# TRAINING MODULE ON AGROECOLOGICAL PRACTICE (ENGLISH VERSION)


**MIZORAM STATE RURAL LIVELIHOODS MISSION**
**RURAL DEVELOPMENT DEPARTMENT**
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# MODULE- 1

# SCOPE OF AGROECOLOGICAL PRACTICE

## Agroecological Practices

"The application of ecological concepts and principles to the design and management of sustainable agroecosystems" These approaches involve the maintenance or introduction of agricultural biodiversity. Interaction of crops, livestock, agroforestry, fish, pollinators, insects, soil biomass and other components around production systems To achieve the desired results in production and sustainability.

AEP approach optimizes the use of locally available resources by combining the components of the farm system i.e. plants, animals, soil, water, climate and people. Reduces the use of external and non-renewable inputs and ensures sustainability, Rely mainly on resources within the agroecosystem with nutrient cycling, better conservation and an expanded use of local resources. Values and conserves biological diversity and makes optimal use of the biological and genetic potential of plant and animal species. Takes full advantage of local knowledge and practices, including innovative approaches not yet fully understood by scientists although widely adopted by farmers.

In Agroecology the emphasis is on diversifying and strengthening the agroecosystem by adding regenerative components such as combining crops in intercrops, animals and trees in agro-silvo-pastoral systems, using legumes as cover crops or in rotations or raising fish in rice. More and more benefits emerge as biodiversity increases in agroecosystems: there will be more beneficial interactions, better resource use efficiency, higher associational resistance to invaders and increased nutrient cycling. Farmer-designed diversity should result in improved biotic diversity and abiotic (soil, microclimate, etc.) conditions, which in turn will lead to good system qualities or ecological processes characteristic of healthy and productive farms. A farm can provide for its own soil fertility, its own pest regulation, and so on, just by imitating the way nature functions, allowing for interactions to occur between the different soil, plant and animal components.

productive pastures and timber trees all combined in a system that can be directly grazed by livestock, enhances total productivity without need of external inputs. System where the interactions of rice, weeds, insects, fish and ducks promote key processes (nutrient cycling, pest control, etc.), allowing the rice system to function without need of external inputs.

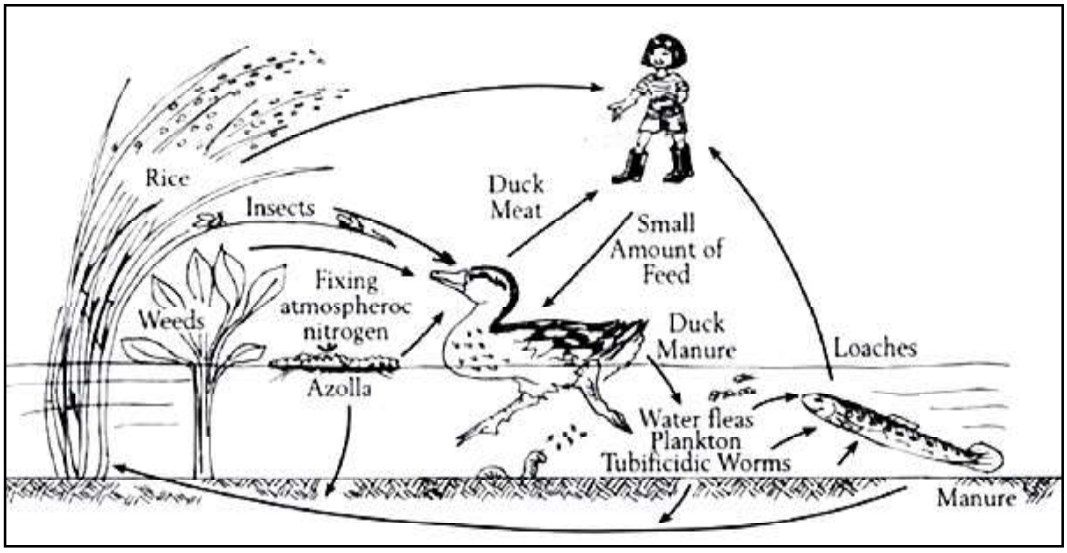



*Fig1 Interactions of various agro-biodiversity components in a rice paddy resulting in processes such as nutrient cycling and pest regulation vital for the productivity of the system*

Agroecology can be carried out at different scales/levels: plot, field, and landscape (including surrounding plots and matrices of vegetation surrounding the system). The plots could be used for experiments, the results of which can be then brought onto real farms where other elements of the landscape will add additional complexities to the system. Agroecology principles (in terms of design) can be applied at the large farm level, but the social and political aspects need to be critically discussed. In any case, large farms also need to transition towards being more sustainable.

### Agroecology and traditional farmers' knowledge

The evolution of agroecosystems is a result of interactions between social and ecological systems. We need to understand how people

- Criteria for technology development considering local goals and priorities, gender pref- erences, etc.; and
- A basis for testing new technologies and their 'rightness-of-fit' to local systems and circumstances.

Farmers have a deep knowledge of the ecosystem as they live within it and interact with nature. In many instances, this knowledge has been eroded and lost.

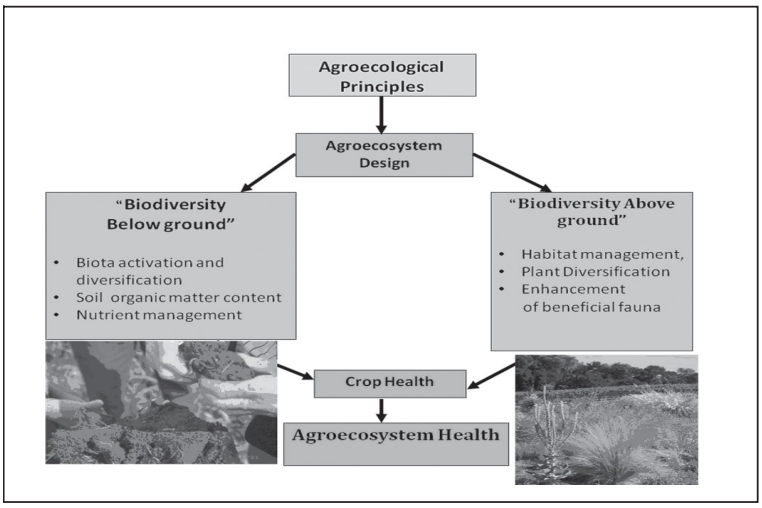



Fig 2 Basic Principles of Agroecological Systems

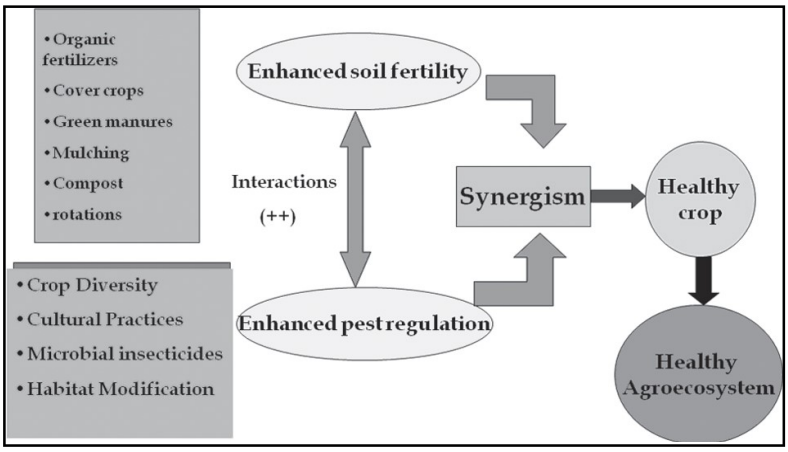



Fig 3- Synergies between pest and soil fertility management practices that lead to optimal soil quality and plant health

# MODULE - 2

# ALL ABOUT SOIL

# ALL ABOUT SOIL

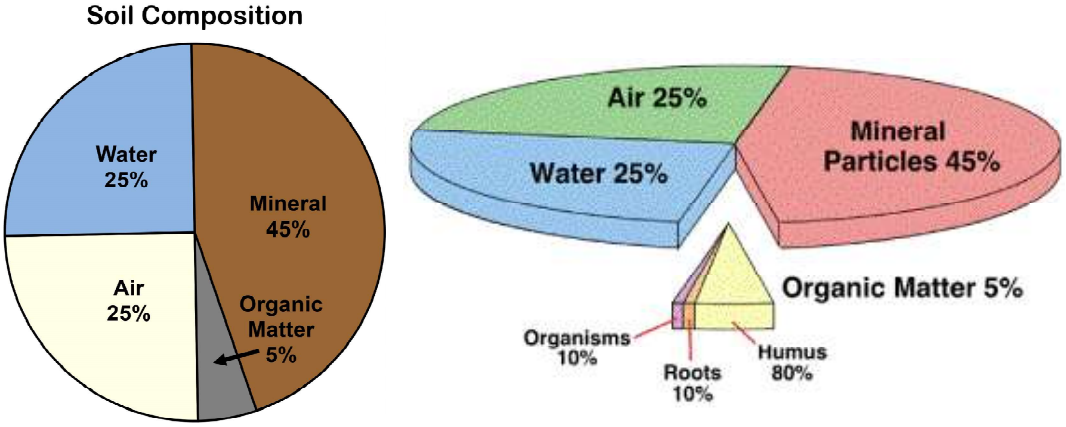
## a. Soil Definition:

Soil is a mixture of organic matter, minerals, gases, liquids, and organisms that together support life. Soil has four important functions: it is a medium for plant growth; it is a means of water storage, supply and purification; it is a modifier of Earth's atmosphere; it is a habitat for organisms; all of which, in turn, modify the soil.

