Cultural Methods

Tillage

- Tillage is an important operation in the crop management system.
- It is carried out for the preservation of soil condition to provide favorable conditions for plant growth and to maintain long-term productivity of the soils.
- Most of the soil borne facultative fungal pathogens, plant pathogenic bacteria and other microorganisms are completed their life cycle in soil or on the plant residues.
- But, the soil conditions can be altered by tillage.
- It may be expected to influence both pathogens and antagonists.
- It reduces disease risk by reducing pathogen inoculums and by acceleration of decomposition of diseased deposits.
- It separates the pathogens from host by burying pathogen deep into the soil or by changing soil conditions.
- The infected residues may be a potential infection source, if it is soil borne disease.
- Tillage is considered as a best crop management system.
- It has play vital role in crop land, which destroying the weeds, because the unnecessary plants that may serve as sources of inoculums for pathogens.
- In addition, tillage may reduce the amount of pathogen inoculums.
- The deep ploughing may bury the pathogen for inactivation by soil microflora or pathogen present in the soil.
- After ploughing, the pathogen may be brought to soil surface and inactivated by heat (solar radiation) and drought.
- For example, the inoculum of *Rhizoctonia solani* infecting many crops and *Verticillium dahliae* infecting cotton. These may be reduced by deep ploughing.
- Deep ploughing is also used for control bean white mold disease caused by *Sclerotinia sclerotiorum.*
- It is recommended for white mold disease because the sclerotia buried deep into soil, for that the spores do not germinate after buried.
- This may have different effects on the current and successive crops.
- Lettuce drop disease caused by *Sclerotinia minor,* which was reduced in the crop planted immediately after ploughing.
- Whereas, the disease prevalence greatly increased in the second crop.

Planting date and sowing

- Date of sowing or planting of a crop depends on several factors such as crop duration, availability of irrigation facility or rainfall, etc.
- In management point of view, the date of sowing or planting may be determined with the primary objective of reducing the period for which the crop may be exposed to the virulent pathogen in propagules available environment or substrate.
- In the case of viruses or other vector-borne pathogens, the date of sowing has to be so adjusted.
- The crop is not exposed to the period, when the vector population is high with active movements.
- The disease incidence pattern has to be studied on crop field in several reasons or years to plan a practical proposal for avoiding the disease by suitable manipulation of date of sowing or planting.
- Although, this approach may appear to be simple, some problems imposed by crop requirements and seasons should be overcome.
- By selecting appropriate dates of sowing, some diseases could be significantly controlled as in the case of wheat foot rot disease caused by *Pseudocercosporella herpotrichoides.*
- The dates of sowing and planting takes all disease of wheat caused by *Gaeumannomyces graminis* var. *tritici* could be reduced by early sowing of winter wheat (late October to early November) in irrigated areas.
- Likewise, Sclerotinia crown and stem rot disease of alfalfa caused by *Sclerotinia trifoliarum.*
- It could be appreciably reduced by combining early sowing and no-till practice
- Some of the viral diseases can be managed by properly adjusting sowing dates.
- The early sowing of sugar beet permits its germination and growth, when temperatures are too low the root fungal infection made by the fungal vector *Polymyxa betae*.
- On the other hand, the late sowing leads to the additional advantage of avoiding the rhizomania disease caused by *Beet necrotic yellow vein virus* for which *P*. *betae* is the vector.
- The effect of planting dates on the incidence of rice tungro disease (RTD) in the Cauvery delta of Tamil Nadu State, India was studied in detail.
- Rice crops planted before the first fortnight of August generally showed minimal infection by rice tungro disease (RTD) while the disease incidence increased markedly in rice crops planted in October and thereafter.
- The higher disease incidence had a significant positive relationship with the buildup of population of green leafhoppers.

Crop rotation

- Crop rotation is used to suppress or avoid certain diseases.
- It is most effective for soil borne pathogens that reside in soil or plant residue left in and on the soil after harvest.

