m².

Bacterial leaf spot: Grow resistant varieties (KAU). Use lime in the field. Grow marigold in field. Soil application of *Pseudomonas fluorescens* or PGPR mix II @ 20 gm/L at 15 days interval. Seedling root dip and foliar spray of *Pseudomonas fluorescens* @ 1-2 per cent.

Chilli leaf curl virus: Spray neem based insecticides @ 2 ml/L to control the vectors. Grow resistant varieties like Punjab Lal & Pusa Sadabahar. Spray neem based insecticides @ 2 ml/L to control the vectors. Grow 5-6 rows of maize around the crop at least 50 days before transplanting. Keep the plot weed free.

Storage of seeds

Packaging of seeds in polythene cover (700 gauges) increases the storage life up to 7 months. Seeds treated with *Trichoderma* and *Pseudomonas* each @ 6 gm/kg seed can be stored upto 5 months.

(Source: AAU, Jorhat)

Okra

Okra or ladies finger is an important vegetable crop grown in North Eastern states especially Assam and India as a whole. The crop is grown for many purposes including green fruits for culinary purpose and dry fruits, stems and leaves for preparation of dry powder to be used as clarificant of jaggery.



Organic Management Technologies

Seed treatment with a mixture of AZB and PSB @ 7.5 gm each with 100 gm of seeds. Pre soaking of seeds in water for 24 hours enhance germination.

Application of manures and biofertilizers

Application of Rock phosphate @ 313 kg/ha and FYM @ 5 t/ha + Vermicompost @ 1 t/ha before sowing of seeds.

Plant protection techniques

- **Use of pheromone traps:** Pheromone traps with lures are commercially available for pests like *Helicoverpa (Heliothis) armigera*, *Spodoptera litura* and *E. arias*. Install 5 traps/ha with lures for each pest, keep the distance of 5 meters between the traps. Trap should be installed in the field in such a way that the position of lure is always 6-12 inches above the crop canopy. Replace the lures once in 15-25 days depending upon the weather conditions. The trapped moths should be collected and killed daily. ETL for *H. armigera* is 8 to 10 moths per day per trap.
- **Use of yellow sticky traps:** Yellow sticky trap @ 10 traps/ha should be set up for monitoring whiteflies, thrips, etc. Locally available empty tins can be painted yellow colour, coated with vaseline/ castor oil on outer surface which may also be used as yellow sticky traps.
- Release of *T. chilonis* or *T. priteosum* @ 50,000/ha against *H. armigera*.
- Spray neem bases @ 20 ml/10 L and judicious application of insecticides are effective for conservation of natural enemies at an interval of 15 days whenever necessary.
- Seed treatment with Org-Pochojal (a liquid bioformulation of *Pochonia chlamydosporia*) @ 5 ml/L along with application of Org-Pochojal enriched

compost @ 2 t/ha (Mix 40 ml Org-Pochojal /kg of compost, incubate for one week and then the compost should mixed with 10 kg of compost. Repeat the incubation for one week and mixed the 10 kg of compost with 100 kg of compost and apply in the field) to reduce the infestation of root knot nematode. Seed treatment with *Bacillus megaterium* @ 5ml/L + soil application of 2 tonnes of vermicompost enriched with 5 litres of *B. megatorium*/ha also reduce the infestation of root knot nematode.

Interculture

Use of black mulch (25 micron) between the rows will help to control weeds and also conserves oil moisture.

(Source: AAU, Jorhat)

SPICES

Large Cardamom

Large Cardamom is one of the main cash crops cultivated in Sikkim and Darjeeling district of West Bengal. India is the largest producer of large cardamom in the world and Sikkim contributes to it significantly. Large cardamom is also cultivated in some other North-eastern states like Nagaland. It is used as spice in several ayurvedic preparations. It contains 2-3% essential oil and possesses medicinal properties.

Organic Management Technologies

Management Practices

- Suckers are treated using *Pseudomonas fluorescens* @ 0.5%.
- FYM application @ 2 kg/plant in the months of Oct-Nov and April-June along with *Trichoderma viride* @ 2.5 kg for 1 ha is recommended.
- Mulching is done with locally available biomass.
- For management of insect pests, spray neem oil (1500 ppm) @ 3 ml/L at 20 days interval (minimum four sprays).
- Shade management using locally available trees like *Alnus nepalensis*, *Schima wallichii* etc.