## b. Function of Soil:

Soil is a major component of the Earth's ecosystem. Soil acts as an engineering medium, a habitat for soil organisms, a recycling system for nutrients and organic wastes, a regulator of water quality, a modifier of atmospheric composition, and a medium for plant growth, making it a critically important provider of ecosystem services. Since soil has a tremendous range of available niches and habitats, it contains most of the Earth's genetic diversity. A gram of soil can contain billions of organisms, belonging to thousands of species, mostly microbial and in the main still unexplored. Most regions receive sporadic rainfall, the water-holding capacity of soils is vital for plant survival. Soils provide readily available nutrients to plants and animals by converting dead organic matter into various nutrient forms.

## c. Soil Composition



| |
|---|
| **Clay**: Clay soil is composed of tiny particles that are hard and able to become easily compacted. This compaction makes it difficult to plant or even shovel within the soil.While clay soil can be difficult to work with, it can be beneficial to the growth of certain plants. It is able to hold onto the roots of plants better and provide a more stable environment than many other types of soil. |
| **Clay Loam**: A fine-textured soil that breaks into clods or lumps that are hard when dry. When the moist soil is pinched between the thumb and finger, it will form a thin ribbon that will break readily, barely sustaining its own weight. |
| **Silty Clay**: Silt has larger particles than clay and is mainly inorganic in nature.A silty clay soil has a higher percentage of clay than silt. |
| **Sandy Loam**: Sandy loam soils have a high concentration of sand that gives them a gritty feel. In gardens and lawns, sandy loam soils are capable of quickly draining excess water but can not hold significant amounts of water or nutrients for your plants. Plants grown in this type of soil will require more frequent irrigation and fertilization. |
| **Loamy Sand**: This soil type is normally made up of sand mixed with a majority of silt and clay. Many people prefer loamy sand soil for their gardening because this type of soil normally allows for good drainage. |
| **Sand**: This type of soil is easy to cultivate but, since it allows for more drainage than needed, it is important to water it regularly, especially during summer days. As sandy soils don't allow the water to pool around the roots, they are a good choice for plants that have a tendency to suffer from root decay. |

## D. How to determine soil type

Texture indicates the relative content of particles of various sizes, such as sand, silt, and clay in the soil. Texture influences the ease

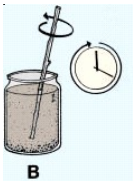
If the ball sticks together, it is probably soil with enough clay in it.

## The bottle test

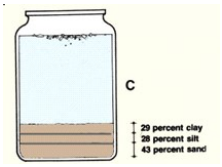
How to find the approximate proportions of sand, silt, and clay This is a simple test which will give you a general idea of the proportions of sand, silt, and clay present in the soil.

Put 5 cm of soil in a bottle and fill it with water.

Stir the water and soil well, put the bottle down, and do not touch it for an hour. At the end of an hour, the water will have cleared and you will see that the larger particles have settled;




- On the surface of the water there may be bits of organic matter floating;-On the top is a layer of clay. If the water is still not clear, it is because some of the finest clay is still mixed with the water;- In the middle is a layer of silt;- At the bottom is a layer of sand;Measure the depth of the sand, silt, and clay and estimate the approximate proportion of each.

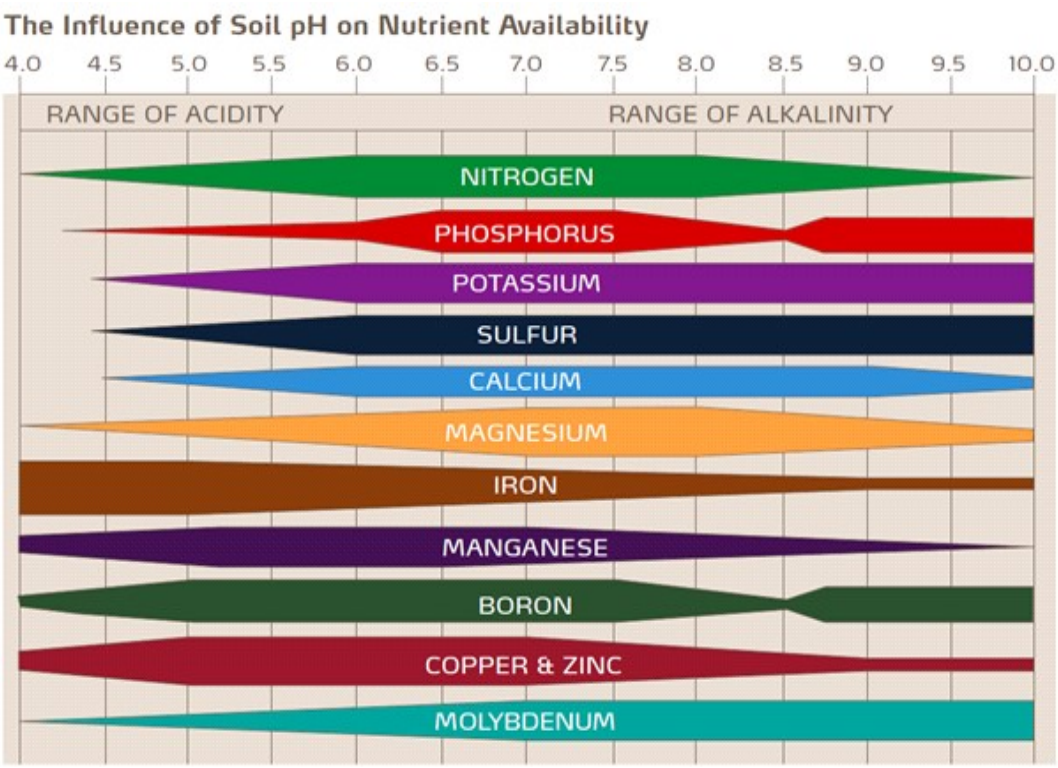



The following three types of particles can make up your soil are clay, sand, and silt.

Most soils are a combination of these three particles, but the particle type that dominates dictates many of the properties of your soil.

The ratio of these sizes determines soil type: clay, loam, clay-loam, silt-loam, and so on.

The ideal soil is 40% sand, 40% silt, and 20% clay. This mixture is referred to as loam. It takes the best from each soil particle type.




| Corps | pH Range* | Corp | pH Range* |
|---|---|---|---|
| Maize | 5.5 - 7.5 | Pineapple*** | 5.0 - 6.5 |
| Millet | 5.5 - 8.0 | Banana | 5.5 - 7.5 |
| Sorghum | 5.0 - 8.0 | Potatoes*** | 5.0 - 7.0 |
| Rice | 5.0 - 7.0 | Sweet Potatoes | 5.0 - 7.0 |
| Wheat | 5.5 - 7.5 | Tomato | 5.5 - 7.0 |
| Beans | 5.8 - 7.5 | Cabbage | 6.0 - 7.0 |
| Soyebeans | 6.0 - 7.0 | Lettuce | 6.0 - 7.0 |
| Peanuts | 5.3 - 6.6 | Onions | 6.0 - 7.0 |
| Cotton | 5.5 - 6.5 | Peppers | 5.5 - 7.0 |
| Tobacco** | 5.5 - 7.5 | Cucurbits | 5.5 - 7.0 |
| Sugarcane | 6.0 - 8.0 | Watermelon | 5.0 - 7.0 |
| Coffee | 5.0 - 7.0 | Alfalfa | 6.2 - 7.8 |

## Soil Erosion causes, problems and remedies

Removal of top soil by different agents is called soil erosion. It can be caused by deforestation, overgrazing, erosion by rivers, manural removal of top soil, shifting cultivation. It affects the total crop area, reduces fertility, reduces water percolation to the lower layer which reduces water level.

## Soil Conservation

Protection of soil from erosion and deterioration of its original qualities is called soil conservation.

## Measures for Soil Conservation:

1. Mulching
2. Terrace Farming
3. Perimeter Runoff Control
4. Windbreaks
5. Cover Crops/ Crop Rotation
6. Soil Conservation Farming
7. Agrostological Measures
8. No till farming
9. Green Manures
10. Salinity Management
11. Stream Bank Protection
12. Crop rotation

## 1.2 Bark

These are good mulch materials because they contain more moisture and retains this moisture for longer periods and helps in the supply of moisture to the growing crop. It is commonly used for vegetation and landscaping, it should be avoided to use in vegetable fields because it is acidic. However, these mulches are excellent for cover the paths between beds.

## Grass Clipping

Grass clipping is one of the most easily and abundantly available mulching material in Indian agriculture. If fresh grass clippings are used in the field, it decomposes easily and increases the percentage of nitrogen in the soil. The different types of grass clipping are widely available such as green or fresh and dry grass. Normally, green grass clippings are not used in the rainy season because it may chance to the development of its own root systems which will be harmful to crop growth. Apply of green clippings can heat up quite a bit and possibly cause damage to plants. So, always the dried grass always preferred to use as mulch. Apply to a depth of 2-3 inches.