- One rotation approach is to plant a crop that does not support the development of a pathogen.
- For example, neither wheat nor corn is susceptible to *Sclerotium rolfsii*, the cause of Southern blight of soybeans.
- Therefore, soybeans can be rotated with grain crops.
- Sometimes, a non-crop species is used between years of planting the crop. For example, tall fescue planted in rotation with tobacco, which can reduce the losses of tobacco to black shank, caused by *P. nicotianae*.
- Plant parasitic nematodes are obtaining their nutrients from living plants.
- If the crop in the field, it is not a suitable host for the nematode, many nematodes die and their population level decreases.
- This is typically the case when lesion nematode (*Pratylenchus*) is present.
- The preliminary nematode population may be low that nematodes do not adversely affect the new crop even if it is a suitable host.
- However, the nematode population may recover on the suitable crop to a level that would make it risky to plant same crop again the following year.
- Rotation is a very important approach for managing diseases caused by the root knot nematode (*Meloidogyne* species) on vegetables and the cyst nematode (*Heterodera* species) on soybeans and some other field crops.
- Usually, the farmer continues to grow the susceptible crop each year, but in a different field each year.
- The continuous growth of wheat may suppress all disease caused by *Gaeumannomyces graminis*.
- Although, during the first few years of continuous wheat production decreases disease severity for the next several years.
- In fact, there is increase the beneficial organisms in the soil and associated with wheat residue that suppress the pathogen.

Trap crops

- If a few rows of rye, corn, or other tall plants are planted around a field of beans, peppers, or squash.
- There many of the incoming aphids carrying viruses that attack the beans, peppers, and squash.
- These plants will first stop and feed on the peripheral taller rows of rye or corn.
- Because, most of the aphid-borne viruses are non-persistent in the aphid, many of the aphids lose the bean, pepper, or squash infecting viruses by the time they move onto these crops.
- In this way, trap crops reduce the amount of inoculums that reaches a crop.
- Trap plants are also used against nematodes, although in a different way.

- Some plants that are not actually susceptible to certain sedentary plant-parasitic nematodes produce exudates that stimulate eggs of these nematodes to hatch.
- The juveniles enter these plants but are unable to develop into adults and finally they die. Such plants are also called **trap crops**.
- By using trap crops in a crop rotation, the growers can reduce the nematode population in the soil.
- For example, *Crotalaria* plants trap the juveniles of the root-knot nematode *Meloidogyne* sp. and black nightshade plants (*Solanum nigrum*) reduce the populations of the golden nematode *Heterodera rostochiensis.*
- Similar results can be obtained by planting highly susceptible plants, which after infection by the nematodes are destroyed (plowed under) before the nematodes reach maturity and begin to reproduce.
- Unfortunately, trap plants have not given a sufficient degree of disease control to compensate the expense and risk involved with their use.
- Therefore, they have been little used in the practical control of nematode diseases of plants.

Physical Methods

Soil Sterilization by Heat

- Soil can be sterilized in greenhouses, and sometimes in seed beds by the heat carried in live or aerated steam or hot water.
- The soil is sterilized under steam either in special containers (soil sterilizers), into which steam is supplied under pressure, or on the greenhouse benches, in which container steam is piped into and is allowed to disperse through the soil.
- At 50°C, the nematodes, some oomycetes, and other water molds are killed, whereas most plant pathogenic fungi and bacteria, along with some worms, slugs, and centipedes, are usually killed at temperatures between 60 and 72°C.
- At 82°C, most of the weeds, the rest of the plant pathogenic bacteria, most plant viruses in plant debris, and most insects are killed.
- Heat-tolerant weed seeds and some plant viruses, such as tobacco mosaic virus (TMV), are killed at or near the boiling point, i.e., between 95 and 100°C.
- Generally, soil sterilization is completed when the temperature in the coldest part of the soil has remained for at least 30 minutes at 82°C or above, at which temperature almost all plant pathogens in the soil are killed.
- Heat sterilization of soil can also be achieved by heat produced electrically rather than supplied by steam or hot water.

- It is important to note, however, that excessively high or prolonged high temperatures should be avoided during soil sterilization.
- Not only do such conditions destroy all normal saprophytic microflora in the soil, but they also result in the release of toxic levels of some (e.g., manganese) salts and in the accumulation of toxic levels of ammonia (by killing the nitrifying bacteria before they kill the more heat-resistant ammonifying bacteria), which may damage or kill plants planted afterward.

