Practical manual on

Principles of Plant Disease Management

APP- 507 3(2+1)

For

M.Sc. (Ag.) Plant Pathology

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Department of Plant Pathology
College of Agriculture
Rani Lakshmi Bai Central Agricultural University
Jhansi, Uttar Pradesh-284003

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Principles of Plant Disease Management

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M.Sc. (Ag.)Plant Pathology

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Contents

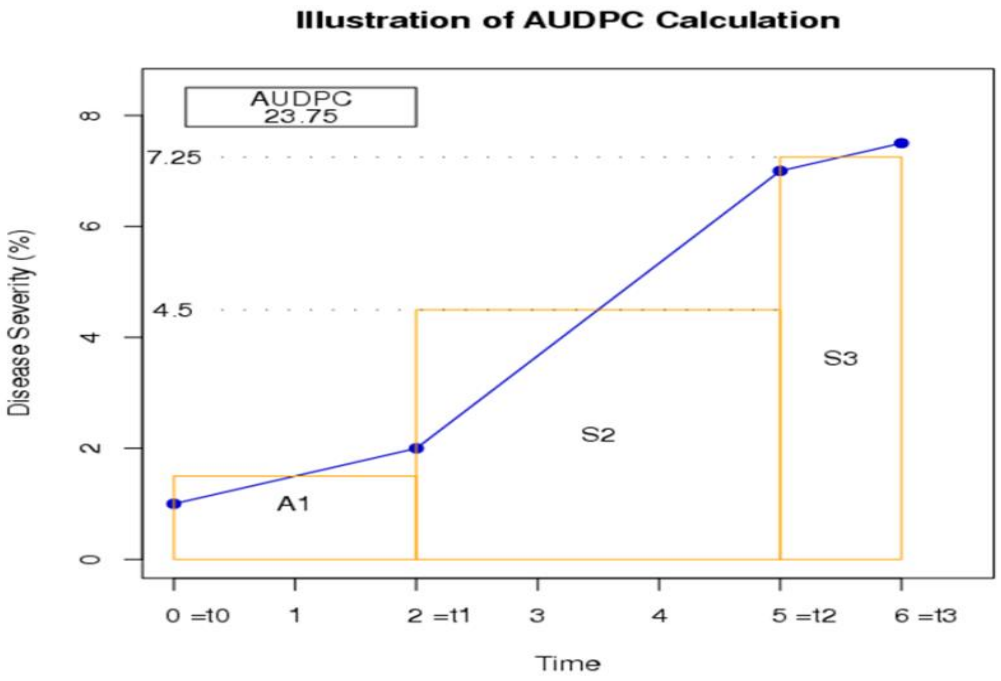
PRACTICAL No. 1

Phytopathometry of plant pathogens

Objective: Phytopathometry of plant pathogens

- **Disease incidence= No. of infected plantsX100**
  Total no. of plants
- **Disease severity= [Class frequency x score of rating class] X 100**
  [total no. of plants X maximum dis index]

Area under disease progress curve: It was given by Shaner and Finney 1977. Area between disease progress curve and the x-axis of the graph when the progress of disease severity over a period of time in relation to disease intensity is plotted against time.



Disease progress curve: It is a curve depicting the epidemic pattern over time in terms of no. of lesions, amt of plant disease, tissue or no. of plants diseased.

Yield loss due to disease is measured by determining the area under a disease progress curve.

Activity: Calculate the disease severity of plant infected with a disease whose disease rating scale is given in the table below and also calculate Area under disease progress curve.

Rating scale	Disease intensity per cent	Disease reaction
0	0	Immune (I)
1	> 5	Highly Resistant (HR)
3	5-10	Resistant (R)
5	11-25	Moderately resistant (MR)
7	26-50	Susceptible (S)
9	>50	Highly susceptible (HS)

Observation

Disease grade	Total Nos. of sample	Total Rating

PRACTICAL No. 2

Artificial epiphytotic and screening of resistance

Objective: To artificially inoculate the pathogen and screen for resistance

Pathogenic isolate of *F. moniliforme* will be multiplied on PDA slants at 27-30°C for 15 days. The conidial suspension will be prepared by harvesting conidia in sterilized distilled water by scrapping the cultures in the water and adjusted to a concentration of (4×104spores/ml) for inoculation. The pathogen can be inoculated in number of ways: seed dipping, root dipping or foliar spray based on nature of the pathogen.
The disease reactions will be confirmed based on disease scale.

For screening in the nursery, the seeds will be dipped in conidial suspension of pathogenfor 3 h and were then sown in nursery beds. However, for screening in transplanted crops, 30 day old seedlings of the test germplasm lines will be uprooted and their roots will be dipped in a freshly prepared conidial suspension for 3 h before transplanting. The inoculated seedlings will then be transplanted in the field. Or else for foliar pathogens, the conidial suspension can be sprayed over the foliage.