## Straw

Straw is ideal for mulching because it is easily applying infield, stays in place and reflects sunlight which helps to bear fruit in some vegetables. It is used as winter protection and as a summer mulch in vegetable fields. These mulches provide great insulation, water penetration and weed control. The main advantageous property is that it does not contain weed seeds itself. Straw mulches are avoided to use in high traffic areas due to its highly inflammable properties. The thickness of the straw mulching is about 6 - 8 inches.

## Compost/Manure

The compost is good mulch and soil conditioner it can easily prepare or formed at home by composting of different types of waste materials like leaves, straw, grass and plant residues, etc. The availability and application of compost in Indian agriculture is old age practice. It improves the soil properties like physical, chemical and biological properties and enhances the carbon content which improves the water retention capacity of the soil. Compost is the good material for improving the soil health. It should not be used in the vegetable field because they have too much nitrogen and it may contain weed seeds. The excellent use of compost is at the time of

the root zone. If it is applying near to or in contact with the stalk, the trapped moisture creates an environment conductive to the growth of diseases and pests. Many of organic mulches cause the breeding spots for many insects and pests. Mulches such as hay and straw contain seeds which may become weeds. These organic mulches are easily biodegradable, and they can serve for the only short period.

### Criteria for the selection of mulching material

**Cost of the material:** If the suitable mulching material is available at little or no cost then don't buy mulching material. Use locally available material.

### The crop selected to mulch

Do not mulch with material from the crop which increases the risk of conveying viruses or pest to the cultivated crops. Also, don't use that mulch material which contains weed seeds.

### The period when the mulch is to be used

During summer season light, colored materials are beneficial as a mulch they reflect the heat. During early spring season use of dark colored materials are beneficial as a mulch it helps to warm the soil which permit crop planting earlier and accelerate the growth of crop.

### Best time or way to applying mulch

Organic much apply in the late fall, after the saturating of soil after initial heavy rainfall; or it may be applied in the late spring, though soil has even retained moisture, but the soil has warmed. At the beginning of the rainy season, the soil has moist and often heats up, causing the soil to release steam. If we apply thick mulch now the soil cannot breathe properly, and steam can't release. Which can increase the chances of many types of pest, insects and disease to be appear. For balancing the soil and mulch to minimizing the risk of occurring of any type of disease, after applying of mulch it

temperature, earlier seedling growth, more and earlier flowering, matured pod numbers, lower bulk density and minimum weed growth. The number of leaves of okra plant formed under sawdust, trash and no mulch treatment were 43, 36, and 27 respectively, and maximum girth diameter under both treatment trash and sawdust was 37 mm, but on control plot it reached only 26 mm dia. The yield of fruits was almost comparable in both mulched treatment in trash mulch 7.5 tonnes/ha. and in sawdust mulch 7.6 tonnes/ha. while in control plot recorded 5.2 tonnes/ha. The dry matter of sawdust, trash and no treatments ash content were 0.25, 0.20 and 0.17 kg, respectively.

### Effect of organic mulching on production

The yield and starch content of potato were higher by 27.9 percentage and 18.18 percentage respectively under paddy straw mulch compared to un-mulched plot. The yield of tomato and okra increased by 100 and 200 % in straw mulch (6 t/ha) applied condition than over control treatment. The production of Okra was much higher in straw mulch applied condition than dust mulch applied condition. Increase in grain yield in sugarcane trash mulch, wheat straw mulch, soybean straw mulch and inter culturing operation over control (no mulch) was 12.64 percentage, 9.06 percentage, 7.46 percentage and 3.74 percentage, respectively. The drip plus sugarcane trash mulch treatment has recorded 53 percentage higher fruit yield.

### Effect of mulching on soil

The starting of evaporation from mulched soil period is slightly higher than the bare soil in the late stage. The total and available soil moisture storage capacities are depending on porosity, texture and structure of soil, it can develop with the help of organic mulching. The wetting depth of soil is increases with increase of machining rates Soil wetting depth increased with increases in mulch rates. Based on these study, straw mulching has the ability of storing more soil water from small amounts precipitation. The soil moisture conserved is higher in straw mulch treatment which is about 55 %

mud wall to prevent run off and hold the soil nutrients in the beds. More commonly found in lesser developed nations due to the difficulty of using mechanized farming equipment in the terraces.

### Perimeter Runoff Control

This is the practice of planting trees, shrubs and ground cover around the perimeter of your farmland which impedes surface flows and keeps nutrients in the farmed soil. Using the grass way is a specialized way of handling perimeter runoff that uses surface friction to channel and dissipate runoff.

### Windbreaks

Rows of tall trees are used in dense patterns around the farmland and prevents wind erosion. Evergreen trees can provide year round protection but deciduous trees can be adequate as long as foliage is apparent during the seasons when the soil is bare.

## Stream Bank Protection :

During floods, stream banks can often cave in. Preventing this by constructing walls along the banks or plant useful tree species will prevent this in the future and prevent soil loss down the stream.

## Crop rotation :

Crop rotation is the practice of growing a series of dissimilar or different types of crops in the same area in sequenced seasons. It is done so that the soil of farms is not used for only one set of nutrients. It helps in reducing soil erosion and increases hence decreases in the same place for many years in a row (Mono-cropping) disproportionately depletes the soil of certain nutrients. With rotation, a crop that leaches the soil of one kind of nutrient is followed during the next growing season by a dissimilar crop that returns that nutrient to the soil or draws a different ratio of nutrients. In addition, crop rotation mitigates the buildup of pathogens and pests that often occurs when one species is continuously cropped, and can also improve soil structure and fertility by increasing biomass from varied root structures. Crop rotation is used in both conventional and organic farming technique. A great advantage of crop rotation comes from the interrelationship of nitrogen fixing-crops with nitrogen demanding crops. Legumes, like alfalfa and clover, collect available nitrogen from the soil in nodules on their root structure. When the plant is harvested, the biomass of uncollected roots breaks down, making the stored nitrogen available to future crops. Legumes are also a valued green manure: a crop that collects nutrients and fixes them at soil depths accessible to future crops. In addition, legumes have heavy tap roots that burrow deep into the ground, lifting soil for better tilth and absorption of water.

# MODULE - 3

# PLANT NUTRITION

## PLANT NUTRITION

Plant nutrition is the study of the chemical elements and compounds necessary for plant growth, plant metabolism and their external supply. In 1972, Emanuel Epstein defined two criteria for an element to be essential for plant growth:

1. In its absence the plant is unable to complete a normal life cycle.
2. Or that the element is part of some essential plant constituent or metabolite.

The essential plant nutrients include carbon, oxygen and hydrogen which are absorbed from the air, whereas other nutrients including nitrogen are typically obtained from the soil

There are seventeen most important nutrients for plants. Plants must obtain the following mineral nutrients from their growing medium:-

- Macronutrients: Nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sulfur (S), magnesium (Mg), carbon (C), oxygen(O), hydrogen (H)
- Micronutrients (or trace minerals): iron (Fe), boron (B), chlorine (Cl), manganese (Mn), zinc (Zn), copper (Cu), molybdenum (Mo), nickel (Ni)

Most soil conditions across the world can provide plants adapted to that climate and soil with sufficient nutrition for a complete life cycle, without the addition of nutrients as fertilizer. However, if the soil is cropped it is necessary to artificially modify soil fertility through the addition of fertilizer to promote vigorous growth and increase or sustain yield. This is done because, even with adequate water and light, nutrient deficiency can limit growth and crop yield.

### Macronutrients (derived from air and water) Carbon

Carbon forms the backbone of most plant bimolecular, including proteins, starches and cellulose. Carbon is fixed through

metabolism, but it does occur in all parts of plants in substantial amounts. It seems to be of particular importance in leaves and at growing points. Potassium is outstanding among the nutrient elements for its mobility and solubility within plant tissues. Processes involving potassium include the formation of carbohydrates and proteins, the regulation of internal plant moisture, as a catalyst and condensing agent of complex substances, as an accelerator of enzyme action, and as contributor to photosynthesis, especially under low light intensity.

Potassium regulates the opening and closing of the stomata by a potassium ion pump. Since stomata are important in water regulation, potassium regulates water loss from the leaves and increases drought tolerance. Potassium deficiency may cause necrosis or interveinal chlorosis. The potassium ion ($K^+$) is highly mobile and can aid in balancing the anion (negative) charges within the plant. Potassium helps in fruit coloration, shape and also increases its brix. Hence, quality fruits are produced in potassium-rich soils. Potassium serves as an activator of enzymes used in photosynthesis and respiration.

### Important Micro-nutrients :

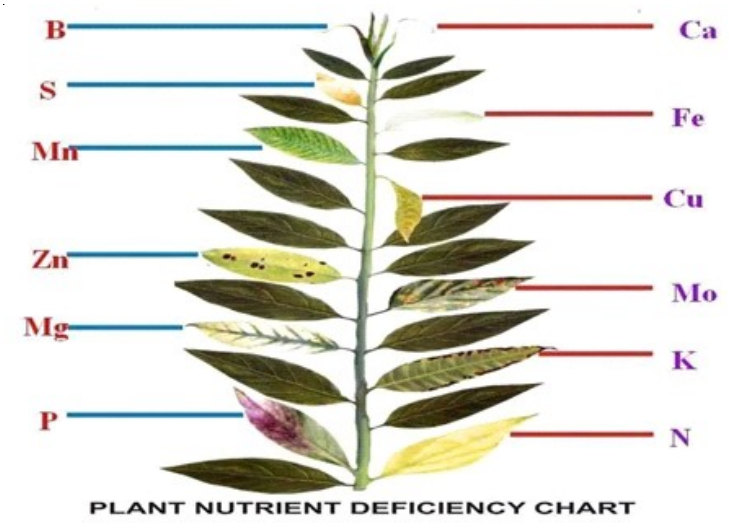
#### Iron

Iron is necessary for photosynthesis and is present as an enzyme cofactor in plants. Iron deficiency can result in inter-veinal chlorosis and necrosis.