Soil solarization

- When, the clear polyethylene is placed over moist soil during sunny summer days, the temperature at the top 5 centimeters of soil may reach as high as 52°C compared to a maximum of 37°C in unmulched soil.
- If hot weather continues for several days or weeks, the increased soil temperature from solar heat, known as solarization, inactivates (kills) many soil borne pathogen fungi, nematodes, and bacteria near the soil surface, thereby reducing the inoculum and the disease causing material.

Soil Sterilization

- In simplest terms soil sterilization consist in getting rid of the organisms harmful to plant growth or atleast, in reducing their numbers to a point where they are no longer of consequence without permanently eliminating or disturbing the balance of those organisms essenstial for fertility.
- Basically, it is treatment of soil of glasshouses, greenhouse and other horticultural soils in order to kill weed, seeds, plant disease organisms, and pests.
- Soil is sterilized in greenhouses or polyhouses and also in nurseries by steam or hot water/air.
- Soil treated with hot water or steam at about

  i). 50°C for inactivate or kill majority of nematodes and some oomycetes fungi

  ii). 60-70°C – most of plant pathogenic fungi and bacteria

  82°C – Most of weeds and plant pathogenic bacteria and insects

  Some heat tolerant weed seeds and virus like tobacco mosaic viruses are killed at near boiling point depend upon pressure.
- It causes their cell structure to physically degenerate
- Sterilization can be achieved with one or more of the following: heat, chemicals, radiation, high pressure, and filtration.
- Sterilization is distinct from disinfection, sanitization and pasteurization in that sterilization kills, deactivates, or eliminates all forms of life and other biological agents. Example: i). Molya disease of wheat caused by *Heterodera avenae*

  ii). White tip disease of rice caused by *Aphelenchoides besseyi*

- Soil borne pathogens like *Fusarium, Rhizoctonia, Sclerotia* can be controlled by this

Types of Sterilization

Heat is used to destroy all forms of life present in soil. It is thorough, quick- acting and clean. And heated soil can be used immediately after it has cooled.

Heat sterilization is of two type's wet/moist and dry heat sterilization.

i) MOIST HEAT STERILIZATION:

- It utilizes hot air that is heavily laden with water vapour and where this moisture plays the most imp role in sterilization.
- Steam sterilization is non-toxic, inexpensive, rapidly microbicidal, sporicidal and rapidly heats.
- A widely used method for steam sterilization is the autoclave, sometimes called a converter or steam sterilizer.
- Autoclaves use steam heated to 121-134°C under pressure for a specific period of time.
- A general cycle is 15-20 mins at 121°C at 100 kPa. It inactivates all resistant bacteria spores in addition to fungi, bacteria and viruses but not eliminate all prions.
- For prions, 121-132°C for 60 mins or 134°C for at least 18 mins.
- Action on microorganisms: Moist heat causes destruction of microorganisms by de-naturation of macromolecules, primarily proteins.

ii) Dry heat sterilization:

- It is one of the earliest forms of sterilization used.
- Dry heat utilizes hot air that is either free from water vapour and where this moisture plays a minimal or no role in the process of sterilization.
- In this process, the heat is absorbed by the exterior surface of an item and then passed inward to next layer.
- Eventually, the entire item reaches the proper temperature needed to achieve sterilization. The proper time and temperature for dry heat sterilization is 160°C (320°F) for 2 hours or 170°C (340°F) for 1 hour.
- Instrument should be well dried before used.
- Generally there are 2 type of hot-air convection sterilizers:
    - A) Gravity Convection
    - B) Mechanical Convection

Dusters

All dusters consist essentially of a hopper which usually contains an agitator, an adjustable orifice and delivery tubes. A rotary fan or a bellows provides the conveying air.

A) Manually Operated Dusters:

1. Plunger Duster

- It is simple in construction and consists of a dust chamber, a cylinder with a piston or plunger, a rod and a handle.
- It is useful for small scale use in kitchen garden and in household.

