Chapter 4- Plant Pathology

Technology no. 1

1. **Name of technology:** Control of False Smut disease of Rice
2. **Source of technology:** RARS, Titabor, AAU
3. **Year of release:** 2013
4. **Agro-climatic zone:** All Agro-climatic Zones of Assam
5. **Detail description of technology:**

   Application:

   Treatment: Spraying of Propiconazole 25 EC once at 50% panicleemergence stage.

   Method of One need based application (based on the disease history of the location) in the evening hours only (after 1 pm)
6. **Critical inputs required:** Fungicide (Propiconazole 25 EC)
7. **Observations to be recorded:** Disease incidence,- % of infected panicle, Disease Severity, % of spikeletes/ panicle, Time of occurrence,Formation of sclerotia, if any, Yield loss, Soil status, B.C. Ratio, Farmers' reaction.

Technology no. 2

1. **Name of technology:** Management of Stem rot disease of *Sali* Rice
2. **Source of technology:** RARS, Titabor, AAU
3. **Year of release:** 2017
4. **Agro-climatic zone:** All agro-climatic zones of Assam
5. **Detail description of technology:** Spraying of Contaf 2 ml/l (Hexaconazol) at the appearance of disease at 5% disease severity (lesion with sclerotia) followed by 2nd and 3rd spray at an interval of 10 to 15 days.
6. **Critical inputs required:** Fungicide (Hexaconazol)
7. **Observations to be recorded:** No. of infected plants at 10-15 days interval with infected lesion and sclerotia, At least 3 observations are to be recorded, Yield record, B: C ratio, Farmers' reaction.

Technology no. 3

1. **Name of technology:** Management of rust disease in Pea
2. **Source of technology:** Assam Agricultural University
3. **Year of release:** 2015
4. **Agro-climatic zone:** All agro-climatic zones of Assam
5. **Detail description of technology:** Rhizome treatment with Copper oxychloride (COC) @ 3g/Lit + streptomycin (0.2g/Lit) for 45 minutes followed by shade drying and planting and two soil drenching with COC @ 3g/Lit at 60 and 90 days after planting against rhizome rot of ginger and alternatively rhizome treatment with Biofor-pf + 2 soil drenching with Copper oxychloride (3g/Lit) at 60 and 90 days after planting and also for organic management, rhizome treatment with Biofor- pf followed by spraying with Biozine @100ml /clump at 60, 90 and 120 days after planting against rhizome rot of ginger
6. **Critical inputs required:** Copper oxychloride, streptomycin, Biofor-pf, Biozine
7. **Observations to be recorded:** No. of infected plants at least 3 observations are to be recorded, Yield record, B: C ratio, Farmers' reaction.

Technology no. 4

1. **Name of technology:** Management of rhizome rot disease in Ginger
2. **Source of technology:** Assam Agricultural University
3. **Year of release:** 2015
4. **Agro-climatic zone:** All agro-climatic zones of Assam
5. **Detail description of technology:**

   Rhizome treatment with Copper oxychloride (COC) @ 3g/Lit + streptomycin (0.2g/Lit) for 45 minutes followed by shade drying and planting and two soil drenching with COC @ 3g/Lit at 60 and 90 days after planting against rhizome rot of ginger and alternatively rhizome treatment with Biofor-pf + 2 soil drenching with Copper oxychloride (3g/Lit) at 60 and 90 days after planting and also for organic management, rhizome treatment with Biofor- pf followed by spraying with Biozine @100ml /clump at 60, 90 and 120 days after planting against rhizome rot of ginger
6. **Critical inputs required:** Copper oxychloride, streptomycin, Biofor-pf, Biozine
7. **Observations to be recorded:** No. of infected plants at least 3 observations are to be recorded, Yield record, B: C ratio, Farmers' reaction.

Technology no. 5

1. **Name of technology:** Management of late blight disease in Potato
2. **Source of technology:** Assam Agricultural University
3. **Year of release:** 2015
4. **Agro-climatic zone:** All agro-climatic zones of Assam
5. **Detail description of technology:**

   One spraying of Mancozeb 75% (Indofil M 45 / Dithane M 45) @ 0.25% (2.5 g/Lit) at canopy closure (35-40 days after planting) and second spraying of Cymoxanil 8% + Mancozeb 64% (Curzet M / Moximate) @ 0.25% (2.5 g/Lit) at first appearance of the disease (if disease appear) and third spraying of Mancozeb 75% (Indofil M 45 / Dithane M 45) @ 0.25% (2.5 g/Lit) after 10 days of second spraying and fourth spraying of Cymoxanil 8% + Mancozeb 64% (Curzet M / Moximate) @ 0.25% (2.5 g/Lit) after 10 days of third spraying against late blight of potato
6. **Critical inputs required:** Mancozeb 75%, Cymoxanil 8%
7. **Observations to be recorded**: No. of infected plants at least 3 observations are to be recorded, Yield record, B: C ratio, Farmers' reaction.

Technology no. 6

1. **Name of technology:** Biological suppression of sugarcane pests
2. **Source of technology:** NBAII, Bangalore
3. **Year of release:** 2011
4. **Agro-climatic zone:** UBVZ
5. **Detail description of technology:**

   Technology: T1: Release of *Trichogramma chilonis* on 45th day after crop germination @ 50,000/ha at 10 days interval. Total of 8-12 releases to be made depending pest severity.

   T2: Chemical control plot

   T3: Untreated control

   Management practices:

Variety:	Any recommended variety
Characteristics:	Drought tolerant, Good for autumn planting
Duration:	360-540 days
Cane Characters:	Straight, Medium thick cane
Sowing time/planting time:	March- April
Harvesting time:	December -March
Sett rate:	45000 – 52000/ ha

Spacing: 75-90 cm row to row

6. **Critical inputs required:** *Trichogramma chilonis, insecticides*
7. **Observations to be recorded:** All observations to be recorded in Bio-control plots as well as plots with farmers' practice for making comparison, Incidence of pests/diseases, Time of occurrence: 45-50 DAP to before harvest, Percent damage/ percent survival, Percent infested cane and healthy canes before and after treatment, Pre and post parasitisation record by releasing tricho card, Yield &yield attributes, Soil status, B: C ratio, Farmers' reaction.

Technology no.7

1. **Name of technology:** Fiber quality improvement in Jute through microbial retting
2. **Source of technology:** RARS, Shillongoni, Nagaon, AAU
3. **Year of release:** 2017
4. **Agro-climatic zone:** CBVZ, LBVZ, NBPZ
5. **Detail description of technology:**

   Method of application to be applied at the time of retting in between jute bundles in retting tanks

   Variety: Tarun, Apeswaree

   Rate/quantity: 4 kg of bacterial formulation per 70 quintal of green sticks

   Duration of retting: 15-20 days during July-August
6. **Critical inputs required:** Microbial culture
7. **Observations to be recorded:** Crop age, Date of sowing and harvesting, Soil characterises, Date of application of bacterial formulation, Date of fibre extraction, Depth of water of retting tank and its area, Water temperature during retting, Colour of jute fibre, B: C ratio, Farmers' reaction.

Technology no. 8

1. **Name of the Technology:** Management of Bacterial Wilt of Binjal, Chilli and Tomato in North East Region
2. **Source of the Technology:** Department of Plant Protection, College of Horticulture & Forestry, CAU, Pasighat -791 102, Arunachal Pradesh.
3. **Year of release:** 2012-13
4. **Agro Climatic Zone:** NEH Region/Hot Humid Region
5. **Detail description about the technology:**

   Wilt diseases of brinjal, chilli and tomato can be caused by fungal and bacterial pathogens (both are soil borne), as well as by abiotic factors. Bacterial wilt is predominant in North Eastern Region of India followed by Fusarium and Verticillium wilt. Determining which

agent is responsible for causing disease can be vital for prescribing the proper management strategies. The external and internal symptoms produced on the host by each pathogen; provides information on the disease life cycle and environmental conditions that favor disease development; and also provides basis for diagnostic techniques that can be used in the field diagnosis of each disease described.

Bacterial Wilt

Causal organism: *Pseudomonas solanacearum* or *Ralstoniasolanacearum* (soil-borne bacterium)

Symptom:

A characteristic of this disease, which sets it apart from other wilt diseases, is that plants wilt and die rapidly without the presence of yellowing or spotting of the foliage. The disease can occur in newly cleared land as well as in areas where susceptible crops have not been grown previously. The bacterium often enters a field on infested transplants, equipment, or through drainage water. The pathogen can overwinter in soil.