#### Molybdenum

Molybdenum is a cofactor to enzymes important in building amino acids and is involved in nitrogen metabolism.

(K) Potassium – Older leaves may wilt, look scorched. Interveinal chlorosis begins at the base, scorching inward from leaf margins. Plants absorb potassium as an ion, which can be readily leached from soil.



PLANT NUTRIENT DEFICIENCY CHART

## Nutrient Management in Crops

A. Composting
B. Bio Gas slurry
C. Green Manures
D. Bio fertilizers
E. Natural Fertilizer ( cow dung based)

### A. Methods of composting

Good quality compost free from weeds, pathogens and rich in nutrients is a prerequisite for adopting organic farming practice. Different methods have been developed for the preparation of quality compost from farm wastes. Depending upon the nature and quantity of raw material available with farmer. Any one or combination of following methods may be adopted for the production of compost.

- NADEP COMPOST
- NADEP PHOSPHO COMPOST
- VERMI COMPOST
- PITCHER KHAD

although the plant nutrients are immediately available, they are slowly released to last longer. Vermicompost is nothing but the excreta of earthworms, which is rich in humus and nutrients. The process in the alimentary canal of the earthworm transforms organic waste to natural fertilizer. The chemical changes that organic wastes undergo include deodorizing and neutralizing.

We can rear earthworms artificially in a brick tank, plastic bed or near the stem / trunk of trees (especially horticultural trees). By feeding these earthworms with biomass and watching properly the food (bio-mass) of earthworms, we can produce the required quantities of vermicompost.

## Nutritive value of vermicompost

The nutrients content in vermicompost vary depending on the waste materials that are being used for compost preparation. If the waste materials are heterogeneous one, there will be wide range of nutrients available in the compost. If the waste materials are homogenous one, there will be only certain nutrients are available. The common available nutrients in vermicompost is as follows

| | | |
|---|---|---|
| Organic carbon | : | 9.5 – 17.98% |
| Nitrogen | : | 0.5 – 1.50% |
| Phosphorous | : | 0.1 – 0.30% |
| Potassium | : | 0.15 – 0.56% |
| Sodium | : | 0.06 – 0.30% |
| Calcium and Magnesium | : | 22.67 to 47.60 meq/100g |
| Copper | : | 2 – 9.50 mg kg-1 |
| Iron | : | 2 – 9.30 mg kg-1 |
| Zinc | : | 5.70 – 11.50 mg kg-1 |
| Sulphur | : | 128 – 548 mg kg-1 |

## Advantages of vermicompost

- Vermicompost is rich in all essential plant nutrients.
- Provides excellent effect on overall plant growth, encourages the growth of new

## Steps involved in Vermicompoting

1. Collection of organic wastes: shredding, mechanical separation of the metal, glass and ceramics, plastics and storage of organic wastes.
2. Pre digestion of organic waste for twenty days by heaping the material along with cattle dung slurry. This process partially digests the material and fit for earthworm consumption. Cattle dung and biogas slurry may be used after drying. Wet dung should not be used for vermicompost production.
3. Preparation of earthworm bed, a concrete or hard preferably non-permeable base is required to put the organic waste for vermicompost preparation. Loose soil will allow the worms to go into soil and also while watering; all the dissolvable nutrients go into the soil along with water. In plastic bed this problem can be easily avoided and Vermi-wash (Excess water containing nutrients) can be collected through a jug.
4. Collection of earthworm after vermicompost collection. Sieving the composted material to separate fully composted material. The partially composted material will be again put into vermicompost bed.
5. Storing the vermicompost in proper place to maintain moisture and allow the beneficial microorganisms to grow.

## Factors contributing to good quality composting

Worms are the basic component of the vermicompost production hence it needs to be provided with a good environment. The factors:

The bed in which Vermicompoting is done need to have proper moisture content (Not very wet and not dry too, 50% water content), the bed should not be filled very tight it will affect the breathing of worms, worms breath through their skin if proper aeration is not allowed then worms may get died. Precaution need to be taken to avoid high heat exposure of the bed, if the bed gets very hot and dry the worms will die.

African earthworm (*Eudrillus euginiae*)

Tiger worm or Red wrinkle (*Eisenia foetida*)

Asian worms (*Perinonyx ecavatus*)

## Selection of site for vermicompost production

Vermicompost can be produced in any place with shade, high humidity and cool. Abandoned cattle shed or poultry shed or unused buildings can be used. If it is to be produced in open area, shady place is selected. A thatched roof may be provided to protect the process from direct sunlight and rain. The waste heaped for vermicompost production should be covered with moist gunny bags.

## Bed for vermi-compost production

A cement tub/ plastic bed/ Dry pit may be constructed to a height of 2½ feet and a breadth of 3 feet. The length may be fixed to a level depending upon the requirement of compost and availability of inputs (Vegetable waste, cows). The bottom of the structure is made with some slope like structure to drain the excess water from vermicompost unit. A small jug is necessary to collect the drain water.

It is advisable to construct an elevated structure which will allow in easy collection of Vermi-wash. Also, since there is no direct contact with soil so it helps in keeping the Vermi-bed in good condition for long time.

## Materials for vermicompost production

Cattle dung (except pig, poultry and goat), farm wastes, crop residues, vegetable market waste, flower market waste, agro industrial waste, fruit market waste and all other bio degradable waste are suitable for vermicompost production. The cattle dung

is mixed in a container and covered with a cloth or gunny begs. The material is fermented for 4-5 days. The fermented mixture is mixed with water 200liter and sprayed over the crop in one acre area. Two -three sprays are sufficient for short duration crops.

## A. BIO GAS SLURRY:

Bio-gas slurry is good manure. Slurry is dried in solar drier. Dried slurry is directly applied in fields.

## B.GREEN MANURES:

Several green manure crops provide sufficient organic matter and nitrogen for growing crops. Both legumes as well as non legumes, however legume crops have inherent capacity to fix atmospheric nitrogen hence these crops are preferred. Some leguminous green manuring crops are Cow pea, Black Gram, Green Gram, Dhaincha and sunhamp , these are most common green manure crops normally used as a source of nutrients and organic matter. They have potential to supply 60-90 kg nitrogen within a period ranging between 45-60 days. One tones Dhaincha dry matter add N 26,2Kg, P 7.3Kg, K 17.8Kg, S 1.9 Kg, Ca 1.4 Kg ,Mg 1.6 Kg , Zn 25ppm,Fe105 ppm Mn 39 ppm, Cu 7ppm per hectare in soil.

Seeds of these crops are broadcasted in the field during onset of monsoon, it can be cultivated in barren lands and after that twigs, tender shoots, leaves are collected and sprayed over the cultivable plots. One more method is to grow the green manuring crops in the main field itself, after 1-2 ploughing seeds of green manuring crops are broadcasted over paddy field and then once they attain a height of 2 feet they are buried in the plot. For dhaincha flowering starts in 6-8 weeks, and best time burring is the flowering stage.

## C. BIO FERTILIZER:

Microorganisms like Azotobacter, Azospirillum, Rhizobium, Blue green algae and Phosphate solubilizing bacteria are being used as bio-fertilizer in different crops. These microorganisms promote plant growth through different process like nitrogen fixation phosphate solubilizer and production of plant growth substances. Blue green algae and Azola are been successfully used as bio-fertilizer in paddy.

paddy field). Mix all the material thoroughly without mizing water, keep it for 4 days, if possible keep it in a air-tight container. During the 4 days, stir the mixture for 10 miutes for 2 times a day. After 4 days, mix 70 litre pof water in the mixture and apply it in crop field. Make a ring around the plants and pur the liquid fertilizer in the ring.

**Figure Jeewamrit Preparation**

Sanjiwak Khad

Sanjiwak khad is a growth promoter as well as it increases disease resistance of the crops. For preparation of 100 litre sanjiwak khad, required 66 litre water, 30 Kg fresh cow dung, 3 litre cow urine and 500 gm juggery.

Mix cow-dung, cow-urine and juggery and keep it in a drum, add 66 liter water into the mixture and keep it for 10 -12 days. Keep the container covered with a gunny bag, stir the mixture twice daily (once in the morning and evening). Apply in base of the plant at a rate of 200 litre per acre.

Liquid compost

Mix 1 kg vermi-compost in 10 liter of water and keep it 48 hours, stir the mix every 6 hours. Dilute it to 4 times with water and spray during flowering phase of crops. It will enhance flowering in the crops.

# MODULE - 4

# NURSERY MANAGEMENT

## NURSERY MANAGEMENT FOR VEGETABLE CROPS

Success of any production system depends on the kind of seed we are sowing", so is true with seedlings. Healthy seedlings grown in a well managed nursery will decide the yield and consequently the profit.

"A vegetable nursery is a place or an establishment for raising or handling of young vegetable seedlings until they are ready for more permanent planting."