2. Bellows Duster

- It has a pair of bellows made of leather, rubber or plastic.
- The bellows can be worked with a handle just like a Blacksmith does.
- The dust is placed either in the bellows or in a separate container made of wood, metal or plastic attached to one end of the bellows.
- The air current that is created runs through the container and drives the dust out through an opening.

3. Hand Rotary Duster

- **Hand Rotary Dusters** are also called crank dusters and fan type dusters.
- It may be shoulder mounted, back or belly mounted.
- Basically, a rotary duster consists of a blower complete with gear box and a hopper with a capacity of about 4-5 kg of dust.
- The duster is operated by rotating a crank and the motion is transmitted through the gear to the blower.
- The air current produced by the blower draws the dust from the hopper and discharges out through the delivery tube which may have one or two nozzles.
- It is used for dusting field crops, vegetables and small trees and bushes in orchards.
- The efficiency of these dusters is 1 to 1.5 ha/day.

B) Power Operated Duster

1) Engine operated dusters
2) Wet dusters

SPRAYERS

- Depending upon the quantity of spray fluid required per unit area, the sprays are described as i) High volume sprays ii) Low volume sprays and iii) Ultra – low volume sprays.
- The spray fluid of 450 to 1000 liters; 12 to 125 liters and 0.5 to 6 liters will be required to cover one hectare of field crop with above mentioned sprays respectively.
- However, the droplet size of these three sprays varies from 250 to 500, 150 to 250 and 70 to 150 microns respectively.

Types of Sprayers:

I) High Volume Sprayers:

A) Manually Operated Hydraulic Sprayers:

1. Hand Syringe:

- It consists of a cylinder and a plunger, spray fluid has to be contained in a separate tank. The liquid is drawn on return stroke of the plunger and ejected during the compression stroke.
- After each ejected the spray fluid has to be drawn in. It is useful for small scale spraying in kitchen gardens and pot plants.

2. Bucker Sprayer or Stirrup Pump:

- It may consist either of a double acting pump with two cylinders or a single acting pump with one cylinder.
- The other parts of the sprayer are the plunger assembly, foot value assembly, hose, lance and nozzle, a stirrup and an adjustable foot rest.
- The pump has to be put in a bucket of any container having the spray fluid.
- In the single acting pump the spray discharge is discontinuous since the fluid is ejected only during the downward compression stroke, while in the double acting pump the discharge is continuous as the fluid is discharged during both sucdon and pressures strokes.
- This type of sprayer is useful for spraying small trees.
- Area covered per day is 0.5 to 0.8 ha.

3. Knapsack Sprayer:

- This type of sprayer has a flat or bean shaped tank.

- The tank has a capacity of 10 to 30 liters and is made of galvanized iron, brass stainless steel or plastic.
- It is similar to bucket type in principle.
- It is operated by a lever handle provided inside the tank and it moves up and down inside the container due to the movements of the pump lever.
- Knapsack Sprayer is used for spraying field crops vegetables and nurseries.
- The area covered per day is 0.8 to 1 ha.

4. Rocker Sprayer or Gatoor Pump:

- It consists of a pump assembly, a rocking lever, pressure chamber, and suction hose with a strainer, delivery hose, cut-off valve and spray lance with nozzle.
- By rocking movement of the lever pressure can be built in the pressure chamber and this helps to force the liquid through the nozzle.
- There is no built in tank. It can be used for spraying trees and tall field crops.
- It covers about 1.5 to 2 hectares of area in a day.

5. Foot Sprayer or Pedal Pump:

- A pedal pump consists of a vertical pressure chamber mounted on to a stand.
- Also, a plunger assembly with the plunger rod attacked to a pedal in addition to a suction hose with a strainer, a delivery hose with an extension rod and spray nozzle.
- It has no built in tank, which works on the same principle as the rocker sprayer except that the pedal is worked up and down by foot in this case.
- Where, the rocker in a rocker sprayer is operated forward and backward by hand.
- In both cases continuous operation of pedal or rocker is required to maintain high pressure for uniform spraying.
- It is used for spraying agricultural crops as well as small fruit trees.
- About 1 to 1.5 hectare area can be sprayed in a day.

B) Manually Operated Pneumatic Sprayers:

- In the sprayer working with air compression system, the pressure is developed on the air contained in the spray tank.