Entry of the bacterium:

Bacteria infect plants through the roots or stem, most often where tissue has been injured by cultivating, or by some other physical means such as nematodes. Bacteria invade the vascular tissue, apparently causing wilt by a gradual blocking of the water conducting vessels.

Epidemiology:

The disease is most commonly found in low, wet areas of fields and is most active at temperatures above 20-25^{0}C.

Identification of the bacterium:

To identify bacterial wilt pathogen, cut and peal back a section of the epidermis and cortical tissue (bark) just above the soil line. The center of the stem (pith) will, in early stages, appear water soaked; later, the pith will turn brown and sometimes become hollow. The discoloration of the pith distinguishes this disease from Fusarium and Verticillium wilt. Another relatively easy diagnostic technique is to cut a portion of the affected stem and place it in a clear glass container filled with water. The appearance of white, milky ooze streaming out of the cut end of the discolored vascular tissue is diagnostic for this disease.

Host range:

Bacterial wilt attacks members of the Solanaceous plant family, which includes peppers, potatoes, and egg plant etc.

Control measures:

i. Before sowing the seeds should be dipped in a solution of Streptocycline (1 g/ 40 litres of water) for 30 minutes.

ii. Roguing of wilted plants and the soil surrounding their roots can reduce spread of the disease and may be a viable control alternative in home garden situations.

iii. Soil fumigation should be considered in heavily infested fields.

iv. Soil solarization is another alternative for control of bacterial wilt.

v. Crop rotation is an effective method of control.

vi. Growing susceptible crops in the same area not more than once every 4 years will reduce inoculum in the soil.

Fig. 1. Wilt infected Tomato crop.

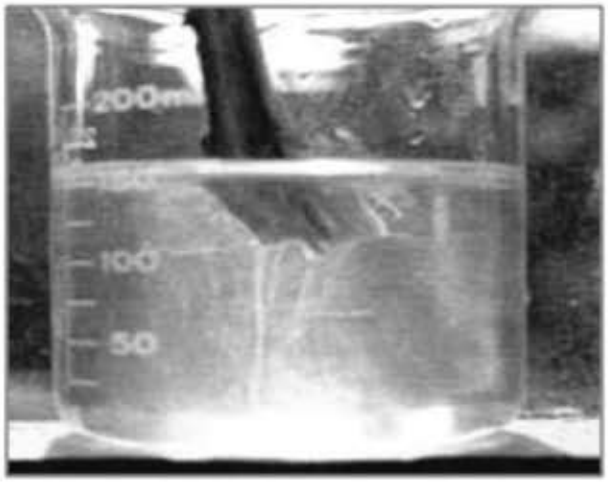

Fig. 2. White milky ooze of bacterial wilt

Fig. 3. Healthy tomato crop.

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Technology no. 9

1. **Name of the technology:** Citrus Rejuvenation
2. **Source of the technology:** Department of Plant Protection, College of Horticulture & Forestry and Krishi Vigyan Kendra East Siang Pasighat -791 102, CAU, Arunachal Pradesh
3. **Year of release:** 2011-12
4. **Agro Climatic Zone:** NEH Region/Hot Humid Region
5. **Detail description about the technology:**

   Management and Rejuvenation of Citrus Orchard in Different Location of North East Region of India

   Citrus is the second most important fruit crop of the world in terms of area, production and utility. India with the production of 6 million tons occupies sixth position in the world. There are four distinct citrus growing regions in the country *viz*. North east region comprising of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, North western region comprising of Himanchal Pradesh, Punjab, Haryana and Rajasthan, Central region including Gujarat, Maharashtra & Madhya Pradesh and Southern region comprising of Andhra Pradesh, Karnataka and Tamilnadu. North east region of India is considered to be the natural home of citrus for many species. Mandarins (*Citrus reticalata*), sweet orange (*C. sinensis*), acid lime (*C. aurantifolia*) and lime (*C. limon*) are the major cultivated species of the region. Citrus crop are widely grown fruit crop in north east region of India but the productivity is very low with 4.54 tons /ha as against the national productivity of 8.42 tons /ha. One of the main reasons of low productivity is due to losses caused by diseases *i.e.* Fungal, bacterial, viral and phanerogamic plant parasites and Insect-pest. The grower do not adopt the proper management practices in terms of plant protection, manuring, irrigation, mulching, pruning etc. and the orchard become sick.

   Rejuvenation strategies:

- Provide technical knowhow including plant health coverage and nutritional management programme.
- Re-planting of old / uneconomically orchards.
- Gap filling by provide disease free quality seedlings.
- The development agencies may prepare comprehensive orchards management programme provide all the necessary inputs like plant nutrients, plant protection horticultural equipment and periodically trainings.
- Training is an important component, which improves overall efficiency and knowledge and skill of field functionaries.
- Complete technological information for the management of decline orchard may be packed and same may be disseminated by farm' fields.

Months	Management Practices
January	❖ 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 liter of water in the bucket do not use plastic & Iron, dissolve 1 kg copper sulphate $CuSo_4.5H_2o$ is another 5 liter of water, mixed the solution well.) ❖ Clean the lichen /mosses growth with a piece of gunny bag.
February	❖ Locate trunk borer and plug the holes with mud after plugging cotton soaked in petrol/kerosene or carbon disulphide. ❖ Cut the wither parts and destroy them. ❖ Loranthus infected branches should be cut well below the last haustorium. The parasitic plant should be eradicated before the maturity of berry. ❖ Orchard phytosanitation and basin preparation by light working of the soil without root injury.
March	❖ Apply 25 kg FYM/tree around the tree trunk and after 15 days apply Urea (800g), Single Super Phosphate (400g), and Murate of Potash (800) / tree. ❖ Swapping of tree trunk with 1% of Carbaryl up to 2 meter from base. ❖ Spray endosulphan 0.07% to kill the adult trunk before feeding the foliage. ❖ Shaking of tree to kill the adult trunk borer manually.
April	❖ Apply Bromocil 6 kg/ha to control weeds ❖ Spray micronutrients mixture (Zinc sulphate 60g, Manganese sulphate 40g, borax 20g and lime 180g dissolve in 20 litres of water) or spray agromin @ 15g in 10 litres of water. ❖ Spray of Quinolphos 1.5ml./litre to control foliage feeder.
May	❖ Swapping of the base of the trunk with 1% Carbaryl and 1% of Bordeaux paste. ❖ Install light trap to catch trunk borer adults or hands picks. ❖ Apply 200g of urea in the soil around the tree basin.
June	❖ Sow intercrops like French bean, Chilli or any leguminous crops. ❖ If fruit drop problem occurs, apply light irrigation in orchard. ❖ Clean the weeds in the entire orchard area manually.
July	❖ Spray Roger or Monocrotophos @ 1.5 ml/liter of water if leaf minor damage appears. ❖ Spray of Bordeaux mixture 1% (dissolve 1kg lime in 50 liter water in plastic bucket + dissolve Copper sulphate 1 kg in 50 liter water separately. Mixed two the solution and use within a day).
August	❖ Kill the grubs of trunk borer by hooking by spike. ❖ Under severe infestation of trunk borer inject 5 ml Monocrotophos or Carbon disulphide / hole and plug with mud. ❖ Cut and burn dried parts of the plants as they harbor grubs and pupae. ❖ Apply 200g of Urea /plant in soil application.

September	❖ Apply Glyphosate 5 liter / ha to weed control ❖ Harvest the Intercrop. ❖ Use poison bait prepared by mixing 20g Malathion 50wp + 200g Jaggery or molaess in 2 liter water. Place in small plastic containers and hang 2-3 / tree for control of fruit sucking moths. ❖ Generate smoke in the orchard @ 2-4 / acre for 2-3 hours after night fall to control fruit piercing moth. ❖ Dispose fallen fruits which attract the moth.
October	❖ Follow control methods (as September) to control fruit sucking moth. ❖ Dispose fallen fruits which attract the moth. ❖ Control of trunk borer may be repeated. ❖ If pre-matured fruit drop problem occurs, spray 10 ppm 2,4 –D or 15-20 ppm Naphthalene acetic acid (NAA).
November	❖ Harvest the mature fruit without damaging the plant. ❖ Cut the dried branches, if any and apply 1% Bordeaux paste at the cut ends.
December	❖ Harvest of matured fruits continued. ❖ Harvest the fruits using secateurs, cutter or clipper avoid hand plucking. ❖ Grade the fruit into too small, too big, rotten, damage, hard green, over ripe. ❖ Wash the fruit at the packing shade with chlorine water and then rinse with fresh water. ❖ Washed fruit should be treated with Benomyl or Bavistin @ 0.25% mix with wax. ❖ Pack 50 fruits in one box or basket. Use chopped rise straw or dry grass for packing.