Some vegetables require special cares during their early growth period. There are some vegetables with very small sized seeds. These are first sown in the nursery for better care and to combat with the time for field preparation and after about one month of seed sowing, transplanted in the main field.

These vegetables are: tomato, brinjal,chilli, capsicum, cauliflower, cabbage, knolkhol etc.

### Advantages of Nursery Management:

- It is possible to provide favorable growth conditions i.e. germination as well as growth
- Better care of younger plants as it is easy to look after nursery in small area against pathogenic infection, pests and weeds.
- Crop grown by nursery raising is quite early and fetch higher price in the market, so economically more profitable.
- There is saving of land and labour as main fields will be occupied by the crops after 1 month. More intensive crop rotations can be followed.
- More time is available for the preparation of main field because nursery is grown separately.

### Site Selection is the first important consideration for nursery management:

- Area selected should be well drained, and free from water logging
- There should be proper sunlight,

## Application of fungicides

Apply Trichoderma Vir dae 100gm per bed, mix T viridae with 10 kg well rotten FYM and then spread it in the nursery bed.

## Nursery bed preparation

Nursery bed should be prepared according to the season and crop.In the rainy season raised beds are prepared but in the winter and summer season flat beds should be prepared. For the uniform and high percentage of germination the soil must be fine and moist enough.

If the seedlings are to be raised in boxes during unfavourable weather condition, the flower pots, polythene bags, potting plugs, wooden treys, earthen pots etc. may be used. Prepare soil mixture in the ratio of 1:1:1 of soil, sand and well rotten FYM/leaf mould etc. and fill the mixture in these seedlings raising structure. Arrangement should be made to drain excess water from these structures by making a hole in the bottom of all types of pots.

## Raised nursery beds :

Length of the bed may be kept 3 to 5 meter; however, width is restricted to 1 meter only which facilitates intercultural operations. The beds are raised 15 to 20 cm high from the ground level. A space of 30 - 40 cm is leaft in between two beds. The space between two beds helps in weeding, nursery care against diseases and insect pest and also for draining out the excess rain water from the nursery beds. The number of beds depends on the particular crop, season and growing area of crop. The beds should be prepared in the east and west direction and line should be made from north to south direction on the beds.

## Sowing of seeds in the nursery :

After the seed bed preparation seeds are sown in the nursery bed either by broadcasting or in lines depending upon the nature and season of crop.

Broad casting method: In broadcasting method seeds are broadcasted on the well prepared nursery beds and later on the seeds are covered with well rotten fine sieved and treated FYM or compost.

### Removal of mulch

Due attention is given to remove the covered mulch from the seedbed. After three days, observe the seed beds daily. As and when the white thread like structure is seen above the ground, remove the mulch carefully to avoid any damage to emerging plumules. Always remove mulch in the evening hours to avoid harmful effect of bright sun on newly emerging seedlings

### Use of shedding net

After seed germination during the seedling growth, if there is very high temperature (> 30$^{o}$ C) then beds should be covered by 50% or 60% shedding nets of green/green + black coloured, about 60 - 90 cm above ground by the use of suitable support.

### Watering

The nursery beds require light irrigation with the help of rose can till the seeds get germinated.

Excess rainwater or irrigated water should be drained out from the field as and when it is required otherwise plants may die due to excess of water.

Watering in the beds depends upon the weather condition. If temperature is high, open irrigation is applied. Need not to irrigate the beds during rainy days.

### Thinning

It is an important operation to remove weak, unhealthy, diseased, insect pests damaged and dense plants from the nursery beds keeping distance of about 0.5 to 1.0 cm from plant to plant.

The thinning facilitates balance light and air to each and every plant. It also helps in watching the diseased and insect pest attacked plants while moving around the nursery.

### Weed control

Timely weeding in nursery is very important to get healthy seedling. If there are some weeds in the seed bed, remove them manually either by hand or by hand hoe (thin forked Khurpi).

## Effect of hardening

The following effect may be observed by the hardening

- Hardening improves the quality and modifies the nature of colloids in the plant cell enabling them to resist the loss of water.
- Hardening increases the presence of dry matter and regards in the plants but decrease the percentage of freezable water and transpiration per unit area of leaf.
- Decreases the rate of growth in the plants
- Hardened plants can withstand better against unfavourable weather conditions like hot day winds or low temperature
- Hardening of the plants increases the waxy covering on the leaves of cabbage.

# MODULE - 5

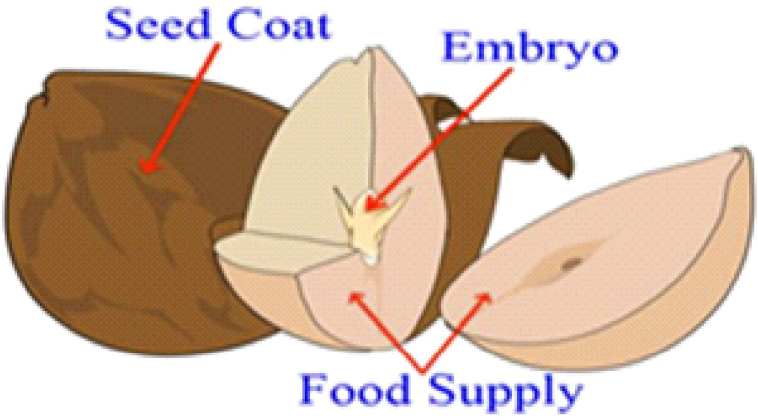
# ALL ABOUT SEEDS

## ALL ABOUT SEEDS

An encapsulated plant embryo is called seed. A seed is a fertilized ovule containing the plant embryo.

Seed has major three parts. Different parts and its functions are given below

1. **Seed Coat:** it's a protective outer cover of a seed. It consists of one or more protective layers that encase the seed. It may be hard like in case of Coconut and it may be soft like bean
2. **Embryo :** It is the baby plant, it becomes the new plant Food Supply: provides energy and nutrient, mainly starch for the embryo to grow. That's why seed does not need food from external sources while germinating and during its growth stage in nursery.
3. **Food Supply:** provides energy and nutrient, mainly starch for the embryo to grow. That's why seed does not need food from external sources while germinating and during its growth stage in nursery.



- Seedlings produced will be more vigorous, fast growing and can resist pest and disease incidence to certain extent
- Ensures uniform growth and maturity
- Development of root system will be more efficient that aids absorption of nutrients efficiently and result in higher yield.
- Good quality seeds of improved varieties ensures higher yield at-least 10 – 12 %

Quality of seed

Seed quality is the sum of all properties contributing to seed performance. The quality of seed can decide whether a farmer's crop will be good, bad or indifferent. Seed quality is determined by the following characteristics:

1. Physical Attributes
2. Physiological Attributes
3. Genetic Attributes
4. Storability

Importance of quality seed

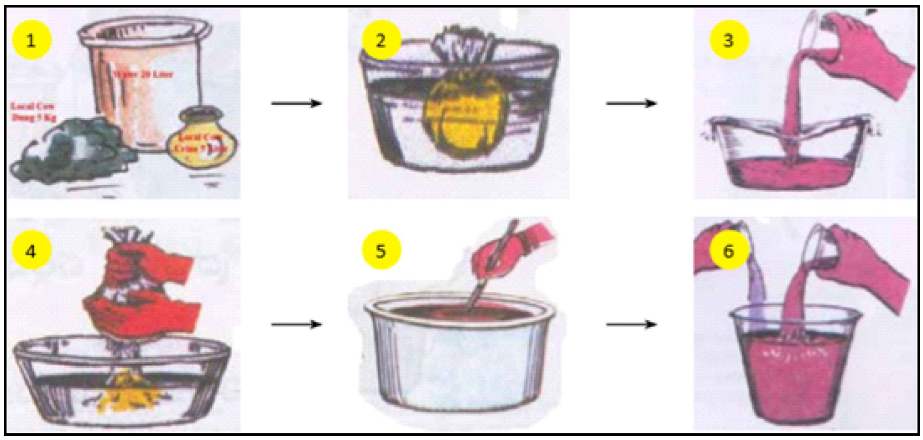
- Ensures genetic and physical purity of the crops
- Gives desired plant population
- Capacity to withstand the adverse conditions
- Seedlings produced will be more vigorous, fast growing and can resist pest and disease incidence to certain extent
- Ensures uniform growth and maturity
- Development of root system will be more efficient that aids absorption of nutrients efficiently and result in higher yield.
- Good quality seeds of improved varieties ensures higher yield at-least 10 – 12 %

How to check quality of seed?

- High genetic purity ( 95-99%)
- High physical purity (95-98%)

## A. How to prepare Beejamrit

1. Take 4 litre water, cow dung 1 kg, cow urine 1 litre, 10gm lime, 5 gm turmeric powder, 100 gm jaggery and some fertile soil.
2. Take 1kg cow dung on a piece of cloth and tie it and dip it in four litre water for 24 hours
3. Soak 10 gm lime in 50 ml water for overnight
4. Squeeze the cloth which was dipped in the water to get the extract and mix fertile soil with the mixture.
5. Add cow urine 1 litre, 10gm lime, 5 gm turmeric powder, 100 gm jaggery and lime water mixture with the solution and mix it properly. The mixture is ready for seed treatment.




## B. Seed treatment with beejamrit

Beejamrit can be used for all kind of seeds. Spread seed on a jute bag and mix properly with hand and then keep under shed to dry it. The dried seed is now ready for sowing.