(Source: ICAR-NOFRI, Tadong, Gangtok)



Large Cardamom cultivation in Sikkim



Organic mulches in Large Cardamom

Turmeric

Turmeric is used as condiment, dye, drug and cosmetic in addition to its use in religious ceremonies. India is a leading producer and exporter of turmeric in the world. In India, turmeric is mainly grown in Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtra, Assam. Turmeric has been used in Indian systems of medicine for a long time. Recently, the demand for organic turmeric is growing rapidly in the global pharmaceutical market due to its anticancer properties. The turmeric of northeast are known for its high curcumin content and other quality parameters.



Organic Management Technologies

Rhizome Treatment: The rhizome is treated with *Trichoderma harzianum* @ 25 gm/kg.

Organic Nutrient Management

- FYM /compost as basal dose @ 20 t/ha should be applied at the time of land preparation or by spreading over the beds after planting and 3 t/ha each at 30 DAP and 60 DAP.
- FYM+ *Trichoderma* + neem cake mixture @ 100 gm/planting pit is applied at the time of planting.
- Vermicompost or coirpith compost may also be used at a reduced dose instead of FYM according to availability.
- *Azospirillum* @ 2.5 kg /ha / PGPR mix I as basal dose is applied and the same dose is applied at 60 DAP.

Mulching

Mulching is done immediately after planting with green leaves @ 15 t/ha. It is applied twice with green leaves @ 7.5 t / ha each, first at 45-60 days and second at 90-120 days.

Plant protection

Rhizome rot, wilt and leaf spot diseases

- The rhizomes are dipped in 5% suspension of *Pseudomonas fluorescens* for 15 minutes before planting. Organic manure enriched with *Trichoderma* is applied at the time of planting.
- Spraying and drenching of the plants is done with *Pseudomonas fluorescens* P₁ / PGPR mix II at 45 days after planting (onset of monsoon). Spraying and drenching is repeated at monthly intervals based on disease incidence and intensity.

(Source: AAU, Jorhat)

Ginger

Ginger is an important cash crop in Northeast region. About 3 lakhs tonnes of ginger are being produced annually from 47,641 ha land and the Northeast region is emerging as India's organic ginger hub. Meghalaya tops the list of ginger producing states among the northeastern states. The Northeast region is rich in ginger diversity. Ginger is raised as sole crop as well as intercrop. A large number of tribal farmers still practice the traditional methods of cultivation in this region. In the traditional methods of cultivation, farmers rely on organic inputs, local resources and practices. Therefore scientific organic management practices is the need of the hour to enhance the yield per unit area.

Organic Management Technologies

Rhizome treatment with *Pseudomonas sp.* + *Trichoderma sp.* @ 10 g/kg.

Organic Nutrient Management

- Soil application of *Trichoderma harzianum* and *P. fluorescens*.
- Application of vermicompost @ 3t /ha.
- Spray neem oil (0.5 %) two times or *Beauveria bassiana* @ 10 gm/L to control shoot borer.

(Source: ICAR RC, Umiam)

Mulching

- Immediately after planting, the beds should be thickly mulched with green leaves @ 15 t/ha. Mulching with green leaves is done twice @ 7.5 t/ha first at 45-60 days and second at 90-120 days after planting.
- Green manure crops like dhaincha and sunnhemp may be grown in the interspaces of beds, along with ginger.



Green manuring in ginger under organic production

Plant Protection

Rhizome rot and bacterial wilt

- Sites having proper drainage should be selected for ginger cultivation. The seed rhizomes are soaked in 5% talc formulated (50 gm/L) suspension of *Pseudomonas fluorescens* P₁ for 15 minutes before planting. To avoid the infection

of disease organic manure enriched with *Trichoderma* should be applied at the time of planting.

- Spraying and drenching the plant with *Pseudomonas fluorescens* P₁/ PGPR mix II at 45 days after planting (onset of monsoon) should be done. Spraying and drenching are repeated at monthly intervals based on disease incidence and intensity.



Rhizome rot in Ginger

(Source : AAU, Jorhat)



हर कदम, हर डगर
किसानों का हमसाफर
भारतीय कृषि अनुसंधान परिषद

*Agri*search with a *h*uman touch