Rejuvenation Practices:

- Pruning of dried branches, after the harvest fruit immediately followed by application of Carbendazim (Bavistin) spraying @ 1g / liter of water.
- Control of bark eating caterpillar (Inderbela) by application of Dichlorovas @ 0.1% (3-5 ml) in each larval tunnel or inserting tunnel cotton swap soaked with insecticides.
- Scrapping of oozing out gum and application of Metalaxyl paste on the wound.
- Spraying of Ridomil MZ 72 WP @ 2.5g /liter for the control of Phytophthora.
- Irrigation by double ring method / drip and provide proper drainage.
- Application of recommended dose of fertilizer and micro-nutrients.
- Spraying of Imidacloprid (0.3 ml) or Monocrotophos @ (0.5 ml) / liter of water for the control of citrus psylla.
- Spraying of Dicofol @ 1.5 ml / liter for the control of mites.
- Application of Bordeaux paste on the tree trunk twice a year before monsoon and after

monsoon.

6. **Critical input required:**
   - Pruning knife (Dao sterilized with fire)
   - Foot sprayer
   - Bordeaux paste
   - Bucket
   - Brush






Fig.1. Citrus Rejuvenation in Arunachal Pradesh

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Technology no. 10

1. **Name of the technology:** Eco-friendly management of turcicum leaf blight of Maize
2. **Source of the technology:** Department of Plant Protection, College of Horticulture and Forestry, Central Agricultural University, Pasighat - 791 102, Arunachal Pradesh
3. **Year of release:** 2012-13
4. **Agro Climatic Zone:** NEH Region/Hot Humid Region
5. **Detail description about the technology**

Maize (*Zea mays* L.) belongs to the family Graminaceae (Poaceae) is one of the most important crops in World agricultural economy used both as food for man and feed for animals. It has yield potential far higher than any other cereal and that's why it is sometimes referred to as the miracle crop or the 'Queen of Cereals'. In India as well as north eastern region with the growth in demand of poultry feed the demand for maize is also going up. Whereas, Human Consumption 35%, Poultry Feed 25%, Cattle Feed 25%, Food processing (corn flakes, popcorns, etc.15%) andother Industries (mainly starch, dextrose, corn syrup, corn oil, etc). A number of diseases are attack during its growth stages. Among the various diseases damaging the maize crop, the turcicum leaf blight is one of the most important diseases in maize growing areas. Earlier the disease was considered as minor, although at the present it has assumed the status of major disease in the World. In this article we will discussed about eco-friendly management of leaf blight of maize.

Symptoms

The disease is characterized by long elliptical grayish green or tan lesions on the leaves measuring 2.5 to 25 cm in length and upto 4 cm in width. The fungus affect the maize plant at young stage. Small yellowish round to oval spots are seen on the leaves. The spots gradually increase in area into bigger elliptical spots and are straw to grayish brown color in the centre with dark brown margins. The spots coalesce to form bigger spots and gives blighted appearance. The surface is covered with olive green velvety masses of conidia and conidiophores. Under high humidity the whole leaf area becomes necrotic and plant appears as dead. Lesions may be extended to husk.

Causal organism: *Helminthosporium turcicum* (Syn: *Helminthosporium maydis*)

Etiology

The conidiophores of pathogen are in group, geniculate, mid dark brown, pale near the apex and smooth. Conidia are distinctly curved, fusiform and pale to golden brown with 5-11 pseudosepta.

Disease cycle

Fungus survives in plant debris, seed and collateral hosts. The fungus is externally seed borne. It also infects Sudan grass, Johnson grass, sorghum, wheat, barley, oats, sugarcane and spores of the fungus are also found to associate with seeds of green gram, black gram and cowpea. Secondary spread is through wind borne conidia.

Favourable Conditions

Optimum temperature for the germination of conidia is 18 - 27^{0}C provided with free

water on the leaf. Infection takes place early in the wet season.

Eco- friendly disease management

- Removal and destruction of infected plant debris.
- Always use deep summer ploughing and stubbles burn it.
- Clean cultivation is to check the disease.
- Use of crop rotation with non host crops.
- Grow resistant hybrids like DHM-1, DHM-103,
- It can also be managed by seed treatment and soil application with *Trichoderma spp.* formulations @ 2% and 5% respectively.
- Foliar application of Nimbicidin @ 3%.

Figure 1. Maize crop infected by leaf blight

Figure 2. Elliptical symptom on maize leaf

Figure 3. Golden brown conidia of fungus

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Technology no. 11

1. **Name of the technology:** Mushroom Cultivation in Arunachal Pradesh
2. **Source of the technology:** College of Horticulture & Forestry, CAU, Pasighat -791102, Arunachal Pradesh
3. **Year of release:** 2010-11
4. **Agro Climatic Zone:** NEH Region/Hot Humid Region
5. **Detail descriptions about the technology:**

Commercial cultivation of mushroom started in north estern region was very late because of the lacking of the knowledge. Now a days according to climatic conditions various mushrooms are cultivated in different places. However, in Pasighat condition of Arunachal Pradesh are suitable for cultivation of Oyster (Dhingri) *Pleurotus* spp. round the year.

Production technology:

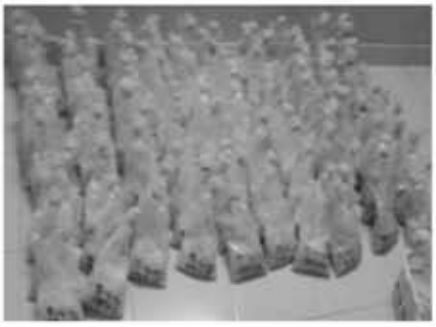
Period: January to December - Oyster mushroom

Mushroom house: It can be constructed with bamboo frames. Air vents on the upper walls and side walls are provided for ventilation. The walls may be covered with gunny cloth to increase the relative humidity to 80-85% in the production house. The sides are covered with tokkopatta (palm) plants. The floor of the shed is filled with sand to a uniform height of 10 cm.

Mushroom House

Spawn running room: Spawn running room is one where the beds are kept for running of spawn under dark condition but ventilation is required. Temperature in the spawn running room should be maintained between, 25-28 ^{0}C.





Cropping room: Cropping room is the one where the opened mushroom beds are to be kept after completion of spawn running. Fruiting requires a temperature range of 20-28 ^{0}C, cross ventilation (2-3 hour daily by opening doors and window) and light (2-4 hours per 24 hours from fluorescent tube), moisture and humidity range of 80-95%.


Substrate for mushroom cultivation: *Pleurotus* spp. can be grown on the tropical wastes like rice straw, wheat straw, corn Cobbs, dried water hyacinth, sugarcane bagasse, banana leaves, cotton waste or sawdust are used for cultivation. Paddy straw is cheap, easily available and used as a substrate in Pasighat conditions of Arunachal Pradesh. Hand thrashed and fresh paddy straw is cut into 3 to 5 cm length were used for pasteurization.


Pasteurization of substrate (Hot water treatment)

Soak the chopped 3-5cm paddy straw in cold water for 4 hr in a drum (Plastic/Teen/

Iron). Drain out the water and add fresh water with cover the drum with gunny sac. Boil the contents over the flame for 45-60 minutes. After boiling, take out the straw and drain the excess water by keeping them in wire baskets. Spread the straw as thin layer on a hessian cloth, spread on a raised platform. Shade dry the straw to get 60-65 % moisture capacity.



Precautions to be observed:

The straw should not be dried on a floor. The hessian cloth should be disinfected with dettol or any disinfectant before use. The 60 % moisture content in the straw can be judged by taking a handful of straw and squeeze it tightly.

Preparation of mushroom bed:

For preparation of bed (spawning) use 60x30 cm polythene bags of 80 gauge. Wash hands thoroughly with antiseptic lotion or dettol liquid/soap. Take the polythene cover and tie the bottom end with a thread and turn it inwards, put two holes of 1 cm dia in the middle to ensure aeration. Mix the dried straw thoroughly to get a uniform moisture level in all areas, put the processed straw in the bottom of the bag to height of 7.5cm, sprinkle 25g of spawn. Fill the second layer of the straw to a height of 12.5cm and spawn it as above. Repeat the process to get four layers of spawn and 5 layers of straw. The last layer of straw is of 5 cm height. Tie the mouth with twine (rubber band). Arrange the beds inside the thatched shed, (Spawn running room) following rack system or hanging system. Maintain the temperature of 22-25^{0}C and relative humidity of 85-90 % inside the shed. Observe the beds daily for contamination, if any. The contaminated beds should be removed and destroyed after 15-20 days of spawn running period, cut and remove the polythene bag and transfer the beds to cropping room. Maintain cropping conditions. Keep the beds moist by periodical spraying with water.