Root of seedling can also be treated with it. Dip the root of the seedling for 10 to 15 minutes and then transplant.

# MODULE - 6

# PESTICIDE EFFECT ON HUMAN HEALTH

# PESTICIDE EFFECT ON HUMAN HEALTH

Pesticides are poisons and, unfortunately, they can harm more than just the “pests” at which they are targeted. They are toxic, and exposure to pesticides can not only cause a number of health effects, but is linked to a range of serious illnesses and diseases in humans, from respiratory problems to cancer.

## Exposure

Exposure to pesticides can occur in many ways. Exposure can occur in agriculture, through the treatment of crops, plants and grain stores. It can occur in forestry, gardening, and professional and domestic pest control and through the spraying and use of amenities e.g. our parks, pavements and playgrounds. In addition, pesticide residues found on, and in, our food also puts us at risk. Pesticides can be acutely toxic. This means that they can cause harmful or lethal effects after one single episode of ingestion, inhalation or skin contact. The symptoms are evident shortly after exposure or can arise within 48 hours.

## Long term (or chronic) toxicity

Pesticides can cause harmful effects over an extended period, usually following repeated or continuous exposure at low levels. Low doses don’t always cause immediate effects, but over time, they can cause very serious illnesses. Long term pesticide exposure has been linked to the development of Parkinson’s disease; asthma; depression and anxiety; cancer, including leukaemia and non-Hodgkin lymphoma; and attention deficit and hyperactivity disorder (ADHD). The term endocrine disruptor refers to substances that interfere with hormones and hormone balance. Hormones are the chemical messengers of the body. They are necessary to regulate different functions, in particular growth and reproductive functions.The endocrine effects can be activated by very low concentrations of chemicals.

### Absorption

Children absorb pesticides more easily through their skin. Not only is a child's skin more permeable than an adult's, but their skin surface area relative to body weight is also higher. This makes it easier to absorb higher rates of pesticides. In fact, infants will absorb around three times more pesticides than adults from similar exposure episodes.

Children take in more air, water and food relative to their body weight compared to adults. This increases their total exposure. For example, the breathing rate of a child is roughly double that of an adult. As a result, the amount of airborne contaminants reaching the surface of the lung can be much higher.

### Poisoning

Not only is exposure likely to be higher, but a child's ability to cope with pesticide poisoning will differ from that of an adult. The systems that our bodies use to deal with toxins are less well developed in children and this can make them less able to cope with these substances. As they grow, children's brains and bodies undergo complex changes that affect tissue growth and organ development. Incidents of exposure that would be tolerated by adults, can cause irreversible damage to unborn babies, infants and adolescents.

### Combined effects

Another problem is that the effect of an individual chemical can be enhanced or changed if it is combined with another substance. Every day we are exposed to a cocktail of chemicals and the fact is that nobody knows what effect this consistent low level exposure to such a mixture of chemicals is having on us.

## Effect of pesticide on resources/environment

### Impact on environment

Pesticides can contaminate soil, water, turf, and other vegetation. In addition to killing insects or weeds, pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects, and non-target plants. Insecticides are generally the most acutely toxic class of pesticides, but herbicides can also pose risks to non-target organisms.

# MODULE - 7

# GINGER PROCESSING

## Nutrient composition

Protein (2.3%), Fat (0.9%), carbohydrates (12.3%), mineral (1.2%), fiber (2.4%) and moisture (80.9%) are the main constituents of fresh ginger. Minerals like phosphorous, calcium, and iron present in ginger are iron, calcium and phosphorous. It also contains vitamins such as thiamine, riboflavin, niacin and vitamin C. The composition varies with the type, variety, agronomic conditions, curing methods, drying and storage conditions

## Beneficial quality of ginger

Ginger is a popular digestive aid and it is famous for its medicinal quality since its origin. Special active components have found in ginger that is responsible for easy digestion or best we can say it act as a trigger for digestion. It is also helps to get relieve from constipation or any unwanted disorder related to digestion. Due to its endless beneficial quality it has been used in Indian Ayurvedic as well as in Chinese medicine since ancient time. In Chinese medicine it was mainly used for easy transportation of body fluid as it accelerate circulation of blood in our whole body due to its amazing stimulatory effect on the heart muscle and by powerful capacity to dilute the blood.

Though its excessive doses may cause certain problem but from a study it was clear that it has no harmful effect on heart rate and blood pressure, also it does not involved with at least one study indicates that ginger has no effect on blood pressure, heart rate, or coagulation parameters and does not involved with anticoagulant drugs like warfarin (Weidner and Sigwart 2000). Later this result was again proven with double confidence saying ginger has no effect on clotting status or the pharmacokinetics or of warfarin in healthy subjects.

Ginger is used worldwide as an ingredient in food and medicine. It has long been used to treat many gastrointestinal disorders and is often promoted as an effective antiemetic (Bhattarai et al., 2011)

## Native properties of the type grown

Native properties of ginger such as taste, flavor, aroma and color will differ according to the different variety of ginger growing in different part of the world. This affects their suitability for processing. When preparing dried ginger it is most important to choose variety of rhizomes with a strong flavor and aroma. Also the size of rhizome plays an important role for ginger drying. In such situation medium sized rhizome are more appropriate to choose otherwise in contrast if we choose large rhizomes, it will not be suitable causing problems with drying due to its high moisture content. Condition medium sized rhizomes are the most suitable as the often have a high moisture content which causes problems with drying.

After selecting the ginger based on our end use we should proceed for processing which include some basic steps that are:

1. Cleaning 2. Sorting 3. Peeling
4. Drying 5. Grading and Packaging

## Cleaning

Cleaning of harvested rhizomes should be necessary to remove debris, shoots and roots. Thorough cleaning of rhizome required immediately after harvest if ginger intended for export or for long-term storage. It is recommended to wash the rhizome in clean sanitized water with 150 ppm hypochlorous acid either by scrubbing with hands or with a brush. Killing of rhizome was being followed by traditional method, in which rhizomes were dipped in boiling water for 10 min. This method is useful in inactivation of enzymatic processes. Optimum sanitization by hypochlorous acid has found to be possible at a water pH of 6.5. It has also recommended to apply fungicidal treatment which can be done by adding fungicides either in to the water at the time of washing or it may sprayed separately. Fungicides like benomyl (500 ppm active ingredient) or thiabendazole (1000 ppm) are recommended for this treatment.

Another mode of washing is pressure washing which tends to reduce the microbial load more efficiently so it is preferred when available.

transportation and for reduction of waste. It is the process of removing the moisture up to a predetermined level by providing heat. Moisture movement and heat transfer, these two phenomena occur simultaneously in this process.

To give high yields with minimum cost to the village level processors the Ginger rhizome processing methods should be imaginative . Although various methods for drying of ginger are there but the very common and traditional method mostly used by the farmer in India is sun drying. Method of treating ginger after harvesting differs according to the country in which it is grown. According to the Indian Spice Board, general method for preparation of dry spices required the following **sequence:**

- Soaking the rhizome with water and leaving it overnight
- Peeling/scraping with pointed-end bamboo splinters
- One week sun drying, Again soaking for 6 hours in water with 2% lime
- Final drying up to 8-10% moisture (Should not exceed 12%).

During drying the normal weight loss is 60- 70%.So drying of ginger is very much beneficial for transportation purpose. A minimum of 7 to 9 days is necessary to attain 7.8% to 8.8% moisture content in case of sun- drying of peeled ginger where as a cross-flow drier took only 5 to 6 hours for sliced ginger. But for drying of whole ginger it will take minimum of 16 to 18 hours even if it has peeled. So it can be noted that in accordance with method of drying, peeling and proper size of rhizome also matter to reduce drying time.

It has found that more homogenous and cleaner product can be obtained from mechanical drying but the essential oil content and oleoresin content was found to be more in sun drying and solar tunnel drying as compare to mechanical drying. Air flow and temperature are the two important factors to be maintained properly in case of hot air drying. In this case of mechanical drying, the optimum drying temperature was considered as 60 °C because after this critical temperature the loss of essential oil and oleoresin is more than 12.2% and 5.3% respectively

# MODULE - 8

# INTEGRATED PEST MANAGEMENT

## INTEGRATED PEST MANAGEMENT

Pest is any living plant or animal which affects the normal growth of cultivated crops for its survival and multiplication. Pests can be insects, mites, Fungi, Bacteria, Virus, Weeds, Nematodes, Rodents, Birds and Mamal. Plant Damages can be caused by Biotic Agents such as Insects, Fungi, Bacteria, Weeds and Nutrients. The a-biotic agents of plant damages are Weather, Rains, and Temperature.

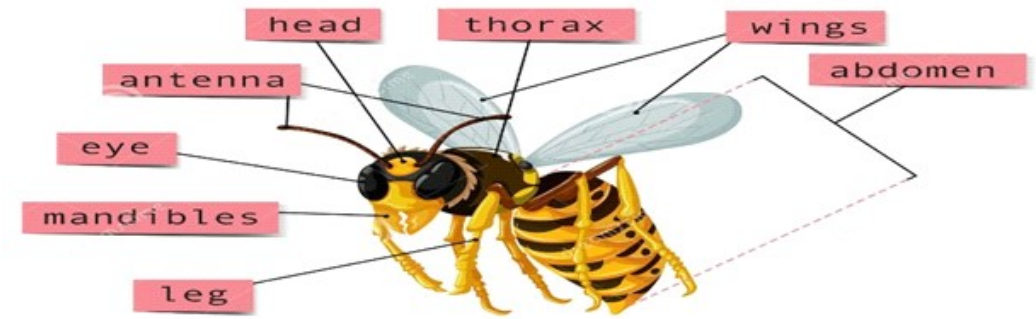
### Effect of pest attack on crops

- Plant damage by making holes, rotting, spots etc.
- Increases cost of cultivation for pest management
- Yield reduction
- Product quality is inversely affected.