- Hence, some air should be allowed to remain in the tank which therefore, should not be filled with spray fluid completely.
- They do not have agitators and hence are not useful spraying materials which settle down quickly.

1. Hand Sprayer or Atomizer

- The container for the spray fluid also acts as the pressure chamber.
- An air pump attacked to the chamber projects inside.
- The inner end of the discharge pipe runs down to the bottom of the container and its outlet terminates in a nozzle.
- The tank is filled about 75% of it and the pump is worked force air into the space to build sufficient pressure upon the spray fluid.
- These sprayers are used extensively in kitchen gardens, in greenhouses and in doors against house-hold insects.
- The capacity of tank is up to one liter, if used in field it can cover an area of 0.1 ha in a day.

2. Knapsack Sprayer:

- They are adopted for spraying large quantities of liquids.
- It comprises a tank for holding the spray as well as compressed air, a vertical air pump with a handle, filling hole with a strainer, spray lance with nozzle and release and shut-off devices.
- The tank is provided a convenient rest with the back of the operator and has shoulder straps that allow it to be carried by them.
- These sprayers are used against for control agricultural pests and mosquito.
- The capacity of tank is 12 to 16 liters.
- This pump covers an area of about 0.8 to 1.2 hectare in a day.

C) Power Operated Hydraulic Sprayer:

A power operated hydraulic sprayer generally consists of a petrol engine and a framework. The following are some of the power operated hydraulic sprayer.

1. Stretcher sprayer
2. Wheel-barrow sprayer
3. Traction sprayer

4. Power take off sprayer

D) Power Operated Pneumatic Sprayers:

It consists of the following sprayers

1. Portable sprayers
2. Traction sprayers

II) Low Volume Sprayers:

- ❖ Since in these sprayers the spray fluid is atomized with the help of an air stream at high velocity, they are called mist blowers or power sprayers.
- ❖ The tank in these is made of a thick polyethylene and has a capacity of 10 liters.
- ❖ The fuel tank capacity is 1.0 to 1.5 liters.
- ❖ It is provided with 1.2 to 3.0 hp petrol engine.
- ❖ This can also be used for dusting provided suitable accessories.
- ❖ The area covered by these sprayers is about 2 ha in a day.

III) Ultra Low Volume Sprayers:

- ❖ The pesticide in ULV formulation is used undiluted at a quantity less than 6 liters/ha and usually at 0.5 to 2.0 liters/ha for field crops.
- ❖ The droplet size varies from 20-150 micron with ground spraying equipment for ULV spray an area of 5 ha can be covered in a day. E.g. Controlled Droplet Applicator (CDA)
- ❖ The desired effects of a pesticide can be obtained only if it is applied in an appropriate time and in a proper method.
- ❖ The important methods of applying pesticides are dusting and spraying.
- ❖ The appliances that are used for applying dust and spray formulation of pesticides are called dusters and sprayers, respectively.

SEED TREATMENT

- ❖ Seed treatment can be chemical or traditional methods that are applied on seeds or vegetative propagation materials to control disease organism's insects, or other pests.
- ❖ The seed treatment pesticides include bactericides, fungicides, insecticides, and herbicide antidotes.

Advantages of Seed treatment

a. Prevents spread of plant diseases.
b. Protect seed from seed rot and seedling blight.
c. Improves germination.
d. Provides protection from storage insects.
e. Control soil insects

Seed treatment equipments in chemical methods

i. Drum mixer
ii. Direct treater
iii. Slurry treater
iv. Grain auger
v. Shovel

i. Drum Mixer

- ❖ This equipment is used for different kind of seeds with chemicals in powder form.
- ❖ Seed treatment drum is made up of angle, iron frame and G.I sheet made drum.
- ❖ In one batch, 10-15 kg seed can be treated with chemicals.

ii. Slurry treaters

- ❖ The slurry treatment principal involves suspension of WP treatment material in water.
- ❖ The treatment material applied as slurry is accurately metered through a simple mechanism composed of a slurry cup and seed drum pan.
- ❖ The cup introduces a given amount of slurry, with each dump of seed, into a mixing where the seeds are mixed thoroughly.
- ❖ The slurry treaters are adoptable to all types of seeds and rates of seed treating.

iii. Direct Treaters

- ❖ Direct treaters are the most recent development and include the Panogen and Mist-o- matic treaters.
- ❖ Mist-o-matic treaters is being used more widely.
- ❖ The Mist-o-matic treater applies chemical as a mist directly to the seed.
- ❖ The treater is equipped with a large treatment tank, a pump and a return that maintains the level in the small reservoir from which the seed is feed.