Precautions to be observed:

Keep the spawn running room dark so that spawn running will be faster. Periodically place Rat-baiting to kill rats as they are attracted by the spawn. Periodically sprinkle water on sand layer to maintain the required conditions. Never spray any insecticides on the mushroom beds.

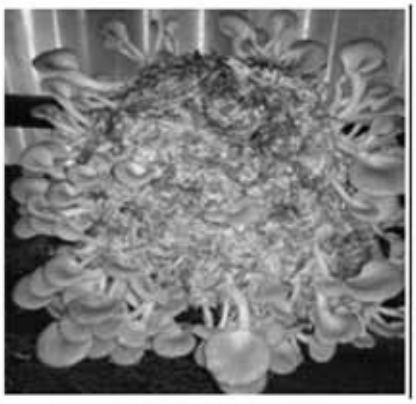
Harvest and yield:

Mushroom pin heads appear on 3rd or 4th day of opening of beds. Matured mushrooms can be seen 3-4 days after pin head formation. Harvest matured mushrooms before spraying water. To harvest the mushrooms, they are grasped by the stalk and gently twisted and pulled. A knife should not be used. The mushrooms remain fresh for up to 3-6 days in a refrigerator/cool place. Second and third harvest can be obtained after scraping the surface of beds to 1-2 cm deep after first or second harvest. The entire cropping will be over in 40- 45 days.

Storage and packaging:

- At ambient temperature mushroom can be kept up to 48 hours and in cold storage conditions it can be stored up to 4-7 days.
- After harvesting wash in running tap water and immediately store at 5^{0}C.
- Packaging of mushroom in 200 g or 500g in polythene bags with the help of shrink wrap machine can be done.





Cost and Profit in Mushroom cultivation

Production: Average production 5kg/day (Mid June to Mid December)

S. No.	Cost and profit	Amount (₹)
1	Non recurring and fixed capital	30,000
2	Fixed cost	4,000
3	Recurring cost (paddy straw, polythene bags, labour, spawn etc.)	25,000
4	Total cost of the mushroom production (2+3)	29,000
5	Total income (400kg @ 200)	80,000
6	Net Profit (5-4)	51,000
7	Cost: benefit ratio	

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Technology no. 12

1. **Name of the Technology:** Mass production of *Trichoderma viride* a bio-control agent
2. **Source of technology:** Funded by DBT, New Delhi
3. **Year of release:** 2009-10
4. **Agro climatic Zone:** North East Region/Hot Humid Region
5. **Detail description about the technology:**

   The bio-control agent *Trichoderma* spp. was isolated from Arunachal Pradesh tested for their efficacy against soil borne pathogen *in vitro* and *in vivo* condition. The promised *Trichoderma* bio-control *Trichoderma viride* was mass multiplied and given the name CAU GREEN GOLD. It is the best bio-control agent to manage of soil born diseases

   Procedure

   - Prepare potato dextrose broth media (Potato 200g, Dextrose 20g, Distilled water 1000ml) in culture flasks and sterilize at 1.1kg/cm^2 for 20 min.
   - Inoculate 10 days old *Trichoderma viride* culture into conical flasks and incubate it 22^{0}C for 10 days.
   - Mix well grown fungal biomass with talk powder at the ratio of 1: 1.
   - Air dry the mixture and mix it with carboxymethyl cellulose @5g/kg of product.
   - Count the fungal population and pack in polythene bag.

❖ The fresh product should contain not less than 10^9CFU/g.

Recommendation:

- Seed treatment with BCA 2g/l water for 30 minutes + Soil application of BCA (5%) is effective.
- Two training was given to ginger growers in Lower Subansri district villages and totally 65 farmers are benefitted. *Trichoderma* bio-formulation was tested in tomato, brinjal, cabbage and cauliflower crops against soil borne pathogens.
- It was observed that bio-control treated plot has shown significant yield than untreated plot.

6. Critical Inputs required:

Mass Multiplication of *Trichoderma viride*

Molasses yeast medium

Molasses	:	30.0 g
Yeast	:	5.0 g
Distilled water	:	1000ml

Molasses yeast medium is prepared in culture flasks and sterilized at 1.1 kg/cm^2 for 20 minutes. *Trichoderma* culture is inoculated by taking a fungal disc from 10 day old culture and incubated for 10 days. The fungal biomass and broth are mixed with talc powder at 1: 2 ratio. The mixture is air dried and mixed with Carboxy Methyl Cellulose (CMC) @ 5g / kg of the product. It is packed in Polythene covers. Fresh product should contain not less than 9 X 10^9CfU / g

7. **Observation to be recorded**
   a. Quality of the medium
   b. Microbial population at the end product
   c. Viability of the bio-control agent
8. **Contact Information for relevant information:**

Dr. P. RAJA, Assistant Professor (Plant Pathology)
Department of Plant Protection,
College of Horticulture and Forestry, Central Agricultural University,
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Technology no. 13

1. **Name of the Technology:** Mass production of Plant growth promoting rhizobacteria agent for management of seed and soil borne disease of tomato, chilli, cabbage cauliflower and citrus.
2. **Source of technology:** CAU, Pasighat
3. **Year of release:** 2014
4. **Agro climatic Zone:** NEH Region/Hot Humid Region
5. **Detail description about the technology:**

   PGPR isolates were collated from Arunachal Pradesh their potentially was checked *in vitro* and *in vivo* isolate Chf 2011 32a and TRB found to be the best one for seed and soil borne diseases of tomato, chilli, cabbage , cauliflower and citrus. Bacterial bio-control agent *Psedomonas putida* was mass multiplied and released as PASIPUSA to manage soil borne pathogenic bacteria and citrus canker.
6. **Critical input required:**

   Production procedure Mass multiplication of PGPR bio-formaulation.

   PGPR isolates *P. fluorescens* is mass multiplied in sterilized king's B broth for 48 hours.

   KING'S B Broth Preparation

   - Peptone: 20.00
   - Heptahydrated Magnesium Sulfate: 1.50
   - Di Potassium Hydrogen Phosphate: 1.50
   - Final pH 7.2± 0.2 at 25°C

     The above chemicals are mixed in one liter of distilled water. Added 10 ml of glycerol and dissolved by heating with frequent agitation. Boiled for one minute until complete

dissolution. Dispense into conical flask, and sterilized in autoclave at 121°C for 15 minutes. The color is amber, slightly opalescent. A loopful of bacterium was inoculated in to the Kings B broth culture under aseptic condition. The bacterial culture is mixed with sterilized talcum powder (pH is adjusted to 7 by adding calcium carbonate @ 150 g/kg). The substrate is then sterilized at 1.1kg/cm^2 pressure for 30 min for two successive days. Four hundred ml of 48 h old culture suspension of *P. fluorescens* was added to 1 kg of substrate containing 5 g of carboxymethyl cellulose (CMC) and mixed well. The formulation was packed in polythene bags and can be stored in room temperature.