### Insect and its damages to the crop:

An insect is a very small animal with particular characteristics. Insects are invertebrates. They have no backbones. Most insects walk, but some can fly and jump. Insects need water, air, and food to live.

Most insects have five basic physical characteristics:




- Insects have an exoskeleton or a hard, shell-like covering on the outside of its body.
- Insects have three main body parts: head, thorax, and abdomen.
- Insects have a pair of antennae on top of their heads.

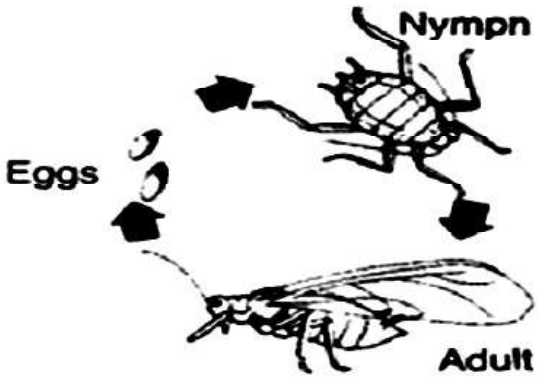
Tar spots are dark, shiny spots of resinous-like material

**Sucking Pest life cycle:** Sucking pests complete their life cycles in three stages

**Adult:** Winged fly. Duration is three to five days. Very active but can't cause damage to plants.

**Egg:** Lays small eggs. Egg stage completes in 3-5 stages. Non movable. No damage

**Nymph:** Most active. Nymph stage completes in 7 – 10 days. Cause damage to plants.




**Aphid Lifecycle**

**Fruit and shoot borers:**

Fruit and Shoot borers bores into young shoots and fruits. Following are the major fruit and shoot borers:

- Brinjal fruit and shoot borer
- Bhendi fruit and shoot borer
- Cotton boll worms

**Damage of Fruit and Shoot borers:**

- Larval feeding inside shoots result in wilting of the young shoot
- The damaged shoots ultimately wither and drop off.
- Reduce the fruit number and size
- Destruction of fruit tissue – Unfit for marketing

| Nemmastra | | | | |
|---|---|---|---|---|
| Effectiveness | Materials | Quan-tity | Process | Remarks |
| Sap Sucking Insects | Cow Urine | 5 Lts | Crush the neem leaves, add cow urine and cow dung mix it thoroughly and then add 100 litre water, keep it for 24 hours for fermentation and then filter it using a cloth then spray in field | Can be stored for 3 months |
| | Cow Dung | 1 Kg | | |
| | Neem Leaf | 5 Kg | | |
| | Water | 100 Lts | | |

| Brahmastra | | | | |
|---|---|---|---|---|
| Effectiveness | Materials | Quan-tity | Process | Remarks |
| Broad Spectrum | Cow Urine | 10 Lts | Take minimum 6 types of leaves of the mentioned leaves, crush then grind the leaves properly, each type of leave need to be grinded differently, add the 10 L cow urine. Now boil the mixture till it becomes 1/5th in voulme. Keep it for cooling and further fermentation for 48 hours. Filter it and spray it in the ration 2 litre/ 50 litre of water. | Can be stored for 3 months |
| | Cow Dung | 1 Kg | | |
| | Neem Leaf | 3 Kg | | |
| | Custard apple leaf | 2 kg | | |
| | Castor leaf | 2 Kg | | |
| | Pomgamia leaf | 2 Kg | | |
| | Lantena leaf | 2 Kg | | |
| | Papaya leaf | 2 Kg | | |
| | Dhatura leaf | 2 Kg | | |
| | Guava leaf | 2 Kg | | |
| | Bitter gourd leaf | 2 Kg | | |

| Chilli Garlic Extract | | | | |
|---|---|---|---|---|
| Effectiveness | Materials | Quan-tity | Process | Remarks |
| Stem Borer and Fruit Borer | Kerosene | 250 ml | Grind the green chilly after removing its petiole, add 3 litre water in it and keep for overnight. Grind the garlic and 250 ml kerosene added to it and kept for overnight. Filter both the solutions and mix it properly. Add 100 gm surf to it and then spray it by mixing 100 litres of water | Cannot be stored |
| | Garlic | 0.5 Kg | | |
| | Surf | 100 gm | | |
| | Green Chilly | 3 Kg. | | |
| | Water | 100 L | | |

### a. Trap Crop, sticky traps and light trap

Trap crop is a crop which attracts pests more than the main crop. Pests prefer trap crops for feed or oviposition. Pests are either prevented from reaching the main crop or concentrated in certain parts of the field away from the main crop. The principle of trap crop relies on pest preference for certain crops or stages of crop growth. Two preliminary techniques used in trap crops are:

Selection of more preferred species Planting of the same crop before the main crop so that preferred stage of the development will arrive earlier than the main crop.

Important aspects in trap crops

- Select a trap crop that is more attractive to pest than the main crop
- Monitor trap crops regularly
- Immediately destroy the eggs that are found on the trap crop

## Sticky trap:

Insects usually gets attracted to yellow color, so yellow color chart papers, colored wooden planks, tin sheets can be used to attract insect, some sticky substances/adhesives are used in the planks, sheets, papers. When insect comes and sits over the chart paper it gets stuck and dies.

## Light trap

Armyworm, bugs, cutworm, flies, gnats, bollworm, leafhoppers, planthoppers, stem borers are controlled by light trap.

Materials required are-

- Plastic buckets 5-10 lts.
- Metal light shade (2 nos.)
- Fluorescent light with holder
- Electrical wires
- Coated metal rods (4 nos.)
- Tin sheets
- String/ flexible wire
- Nut bolts & Screws
- Rubber plug for drainage hole
- Soap water or Kerosinized water


Fig: Light trap

## TYPES OF NATURAL ENEMIES

Parasites, pathogens, and predators are the primary groups used in biological control of insects and mites . Most parasites and pathogens, and many predators, are highly specialized and attack a limited number of closely related pest species.

### Parasites

A parasite is an organism that lives and feeds in or on a host. Insect parasites can develop on the inside or outside of the host's body. Often only the immature stage of the parasite feeds on the host. However, adult females of certain parasites (such as many wasps that attack scales and whiteflies) feed on and kill their hosts, providing an easily overlooked but important source of biological control in addition to the host mortality caused by parasitism. Most parasitic insects are either flies or wasps. Parasitic wasps attack aphids. Trichogrammatidae parasitize insect eggs. Aphelinidae, Encyrtidae, Eulophidae, and Ichneumonidae are other groups that parasitize insect pests. It's important to note that these tiny to medium-sized wasps are incapable of stinging people.

### Pathogens

Natural enemy pathogens are microorganisms including certain bacteria, fungi, nematodes, protozoa, and viruses that can infect and kill the host. Populations of some aphids, caterpillars, mites, and other invertebrates are sometimes drastically reduced by naturally occurring pathogens. Some beneficial pathogens are commercially available as biological or microbial pesticides. These include Bacillus thuringiensis or Bt, entomopathogenic nematodes, and granulosis viruses. Additionally, some microorganism by-products, such as avermectins and spinosyns are used in certain insecticides; but applying these products is not considered to be biological control.

### Predators

Predatory beetles, flies, lacewings, true bugs (Order Hemiptera), and wasps feed on various pest insects or mites. Most spiders feed entirely on insects. Predatory mites that feed primarily on pest spider mites include Amblyseius spp., Neoseiulus spp.