Chemical method of seed treatment

a. Rice

Rice blast:

***Pyricularia grisea*-**Seed treatment with binomyl+thiram @ 2g/kg.

Brown spot:

Bipolaris oryzae-Seed dressing with Organo mercurial fungicide like agrosan GN or thiram @2g/kg

b. Wheat

Loose smut of wheat, Flag smut & Karnal Bunt: Vitavax or Bavistin 2g/kg or Tebucanazonole (Raxil–2DS) @ 1g/kg

c. Chickpea

Fusarium wilt: *Fusarium oxysporium f.sp. cicer Trichoderma viridi* (Bioderma)@4g + 1g Vitavax /kg of seed

ii. Vegetable & spices

Potato black scruf: *Rhizoctinia solani* seed treated with boric acid (3%), spray before cold storage or *T. viridi* before planting.

Common scab: *Streptomyces scabbies* seed treated with boric acid 3%.

Tomato:

Damping off: *Phytopthora sp* & *R. spp.* Dry seed treated with captan or thiram 3g/kg of seed.

Wilt: *Fusarium oxysporum* Seed treated with Bavistin 2.5g/kg of seed

Leaf mosaic: Tomato Mosaic Virus (TMV) seed treated with Trisodium phosphate solution 20%.

Corriander

Corriander stem gal: *Protomyces macrosporus* seed treated with Captan & Thiram @ 4g/kg of seed.

Cumin Cumin wilt: *Fusarium oxysporum* seed treated with Bavistin @ 2g/kg of seed.

TRADITIONAL METHOD OF SEED TREATMENT

SEED TREATMENT WITH COW URINE:

Requirements:

Cow urine : 2 litres (preferably buffalo's urine which can effectively control fungal diseases)

Cow dung : 1 Kg Mond or live

Soil : 1 Kg

Mix all the above mentioned materials with seeds and allow them for drying up to one hour.

This method is suitable for the crops with seed rate of 30-60Kgs, e.g., Groundnut

SEED TREATMENT FOR IMPROVING GERMINATION:

- ❖ Soaking the seeds in water before sowing.
- ❖ It will improve the germination percentage of seed.
- ❖ The duration of soaking depends on the nature of the seed coat.
- ❖ For this method, we can improve the disease resistance by soaking these seeds in cow urine.

Example: Soaking time required for

Paddy **:** 12 hours soaking in water and drying of seed under shade for 4-5 hrs

Maize **:** 24 Hrs soaking in water

Wheat **:** 7 Hrs soaking in water

Groundnut **:** 1-2 Hrs soaking in water

OTHER METHODS:

For any variety of seed, the seed spraying with cow milk and water mix with 1:9 ratio. Thereafter, the seeds drying under shade will be beneficial

1. Seed treatment with cow urine (1or 2 litres for 100Kg of seed) and drying under shade
2. The sprinkling of ash and water and drying under shade.
3. Beejamrut (a mix of cow dung, cow urine, water, lime and a handful of soil)
4. Desi cow urine -2lit, cow dung - 1kg, termite soil (snakes)-1kg.
5. Cow urine 1lit, ash- 1/2 kg, asafoetida100g
6. Cow milk+ water in 1:9 ratio
7. Cow urine with seed Soak overnight before sowing
8. Red soil/termite soil - 100g, ash100g, asafoetida 20g, turmeric 20g, cow urine 10 ml
9. Buttermilk treatment: Take 1 lit water add 50-100ml of buttermilk and soak seeds at least 5 hours
10. Some farmers use hot water (50 degrees) treatment to overcome seed-borne diseases.
11. Salt water treatment is another which used for paddy extensively.