Releasing of PGPR as PASI PUSA in Agri Horti Expo, 2014

Sparying of PGPR in College Orchard

Awareness training about Citrus Management at Renging Village

7. **Observation to be recorded:**
    a. Quality of the medium
    b. Microbial population at the end product
    c. Viability of the PGPR
8. **Contact Information for relevant information:**

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Technology no. 14

1. **Name of the Technology:** Storage of Planting Material for Effective Management of Rhizome Rot of Ginger
2. **Source of technology:** CAU, Pasighat
3. **Year of release:** 2009
4. **Agro climatic Zone:** NEH Region/Hot Humid Region
5. **Detail description about the technology:**
    - Make a pit of 1 x 2 m^2 size under shade
    - Spread a 5cm uniform layer of sand at the bottom of pit
    - Treat the ginger planting materials with CAU Green Gold (*Trichoderma* Bio-control Agent) 5g/lit of water for 30 min
    - Treated rhizomes keep under shade for 24 hours
    - Keep the dried rhizomes in pit and cover with fine sand
6. **Critical input required:**
    1. Trichoderma
    2. Ginger
    3. sand
7. **Observation to be recorded:**

a. Viability of ginger
b. Diseased ginger
c. Germination percentage

8. Contact Information for relevant information

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Technology no. 15

1. **Name of the technology:** Organic management of late blight in tomato
2. **Source of technology:** ICAR- National Organic Farming Research Institute
3. **Year of release:** 2014
4. **Agro-climatic zone:** North Eastern Himalayan Zone
5. **Details description about the technology:**

S. No	Particulars	Description
1.	Introduciton	Tomato (*Solanum lycopersicum*) is one of the important vegetables belonging to the family solanaceae. Among the pests and diseases Associated with tomato production in Sikkim, late blight caused by *Phytophthora infestans* (Mont) de Bary is one of the most significant constraints for its tomato production. The disease is more severe in humid and high rainfall areas.
2	Management	❖ Application of Copper oxychloride(COC) @0.25% (25 g in 10 l of water). ❖ Planting in suitable areas and climate. ❖ Practicing rain shelter cultivation in the areas of high rainfall.
3.	Interval of application	COC can be applied immediately after the onset of disease after removing the infected leaves on tomato and should be continued at 7-10 days interval until the disease become less severe.
4.	Observations to be recorded	Disease severity will be determined using a 1-6 severity scale (Gwary and Nahunnaro1998) where scale 1= trace to 20% leaf infection, 2=21-40% leaf infection, 3= 41-60% infection, 4= 61-80 infection, 5= 81-99% infection, 6= 100% leaf infection or the entire plant defoliation and the Per cent Disease Index (PDI) was calculated using standard formula. At physiological maturity, tomato fruits from each plot will be harvested and weighed separately to determine fruit yield. Benefit: cost ratio will calculated from the average yield.
5.	Precautions to be followed	❖ Normally copper and sulphur fungicides are not systemic fungicides. ❖ They should be applied before the arrival or when the disease incidence is very less or just started. ❖ Three to four applications or until the disease become less severe. ❖ They should not be sprayed on the plants which are sensitive. ❖ Copper is more toxic to crop plants under acidic conditions whereas it is more effective under higher pH conditions. ❖ The rate of application of copper fungicides should not exceed 8kg per hectare per year.

6.	Contact address for relevant information	Joint Director, ICAR-NOFRI, Tadong, Gangtok, Sikkim or Dr. R. Gopi, Scientist (Plant Pathology), ICAR-NOFRI, Tadong, Gangtok, Sikkim.

$$PDI = \frac{\text{Sum of individual rating}}{\text{Number of plants examined x Maximum disease grade in the scale}} \times 100$$

Technology no.16

1. **Name of the technology:** Organic oyster mushroom production
2. **Source of technology:** ICAR- National Organic Farming Research Institute
3. **Year of release:** 2013
4. **Agro-climatic zone:** North Eastern Himalayan Zone
5. **Details description about the technology**

Particulars	Description
Mushroom bed preparation	Cultivation of oyster mushroom is usually carried out in transparent polythene covers. The size of the cover should be 60 cm x 40-45 cm with a thickness of 80 gsm. ❖ Collect good quality paddy straw(golden yellow in colour without blemishes or spots) and chop 2 kg dry straw with a hand chopper(about 5 cm long) for one polythene bag. ❖ Soak the straw overnight(6-8 hrs) in cold water; the 2 kg Dry straw becomes 4.5 kg/ 5 kg in weight. ❖ Boil the soaked straw for 30 mins. ❖ Remove the straw from boiled water and allow cooling by spreading on a clean floor. Squeeze or drain out the excess water. ❖ The poly bags are perforated by making holes with a punch machine or similar toll at a distance of about 10 cm between the holes. The closed end of the poly bag is then tied with a piece of jute thread. ❖ The bag is then filled with a little compact layer of the straw(4-5 cm). On a tray, the spawn packet of 200 gm is first divided into parts of 25 gm each. The straw layer is spawned with 25 gm of the spawn. ❖ Likewise with a total of five straw layers and four layers of spawn in between fill up the poly bag. Once the bag is filled, the open end of the bag is now tied up with a piece of jute thread. The mushroom bag is then placed in a cool and dark place, for spawn run whic is completed within 15-20 days with a white mycelia mat covering the entire straw. ❖ Maintain 22-25°C temperature and 85-90 per cent relative humidity inside the shed.

Mushroom bed preparation	❖ Observe the beds daily for contamination, if any. The contaminated beds should be removed and destroyed. ❖ Remove the polythene bag after completion of spawn run to allow space for fruiting. Open the mouth of the bag; hold the bag upside down with right hand and place the other hand on the open end below, remove the poly bag with slight thrust. ❖ The fully spawn run beds can be shifted to cropping room for initiation of buttons. (Completion of spawn run is indicated by the growth of white to creamy coloured mycelium mat covering the entire straw). ❖ Place the mushroom bed on racks or hang it like pots in the mushroom house. ❖ Allow the bed to dry for one day and start watering from second day onwards on the basis of requirement with the touch of the hand. ❖ Periodically observe the beds and remove the contaminated beds, if any. ❖ Mushroom fruit bodies (pinheads) starts appear from 5-7 days after opening. The pinheads develop into fully mature mushroom after 3-5 days of the appearance.
Harvesting	Harvesting is done by gentle twisting of stalk in the early hours of morning before attaining over maturity (curling of margin of pileus either upward or downward indicates over maturity). The left over part of stipe is scooped out to prevent contamination of saprophytic fungi or bacteria. Trimming the stalk or stipe should be done to remove the adhering straw particles. The fruit bodies should be neatly packed in perforated polythene cover @ 200 g or 500 g per bag as per requirement. *Note*: It is reported that addition of 5 per cent steamed neem cake or 2 per cent deoiled soybean meal or 4 per cent rice bran or 2-5 per cent wheat bran enhanced the yield of oyster mushroom.
Yield	Yield range from 100-200 per cent of dry weight of the substrate depending upon the substrate combination and the manner in which the substrate has been managed during the growing season.
Observations to be recorded	❖ Days taken for spawn run. ❖ Days taken for pinhead formation. ❖ Yield data (number and weight up to 4 weeks). ❖ Time taken for I, II and III flush
Contact address for relevant information	Joint Director, ICAR-NOFRI, Tadong, Gangtok, Sikkim or Dr. R. Gopi, Scientist (Plant Pathology), ICAR-NOFRI, Tadong, Gangtok, Sikkim.

Technology no. 17

1. **Name of the technology:** Organic large cardamom production
2. **Source of technology:** ICAR- National Organic Farming Research Institute
3. **Year of release:** 2015
4. **Agro-climatic zone:** North Eastern Himalayan Zone
5. **Details description about the technology**

S. No	Particulars	Description
1.	Land preparation/ Method of planting	Pits of size of 30 cm x 30 cm x 30 cm are prepared at a spacing of 1.5 m x 1.5 m. Wider spacing of 1.8 m x 1.8 m is recommended for robust cultivars like Ramla, Ramsey, Sawney, Varlangey *etc*. While closer spacing 1.45 m x 1.45 m is advised for non-robust cultivators like Dzongu Golsey, Seremna *etc*. Suckers are treated using *Pseudomonas fluorescence* @ 0.5%.
2.	Organic nutrient management	FYM application 2 Kg per plant in the months of October-November and April to June along with *Trichoderma viride* @ 2.5 kg for one hectare is recommended. Mulching is done with locally available biomass. Mulching is done with locally available biomass.
3.	Time of planting	Planting is done in June-July.
4.	Cutivars/varieties	1. Ramsey: It is well-suited to high altitudes (1515 m amsl) and can be cultivated even on steep slopes. 2. Ramla: Cultivation is restricted to few high altitude areas in North Sikkim. 3. Sawney: It is a widely adapted cultivar, which is most suited to medium (975-1515 m amsl) and high (> 1515 m amsl) altitude areas. 4. Varlangey: It is found to grow in mid and high altitude (> 1515 m amsl) areas. 5. Seremna: The cultivar is grown in a small pocket of the Hee-Gaon, 6. Dzongu Golsey: It is suitable to areas below 975 m amsl and is very specific in Dzongu area of North Sikkim. 7. ICRI Sikkim 1: Medium(1500 m amsl) to high (1650 m amsl) altitudes. 8. ICRI Sikkim 2: Medium (1500 m amsl) altitude
5.	Pest and disease management	Application of Copper oxychloride @ 0.25% during rainy season 15- 20 days interval to manage capsule rot if any. For management of insect pests spray neem oil (1500 ppm) @ 3 ml/l at 20 days intervals (minimum four sprays).