*Figure 5 Garlic*

*Neem leaves*

*Figure 6 : Green Chilly*

*Tobacco leaf*

1. **Plant Disease**

The term disease is usually used for the destruction of live plants. Plant diseases are caused by microorganisms such as fungi, bacteria and viruses

**Disease triangle:**

It is important to understand that there are three conditions need to be fulfilled for a disease to occur, one is a suitable host plant which is preffered by that disease agent (Fungi, Bacteria and Virus), Second is presence of the pathogen/ infectious bacterial or fungi or virus. The third important condition is a suitable environment with favored humidity and temperature for the agent to become active and multiplicity.

| | | | | |
|---|---|---|---|---|
| 2. | Downy mildews (individual species damage particular crop families) | High humidity, leaf wetness and cool to mild temperatures (10°C - 16 °C). | Wide host range including onions; peas; lettuce; celery; spinach; kale; herbs; cucurbits; brassicas; Asian leafy brassicas. | Symptoms usually begin with yellowish leaf spots which then turn brown; downy growth appears on underside of leaves. |

| | | | | |
|---|---|---|---|---|
| 4. | Clubroot *(Plasmodiophora brassicae)* | Warm weather; acidic soil (pH less than 7); high soil moisture. | Brassicas (including Asian leafy brassicas). | Plants are yellow and stunted and may wilt in hotter parts of the day; large malformed 'clubbed' roots which prevent the uptake of water and nutrients, reducing the potential yield of the crop. |


| | | | | |
|---|---|---|---|---|
| 7. | *Sclerotium*-rots *(Sclerotium rolfsii and S. cepivorum)* | *S. rolfsii* – Warm, moist conditions. *S. cepivorum* – Development is favoured by cool soil conditions (14°C-19°C) and low moisture. | *S. rolfsii* – Wide host range including: beans; beets; carrot; potato; tomato; capsicum; cucurbits. *S. cepivorum* – only affects onions, garlic and related Alliums (shallots; spring onions; leeks). | *S. rolfsii* – Lower stem and root rots; coarse threads of white fungal growth surround the diseased areas; small brown fungal resting bodies. *S. cepivorum*– Yellowing and wilting; fluffy fungal growth containing black sclerotia forms at the bases of bulbs. |

| | | | | |
|---|---|---|---|---|
| 10. | *Anthrac-nose* (*Colletotri-chum* spp. except for in lettuce – *Microdo-chium panatton-ianum*) | Cool, wet conditions. | Wide range of crops including: lettuce; celery; beans; cucurbits; tomato, capsicum; potato; globe artichoke. | Typical symptoms begin with sunken and water-soaked spots appearing on leaves, stems and/or fruit. |

| | | | | |
|---|---|---|---|---|
| 11. | *Rhizoctonia* rots (*Rhizoctonia solani*) – range of common names, e.g. Bottom rot (lettuce) and Wire stem (Brassicas) | Warm, humid weather; can survive for long periods in the soil in the absence of a host plant. | Wide host range including: lettuce; potato; brassicas;beans; peas; beets; carrots; capsicum; tomato; cucurbits. | Range of symptoms depending on the crop being grown but can affect roots, leaves, stems, tubers and fruit; plants wilt and may collapse and die. |

| | | | | |
|---|---|---|---|---|
| 13. | Cavity spot (*Pythium sulcatum*) | Growing carrots after carrots; acidic soil; not harvesting carrots as soon as they reach marketable size. | Carrots. | Cavity spots are small elliptical lesions often surrounded by a yellow halo. |

| | | | | |
|---|---|---|---|---|
| 14. | Tuber diseases (Various species) | | Potato and sweetpotato. | Potato tubers may be infected with superficial skin diseases, such as common scabs, powdery scab, and *Rhizoctonia*. Sweetpotatoes may be infected by scurf. |

## B. Bacterial Diseas :

| Sl. No. | Bacterial disease | Factors conducive to spread | Crops affected | Symptoms |
|---|---|---|---|---|
| 1. | Rusts (several species, e.g. *Puccinia sorghi*– sweet corn; *Uromyces appendi-culatus*– beans; *Puccinia allii* – spring onions). | Wind can spread spores great distances; favoured by low rainfall, 100% relative humidity and cool to mild temperatures. | Sweet corn; beans; onions; spring onions; beets; celery; silverbeet; endive. | Small, red or reddish-brown pustules that form on the underside of the leaves and sometimes on the pods as well; dusty reddish-brown spores released from pustules (may be black in cold weather). |


| | | | | |
|---|---|---|---|---|
| 4. | Bacterial leaf spot/ Bacterial spot (*Xantho-monas campestris* - various strains) | Overhead irrigation and windy conditions. | Range of vegetables including lettuce; cucurbits; tomato; capsicum. | Lettuce – Large brown to black circular areas that start as small translucent spots; usually on outer leaves. Tomatoes and capsicums – Greasy spots on leaves and stems that go from tan to black; fruit may have circular spots with central scab. Cucurbits – Begin as small water-soaked/ greasy spots on underside of leaves with corresponding yellowing on upper side; fruit may produce light-brown ooze from water-soaked markings. |

## C.Viral diseases:

Viruses, crops affected, and damage caused:

**Means of transmission: Aphid**

| Virus | Host plants | Primary damage |
|---|---|---|
| Bean common mosaic virus | Beans | Mottling, curling, and malformation of leaves and a general stunting of the plant. |
| Cucumber mosaic and potato mosaic virus | Capsicum; tomato; potato; celery. | Chlorosis and blistering mottle of leaves; plants are stunted. |
| Carrot virus Y | Carrot. | Severe root symptoms in carrots including shortened root |
| Potato leafroll virus | Potato. | Stunted plants; lower leaves roll upwards at the margins, develop leathery texture and die prematurely. |




## Means of transmission: Whitefly

| Virus | Specific vector | Host plants | Primary damage |
|---|---|---|---|
| Begamo-viruses - Tomato yellow leaf curl virus (TYLCV) | Silverleaf whitefly | French beans; cucurbits; capsicum; several weed species. | Affected plants stunted' interveinal chlorosis develops; leaves bent downwards and stiffened; fruit quality reduced. |
| Beet pseudo-yellows virus (BPYV) | Greenhouse whitefly | Lettuce; beet; endive; cucumber; common weeds. | Chlorosis or yellowing between veins in older cucumber leaves, with symptoms spreading to younger leaves; severely affected plants stunted. |
| Tomato torrado virus (ToTV) | Both Greenhouse and Silverleaf whitefly, | Capsicum; eggplant; weeds including Amaranthus, Atriplex, Chenopodium, and Malva. | Early symptoms include necrotic or dead spots; affected areas may fall out, leaving shot holes in the leaflets; necrosis and mottling also extends to the remainder of the leaves. |

## *Means of transmission: Tobamoviruses*

*Not transmitted by any insects, remains in the environment*

| Virus | Host plants | Primary damage |
|---|---|---|
| Tobacco mosaic virus | Crop plants and weeds: eggplant; tomato; bok choy; choy sum; bitter melon; Chinese mustard; long melon; snake bean; Chinese cabbage. | Mosaic; mottling; leaf distortion; and sometimes leaf death and defoliation. |
| Tomato mosaic virus | Tomato capsicum | |
| Pepper mild mottle virus | Capsicum including chillies | A mild mosaic or mottle. |

## a. Biological control

Top of Form

In organic disease control, natural materials (things found in nature or that exist in the environment) can be used to inhibit or prevent the activity of plant pathogens.

| Organic control Material | Target pathogen on one or more of the product label |
|---|---|
| Copper | *Altemaria, Erwinia, pseudomonas, xanthomonas, cercospora*, *colletotrichum*, powdery mildew, downy mildew, *phytophthora, pythium*. *Mycosphaerella, phomopsis*, *taphrina, elsinoe, gnomonia, fusicladium, nectria, phyllosticta, diclocarpon, albugo, guignardia, botrytis, exobasidium, entomosporium, pestalotia, phoma, cristulariella.* |
| Oil derived form plants extract | Powdery mildew. |
| Potassium bicarbonate | Powdery mildew |
| Potassiom silicate | Powdery mildew, pythium, botrytis, fusarium. |
| Sulfur | Powdery mildew. |

'Biological' control of a plant disease involves the use of one living organism to inhibit the activity of a living plant pathogen. Biological control agents (BCAs) are registered for use by the Environmental Protection Agency (EPA) and have labels very similar to those for chemical pesticides. Below is a partial list of BCAs and the pathogens listed on at least one of the product labels as being controlled:

of the target fungi. This process (mycoparastitism) limits growth and activity of plant pathogenic fungi. Mycoparasites produce cell wall-degrading enzymes, which allow them to bore holes into other fungi and extract nutrients for their own growth.

**Target diseases** :

*Pythium* spp., *Ganoderma* spp., *Rhizoctonia* solani, *Fusarium* spp., *Botrytis cinerea*, *Sclerotium* spp., *Sclerotinia* sp. and *Ustilogo* spp, etc.

**Frequency of application :**

Two to three applications in vegetables ornamentals and 4-5 applications in lawns and landscape crops are recommended. Applications during early stages of plant growth protect the plant during critical stages of development.

**Dosage** :

Soil application: 5 kg /ha along with any organic fertilizer (without pathogenic contaminants). Seed treatment: @ 4-5 gm per kg of seeds as per standard wet treatment. Seedling treatment: @ 100 g/ l prior to planting.

a. **Use of indigenous varieties**
b. **Seed treatment**

Seed borne infestation of insects and diseases pose devastating consequences to crop production. The concept of seed treatment is the use and application of biological and chemical agents that basically can control or contain primary soil and seed borne infestation. This helps to improve crop safety which in turn leads to good establishment of healthy and vigorous plants which results in better yields. The benefit of seed treatment leads to increased germination and ensures uniform seedling emergence. As already seen it protects seeds and seedlings from early season diseases and insect pests thereby improving crop emergence and growth. Treating seeds with *Rhizobium*also enhances the nitrogen fixing capability of legume crops and their productivity. Overall seed

Ground nut. For any variety of seed spraying of cow milk and water mix with 1:9 ratio and drying under shade will be beneficial

### Seed Treatment for fungal diseases

Large number of microbes present in the cow dung and urine which are useful for controlling many fungal diseases. Nutrients present in the solution are useful for effective plant growth. This can be applied for two to three in a crop period. Cow dung – 5Kgs, Cow urine – 5lts, Lime – 150grs

### Process:

Store 5Kg cow dung, 5lts of cow urine and 5lts of water in a tub, Cover the tub and allow the solution for fermentation for 4days. Stir the solution with a stick every day, After 4days filter the solution and add 150grs of lime to it, Add 100lts of water to the solution to spray it in 1 acre.