6.	Shade management	Shade management using locally available trees like *Alnus nepalensis*, *Schima wallichii etc.*
7.	Observations to be recorded	No. of tillers, no. of spike, no. of capsules on the spike and total yield of capsules and damaged capsules.
8.	Contact address for relevant information	Joint Director, ICAR-NOFRI, Tadong, Gangtok, Sikkim or Dr. R. Gopi, Scientist (Plant Pathology), ICAR-NOFRI, Tadong, Gangtok, Sikkim.

Technology no. 18

1. **Name of the technology:** Soft rot management in ginger
2. **Source of technology:** ICAR- National Organic Farming Research Institute
3. **Year of release:** 2013
4. **Agro-climatic zone:** North Eastern Himalayan Zone
5. **Details description about the technology:**

S. No	Particulars	Description
1.	Introduciton	Soft rot is one of the most important diseases of ginger. soft rot of ginger caused by *Pythium* sps. is a major bottleneck, causing huge crop losses up to 70% in a cropping season The disease symptoms appear as yellowing, drooping, withering and drying of leaves and brown discoloration in rhizome and collar region.
2.	Management	Hot water treatement @ 47°C for 30 mins+ *Trichoderma harzianum*+ drenching of COC @ 0.3 %. ❖ Crop rotation for 4-5 years ❖ Provision of good drainage. ❖ Use of disease free healthy rhizomes for planting.
3.	Interval of application	The COC drenching can be done immediately after the onset of disease after removing the infected plants and should be continued at 7-10 days interval until the disease become less severe.
4.	Observations to be recorded	No. of tillers, per cent disease incidence and total yield of ginger.
5.	Precautions to be followed	❖ Normally copper and sulphur fungicides are not systemic fungicides ❖ They should be applied before the arrival or when the disease incidence is very less or just started ❖ Three to four applications or until the disease become less severe ❖ They should not be sprayed on the plants which are sensitive

	Precautions to be followed	❖ Copper is more toxic to crop plants under acidic conditions whereas it is more effective under higher pH conditions. ❖ The rate of application of copper fungicides should not exceed 8kg per hectare.
6.	Contact address for relevant information	Joint Director, ICAR-NOFRI, Tadong, Gangtok, Sikkim or Dr. R. Gopi, Scientist (Plant Pathology), ICAR-NOFRI, Tadong, Gangtok, Sikkim.

6. Observations to be recorded:

$$\text{Per cent disease incidence} = \frac{\text{Total no. of infected plants}}{\text{Total no of plants}}$$

Technology no. 19

1. **Name of the technology:** Blast disease management in rice
2. **Source of technology:** ICAR- National Organic Farming Research Institute
3. **Year of release:** 2016
4. **Agro-climatic zone:** North Eastern Himalayan Zone
5. **Details description about the technology:**

S. No	Particulars	Description
1.	Introduciton	Rice is affected by many diseases among them blast, caused by Magnaporthe oryzae (T.T. Hebert) Barr (anamorph = Pyricularia grisea (Cooke) Sacc.), is the most important disease of rice and it appears at all the stages of plant growth. It affects stem nodes (nodal blast), leaf (leaf blast) neck (neck blast) and also grains of paddy. Blast disease occurs both in nursery and main field. The disease results in yield loss as high as 70–80%
2.	Management	❖ Field sanitation. ❖ Seed treatment with *Pseudomonas flourescens* at the rate of 10 g per kg of seeds. ❖ Copper oxycholoride @ 0.25% or copper hydroxide @ 0.25%.
3.	Interval of application	The COC application can be done immediately after the onset of disease and should be continued at 7-10 days interval until the disease become less severe.
4.	Observations to be recorded	No. of tillers, per cent disease index and per cent neck blast infection total yield.

5.	Precautions to be followed	❖ Normally copper and sulphur fungicides are not systemic fungicides ❖ They should be applied before the arrival or when the disease incidence is very less or just started ❖ Three to four applications or until the disease become less severe ❖ They should not be sprayed on the plants which are sensitive ❖ Copper is more toxic to crop plants under acidic conditions whereas it is more effective under higher pH conditions. ❖ The rate of application of copper fungicides should not exceed 8kg per hectare.
6.	Contact address for relevant information	Joint Director, ICAR-NOFRI, Tadong, Gangtok, Sikkim or Dr. R. Gopi, Scientist (Plant Pathology), ICAR-NOFRI, Tadong, Gangtok, Sikkim.

Technology no. 20

1. **Name of technology:** Bio- control of stem borer and leaf folder in rice
2. **Source of technology:** NBAII, Bangalore
3. **Year of release:** 2011
4. **Agro-climatic zone:** UBVZ of Assam
5. **Detail description of technology:**

   Treatment T1: BIPM package consists of

   a. Seed treatment with *Pseudomonas fluorescence* @ 8g/kg of seeds or Seedling root dip treatment with 2% suspension of *P. fluorescence*
   b. Spray of *Beauveria bassiana* @1013 spore/ha against sucking pests.
   c. Three release of *Trichogramma japonicum*@ 1,00,000/ha from 30 days after transplanting against stem borer and leaf folder
   d. Spray of *Pseudomonas fluorescence* @2% against foliar diseases
   e. Application of botanicals (Neem oil/pestoneem @ 3ml/li) at the time of pest occurrence
   f. Erection of Bird perches @ 15/ha and to be removed before crop maturity

   T2: Chemical control plot (Farmers' practice)
6. **Critical inputs required:** *Pseudomonas fluorescence, Beauveria bassiana,Trichogramma japonicum,* botanicals.
7. **Observations to be recorded:** All observations to be recorded in BIPM plots as well as plots with farmers' practice for making comparison, Incidence of pests/diseases: Per cent Dead heart /white ear head damage from 20 randomly selected hills before treatment and after treatment at 7, 10 and 15 days interval starting from imposition of treatment, per

cent damage of leaf folder, and case worm larvae from 20 randomly selected hills before treatment and after treatment at 7, 10 and 15 days interval starting from imposition of treatment, Number of sucking pests before and 7 days after each spray of B. bassiana from 20 randomly selected hills, Record Per cent disease incidence, Time of occurrence: Dead heart 25 DAT to 65 DAT, White ear head: Before penicle initiation or at before harvest stage, Leaf folder: 30DAT to flowering stage, Caseworm: 25 DAT to maximum tillering stage, Per cent damage/ per cent survival, Yield &yield attributes, Soil status, B: C ratio, Farmers' reaction.

Technology no. 21

1. **Name of technology:** Management of white grub in Potato
2. **Source of technology:** Assam Agricultural University
3. **Year of release:** 2015
4. **Agro-climatic zone:** All Agro-Climatic Zones of Assam
5. **Detail description of technology:** Treatment Soil application of Quinalphos 25EC @ 400 g a.i./ha (1.5 lit./ha or 2 ml/lit of water) against white grub and other soil insects in potato.
6. **Critical inputs required:** Quinalphos 25EC
7. **Observations to be recorded:** Per cent damage, Yield &yield attributes, Soil status, B: C ratio, Farmers' reaction.

Technology no.22

1. **Name of technology:** Integrated pest and disease management module for *olitorius* jute
2. **Source of technology:** Assam Agricultural University
3. **Year of release:** 2015
4. **Agro-climatic zone:** All Agro-Climatic Zones of Assam
5. **Detail description of technology:** Treatment - Application of *Trichogramma viride* @ 2.5 Kg /ha (mixed with 150 Kg FYM, covered with moist gunny bag and incubated for 48 hours in shade) in soil at the time of sowing and incorporated with soil.
    - ❖ Manual weeding at 3-4 weeks after sowing
    - ❖ Hand picking and destruction of egg masses and
    - ❖ larvae of Bihar hairy caterpillar
    - ❖ Erection of bamboo perches @ 40 Nos./ha
    - ❖ Two sprays of neem oil @ 4 ml/lit of water at 2nd
    - ❖ week of June and 1st week of July.
    - ❖ One spray of recommended insecticide (ifnecessary).

6. **Critical inputs required:** *Trichogramma viride,* FYM, Bamboo perches, Neem oil, Insecticide
7. **Observations to be recorded:** Per cent damage, percent insect pest and disease incidence, yield &yield attributes, B: C ratio, Farmers' reaction.

Technology no. 23

1. **Name of technology:** Protection of wheat seeds from insect pests during storage
2. **Source of technology:** Assam Agricultural University
3. **Year of release:** 2015
4. **Agro-climatic zone:** All Agro-Climatic Zones of Assam
5. **Detail description of technology:** Treatment -Dry the wheat seeds to reduce moisture content up to 11-12%
   - ❖ Mix black peeper seed powder @ 6 g / kg seed thoroughly
   - ❖ Store in gunny bags impregnated with polyethene in dry places
6. **Critical inputs required:** Black peeper seed powder, gunny bags, polyethene
7. **Observations to be recorded:** Per cent damage, B: C ratio, Farmers' reaction

Technology no. 24

1. **Name of technology:** Management of papaya mealy bug (Paracoccus marginatus)
2. **Source of technology:** Assam Agricultural University
3. **Year of release:** 2015
4. **Agro-climatic zone:** All Agro-Climatic Zones of Assam
5. **Detail description of technology:** Treatment - **Mechanical:** Removal and burning of infestedparts/plants

- ❖ **Cultural:** Removal of weeds/ alternate hosts like *Hibiscus sp.* and application of sticky bands or alkathene sheet on main stem of the plant to prevent upward movement of crawlers.
- ❖ **Chemical:** Dusting of chlorpyriphos 1.5% dust or malathion 5% dust around the healthy plants to check the movement of crawlers; spot spraying of Neem oil (1 to 2%), NSKE (5%), profenophos 50 EC (2 ml/l), chlorpyriphos 20 EC (2 ml/l), dimethoate 30 EC (2 ml/l), thiomethoxam 25WG (0.6 g/l) and imidacloprid 17.8 SL (0.6 g/l); destruction of ant colonies with drenching of chlorpyriphos 20 EC @ 2 ml/l

6. **Critical inputs required:** Insecticides, sticky bands or alkathene sheet
7. **Observations to be recorded:** Per cent damage, B: C ratio, Farmers' reaction

Technology no. 25

1. **Name of technology:** Beneficial birds in suppression of insect and rodent pests
2. **Source of technology:** AINP on Agricultural Ornithology(ICAR)
3. **Year of release**: 2011
4. **Agro-climatic zone:** All zones of Assam
5. **Detail description of technology:**

   Technology: Barn owl (*Lakhi Fesa),* Nest box (Made of country wood/ Ply wood) Floor = 35cm X 35cm Height= 45cm with an entrance hole of 15cmX15cm at a height of 15cm on the front cover of the box with a 15 cm floor at bottom of the box and a roof cover(lid) with provision of 2 hinges at the top of the back cover for hanging or fixing on substrate. Spotted owlet *(Futuki Fesa)* nest box(Country wood/ Apple box/ shop box) Floor = 25cmX25cm.

   Method of application: Height= 30cm with an entrance hole of 10cmX10cm at a height of 15cm on the front cover of the box with a 15 cm floor at bottom of the box.

6. **Critical inputs required:** Barn owl (*Lakhi Fesa),* Nest box (Made of country wood/ Ply wood) Spotted owlet *(Futuki Fesa)* nest box(Country wood/ Apple box/ shop box)
7. **Observations to be recorded:** Owl species occupied the nest box, Time of occupation, No. of Live burrow of rodents in the crop field, Pests infestation records both in control and trcated plots, percent damage/ yield loss, Farmers' reaction.

Technology no.26

1. **Name of Technology:** Biorational management of insect pests in Sikkim mandarin
2. **Source of Technology:** ICAR-NOFRI, Tadong-737102, Sikkim (*formerly ICAR Research Complex for NEH Region, Sikkim Centre, Tadong-737102*)
3. **Year of release:** 2012
4. **Agro Climatic Zone**: Mid hills of Sikkim
5. **Detail description about the technology:**

Management of insect pests

- ❖ Cleaning and pruning of the orchard after harvest.
- ❖ Smearing of Bordeaux paste at the base of the trunk up to 1 m height in April.
- ❖ Frequent monitoring of the orchard.
- ❖ Two sprays of petroleum-oil based spray @ 10 ml/l during April-May for control of aphids and leaf miner and one spray of *Bacillus thuringiensis* @ 2 g or 2 ml/l when infestation of lemon butterfly is observed.
- ❖ Cleaning of trunk borer and bark eating caterpillar infested plants and insertion of iron wire to kill the larvae June onwards and insertion of cotton soaked in petrol or kerosene

in to the holes and plastered with soil and cow dung mixture.

- ❖ Installation of methyl eugenol based para pheromone trap September onwards to manage fruit fly @ 20 traps/ha.
- ❖ The dropped infested fruits should be collected on community basis and buried under the soil or destroyed by keeping in hot water to reduce the infestation of fruit fly.
- ❖ During August-September also spray of petroleum-based oil spray @ 10 ml/l should be done in case of occurrence of aphids and leaf miner and one spray of *Bacillus thuringiensis* @ 2 g or 2 ml/l when the infestation of lemon butterfly is observed.
- ❖ Yellow colour trap can be installed in the field throughout the year to trap the population of aphids, leaf miner and psylla.

6. **Critical inputs required:** Biopesticdes (Bordeaux paste, petroleum oil based agro-spray, *Bacillus thuringiensis*), methyl eugenol based para pheromone traps, yellow colour sticky traps etc.
7. **Observation to be recorded:** % of incidence of Trunk borer and bark eating caterpillar from randomly selected 20 plants, for leaf miner, lemon butterfly, aphids, mealy bug and scale insects observations from randomly selected 50 shoots; for fruit fly randomly selected 100 fruits from each treatment.
8. **Contact Address for relevant information:** Joint Director, ICAR- National Organic Farming Research Institute, Tadong, Sikkim

Technology no. 27

1. **Name of Technology:** Eco-friendly management of insect pests in organic rice cultivation
2. **Source of Technology:** ICAR-NOFRI, Tadong-737102, Sikkim (*formerly ICAR Research Complex for NEH Region, Sikkim Centre, Tadong-737102*)
3. **Year of release:** 2011
4. **Agro Climatic Zone:** Mid hills of Sikkim
5. **Detail description about the technology:**

Management of insect pests

The insect pests of rice can be managed by adopting the practices in an integrated approach.

- ❖ 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 the pests.
- ❖ Spraying of neem oil 0.03 EC @ 3 ml/l at 10 DAT followed by second spray after 20 days interval.
- ❖ Regular monitoring, collection and destruction of egg, larvae, pupae and adults of different insects.
- ❖ Installation of pheromone traps @ 16-20 traps/ha in a triangular pattern at 60 m distance

for trapping the adult male of yellow stem borer.

- ❖ Release of *Trichogramma japonicum* or *T. chilonis* @ 50,000 per hectare at weekly interval for 7-8 times starting from 30 days after transplanting
- ❖ At the beginning of Gundhi bug infestation, a few first batch population of Gundhi bug should be collected and after preparing the aqueous extract from them it should be sprayed in the field to repel subsequent population.
- ❖ One spray of *Beauveria bassiana* @ 7 g/l at the boot leaf stage to reduce Gundhi bug population.

6. **Critical inputs required:** Biopesticdes (Neem oil, *Beauveria bassiana*), sex pheromone traps, Tricho cards, Sherman traps for rodent *etc.*
7. **Observation to be recorded:** Dead heart % for stem borer, damaged leaves per 10 hills for leaf folder, case worm, whorl maggot and for gundhi bug no. of insects per 10 hills.
8. **Contact Address for relevant information:** Joint Director, ICAR- National Organic Farming Research Institute, Tadong, Sikkim

Technology no. 28

1. **Name of Technology:** Organic management of insect pests in mustard
2. **Source of Technology:** ICAR-NOFRI, Tadong-737102, Sikkim (*formerly ICAR Research Complex for NEH Region, Sikkim Centre, Tadong-737102*)
3. **Year of release:** 2014
4. **Agro Climatic Zone:** Mid hills of Sikkim
5. **Detail description about the technology:**

Pre-sowing

- ❖ Proper planning of cropping pattern for avoiding pest like painted bug.
- ❖ Summer ploughing should be done to kill the residual population of the pests.
- ❖ Remove the residue of previous crops from preventing the painted bug.

Sowing

- ❖ Planting should be done during first fortnight of October to reduce major pest like aphid and saw fly.

Seedling and vegetative stage

- ❖ Periodical weeding helps in reducing building up of painted bug population.
- ❖ Irrigate the crop in the 4th week after sowing.
- ❖ Collection and destruction of the saw fly larvae during the early morning time.
- ❖ Need based and judicious application of *Bacillus thuringiensis* @ 2 g or ml/l or botanical insecticides like neem oil 0.15 EC (1500 ppm) @ 3 ml/l.

Flowering stage

- ❖ Removal of the aphid infested twigs at the initial level of the pest attack at community level to stop the further spread of the pest.
- ❖ Conservation of natural enemies like Syrphid fly, *Coccinella septempunctata*, *Menochilus sexmaculata etc.*
- ❖ If population reaches ETL one spray of neem formulation @ 3 ml/l or petroleum oil-based spray @ 10 ml/l and second spraying followed by 20 days interval. Spraying should be done in the afternoon to save pollinators.

Pod formation stage

- ❖ For painted bug, threshing of harvested crop should be done quickly.

6. **Critical inputs required:** Biopesticdes (Neem oil, petroleum oil-based spray, *Bacillus thuringiensis*), *etc.*
7. **Observation to be recorded:** Aphids/10 cm central shoot, sawfly larvae per plant, painted bug per plant (10 observations from each treatment)
8. **Contact Address for relevant information:**

   Joint Director, ICAR- National Organic Farming Research Institute, Tadong, Sikkim

   Director, ICAR RC for NEHR, Umiam, Meghalaya

Technology no. 29

1. **Name of Technology:** Organic management of insect pests in tomato
2. **Source of Technology:** ICAR-NOFRI, Tadong-737102, Sikkim (*formerly ICAR Research Complex for NEH Region, Sikkim Centre, Tadong-737102*)
3. **Year of release:** 2014
4. **Agro Climatic Zone:** Mid hills of Sikkim
5. **Detail description about the technology**

Management

- ❖ Transplant two rows of marigold for every 16 rows of tomato, as a trap crop, as the female of fruit borer will be attracted to marigold flowers and lay eggs.
- ❖ Regular monitoring and collection and destruction of fruit borer larvae, infested shoots of aphids and whitefly.
- ❖ Spraying Spinosad 45 SC @ 0.3 ml/l and second spray at 20 days interval is effective to control of tomato fruit borer.
- ❖ Installation of sex pheromone trap for mass trapping of adult of fruit borers is highly effective.
- ❖ Use petroleum-oil based spray @ 10 ml/l and second spray at 20 days interval can easily control aphids in tomato for aphids and whitefly.

6. **Critical inputs required:**

   Petroleum oil-based spray , Spinosad 45 SC, sex pheromone trap of fruit borer *etc.*

7. **Observation to be recorded:**

   Aphids and white flies/leaf, no. of fruits and infested fruits (10 observations from each treatment)

8. **Contact Address for relevant information:**

   Joint Director, ICAR- National Organic Farming Research Institute, Tadong, Sikkim

   Director, ICAR RC for NEHR, Umiam, Meghalaya

Technology no. 30

1. **Name of Technology:** Enriched vermicompost production technology
2. **Source of Technology:** ICAR-NOFRI, Tadong-737102, Sikkim (*formerly ICAR Research Complex for NEH Region, Sikkim Centre, Tadong-737102*)
3. **Year of release:** 2010
4. **Agro Climatic Zone:** Mid hills of Sikkim
5. **Detail description about the technology**
   - ❖ Bed of cow dung and legume leaves (3: 1)
   - ❖ Addition of bio-fertilizers; Azospirilium + PSB + PMB @ 100 g each/quintal of raw material.
   - ❖ Mixed culture of earthworms (*Eudrilus euginea* + *Eisenia foetida*) should be added @ 1000/q
   - ❖ Turning of bed after 25-30 days and vermicompost gets ready between 60-70 days.
   - ❖ Regular monitoring and spraying of water to be done as required maintaining moisture (75-90%).
6. **Critical inputs required:**

   Cow dung, legume leaves, Azospirilium, PSB, PMB, *Eudrilus euginea* and *Eisenia foetida etc.*

7. **Observation to be recorded:**

   N, P, K, OC to be recorded.

8. **Contact Address for relevant information:**

   Joint Director, ICAR- National Organic Farming Research Institute, Tadong, Sikkim

   Director, ICAR RC for NEHR, Umiam, Meghalaya

Technology no. 31

1. **Name of technology:** Management of rice root knot nematode *Meloidogyne graminicola*
2. **Source of technology:** Department of Nematology, AAU, Jorhat
3. **Year of release:** 2012
4. **Agro-climatic zone:** In all zones of Assam where rice root knot nematode is a problem.
5. **Detail description oftechnology**:

1. Treatment: Application of *Pseudomonas fluorescens*(Bioforpf) cfu-2x108 @20g/m2
2. Methods of application: Direct seeded *ahu* rice: 20 kg of Bioforpf should be mixedwith180kg well dried FYM and kept for 10-15 days covered with gunny bag. To keep it moistened, a little water should be added in to the mixture. After 10-15 days, the FYM will be enriched and bacterial colony will be observed, which will be whitish in colour. Then the mixture should be mixed thoroughly and applied in the field before sowing of seeds. Transplanted *Sali* rice: Bioforpf should be applied in the nursery bed @20g/m2 before sowing of seeds.

6. **Critical inputs required:** Bioforpf, FYM
7. **Observations to be recorded:** Incidence of pest: Nematode population at the start of the experiment and at harvest, Per cent survival: Per cent decrease of pests at harvest, Yield and yield attributes: Plant height in treated and untreated, Yield in treated and untreated, Per cent increase in yield, ICBR/B: C ratio, Farmers' reaction.

Technology no.32

1. **Name of technology:** Management of root knot nematode *Meloidogyne incognita, Ralstonia solanacearum*andm, *Macrophomina phaseolina* complex in jute
2. **Source of technology:** Department of Nematology, AAU, Jorhat
3. **Year of release:** 2012
4. **Agro-climatic zone:** Lower Brahmaputra Valley Zone
5. **Detail description of technology:**

1. Technology: Application of carbofuran @1kg a.i/ha +*Pseudomonas fluorescens*(Bioforpf) cfu-2x108 @20g/m^2 withvermicompost at 1: 10 ratio
2. Methods of application: 20 kg of Bioforpf should be mixed with 180kg well dried FYM and kept for 10-15 days covered with gunny bag. To keep it moistened, a little water should be added in to the mixture. After 10-15 days, the FYM will be enriched and bacterial colony will be observed, which will be whitish in colour. Then 2 tons vermicompost should be mixed thoroughly with this and applied in the field before sowing of seeds.

6. **Critical inputs required:** Carbofuran, *Pseudomonas fluorescens,* vermicompost
7. **Observations to be recorded:** Nematode population at the start of the experiment and at harvest, Bacterial and fungal population at harvest, Incidence of pest: Per cent decrease of

pest at harvest, Per cent survival: Plant height in treated and untreated Yield in treated and untreated, Per cent increase in yield, Yield and yield attributes: ICBR/B: C ratio, Farmers' reaction.

Technology no.33

1. **Name of technology:** Management of rice root-knot nematode, *Meloidogyne graminicola in direct seeded Rice*
2. **Source of technology:** Department of Nematology, AAU, Jorhat
3. **Year of release:** 2015
4. **Agro-climatic zone:** -
5. **Detail description of technology:**
   Technology: Application of *Pseudomonas fluorescens* @ 20 g/m2 at sowing time of direct seeded upland rice for management of rice root-knot nematode, *Meloidogynegraminicola.*
6. **Critical inputs required:** *Pseudomonas fluorescens*
7. **Observations to be recorded:** Nematode population at the start of the experiment and at harvest, Bacterial and fungal population at harvest, Incidence of pest: Per cent decrease of pest at harvest, Per cent survival: Plant height in treated and untreated Yield in treated and untreated, Per cent increase in yield, Yield and yield attributes: ICBR/B: C ratio, Farmers' reaction.

Technology no. 34

1. **Name of technology:** Management of root-knot nematode *Meloidogyneincognita in* Green gram
2. **Source of technology:** Department of Nematology, AAU, Jorhat
3. **Year of release:** 2015
4. **Agro-climatic zone**: -
5. **Detail description of technology:**

Treatment of seed with NSKP @ 5 g/kg and *T. viride* @ 5 g/kg separately for the management of root-knot Nematode, *Meloid ogyne incognita*

6. **Critical inputs required:** NSKP, *T. viride*
7. **Observations to be recorded:** Nematode population at the start of the experiment and at harvest, Bacterial and fungal population at harvest,Incidence of pest: Per cent decrease of pest at harvest,Per cent survival: Plant height in treated and untreated Yield in treated and untreated, Per cent increase in yield, Yield and yield attributes: ICBR/B: C ratio, Farmers' reaction.