Observations on disease incidence in different genotypes/varieties/ susceptible crop in the nursery beds and transplanted fieldwill be recorded 15 and 30 days after sowing and transplanting in terms of infected plants and total number of plants and the per cent disease incidence (PDI) will be calculated. The evaluated plants or pathogens can be classified in different categories on the basis of disease scale specified for each diseases.

Activity:

1. Create an artificial epiphytotic condition for a pathogen isolated from any foliar leaf disease. And go for screening in susceptible variety to observe the virulence of the pathogen.
2. Take 5 varieties of ground nut and screen for its resistance against the Cercospora leaf spot using its disease scale. Classify in different categories on the basis of disease scale.

PRACTICAL No.3

Market survey for determining commonly used agro-chemicals and bio-control agents

Objective: Market survey for determining commonly used agro-chemicals and bio-control agents

Fungicides					
S.No.	**Technical Name**	**Trade Name & Company**	**Disease & crops in which used**	**Size available**	**Price (Rs.)**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Antibiotics

S.No.	Technical Name	Trade Name & Company	Disease & crops in which used	Size available	Price (Rs.)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Bio-control agents

S.No.	Technical Name	Trade Name & Company	Disease & crops in which used	Size available	Price (Rs.)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

PRACTICAL No.4

Methods of *in-vitro* evaluation of chemicals against fungal plant pathogen

Objective: To evaluate commonly available chemicals against fungal plant pathogen*in vitro*

A.Isolation from leaves and stems

Avoid using potato dextrose agar (PDA) or other carbohydrate-rich media for isolation from diseased plant tissues, especially if isolating from roots. Saprophytic fungi and bacteria grow quickly on carbohydrate-rich media and suppress the growth of slower growing fungal pathogens.

Isolation from stems is often improved by removing the bark or outer stem tissues before surface sterilization.

1. Wipe the work area with 70% ethyl alcohol.
2. Dip instruments (forceps and knife or scalpel) in 70% ethyl alcohol and flame dry.
3. Rinse leaf or stem tissue in water to remove soil and other debris.
4. Surface sterilize leaf or stem tissue by wiping the surface with soft paper (paper tissue) dipped in 70% ethyl alcohol or by briefly dipping thick leaves in 70% ethyl alcohol for 5 seconds, rinsing in sterile water and damp-drying on sterile paper tissue.
5. Aseptically cut small pieces (approximately 2 × 2 mm) from the margin of the healthy and diseased tissue, and transfer them to a low-nutrient medium (e.g. water agar [WA]) or a selective isolation medium, placing the pieces near the side of the plate.
6. Incubate the plates at approximately 25°C, ideally under lights.
7. Check plates each day, and when fungal colonies develop from the pieces of plant tissue, transfer material from the margins to a medium such as PDA or WA that contains sterile pieces of plant tissue, for example, pieces of green rice stem, carnation leaf or bean pod

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Material required

Five-day-old culture of *Sclerotium rolfsii* growing on potato dextrose agar • Petri dishes (n = 3) containing approximately 20 mL of potato dextrose agar amended with given fungicides at concentrations of 0, 100,200,300,400 and 500 ppm • Disposable nitrile gloves • A #4 cork borer • Parafilm • Ruler. Pencil.

Procedure

1. Amend potato dextrose agar with technical/commercial grade of given fungicides to achieve final concentrations of 0, 100,200,300,400 and 500 ppm of medium
2. The fungicide should be dissolved in acetone (0.05% vol/vol) before mixing with agar that has been cooled to 60°C
3. Nonamended media will serve as the control
4. Label each Petri dish with the appropriate concentration
5. Surface sterilize a #4 cork borer and obtain hyphal plugs of 1-cm-diameter from the edge of actively growing *S. rolfsii* colonies
6. Inoculate Petri dishes by placing the plug hyphal side down on the center of each of the six different concentrations
7. Three replicates should be used for each concentration
8. Wrap Petri dishes with Parafilm, incubate at 27^{o}C temperature in the dark for 3 days
9. Measure mycelial growth (in mm) from the edge of the inoculum plug at two locations perpendicular to one another, record your data, and calculate the mean mycelial growth for each concentration
10. Using logarithm (base 10) graphing paper, plot the means of growth on each of the concentrations
11. Determine the effective concentration to inhibit growth by 50% (EC50 value)
12. This can be done by regressing the percent inhibition (100 – [colony diameter on amended medium / colony diameter on the control × 100]) against the log (base 10) of the fungicide concentration
13. Count the number of sclerotia produced by the fungus on each of the fungicide-amended media after 10–14 days.

Observations

Name of the given fungicide	**Radial growth of fungal plant pathogen at different fungicide concentration(ppm)**					
	0.0	**100**	**200**	**300**	**400**	**500**

Calculations

$$\text{Percent inhibition of radial growth} = \frac{\text{Radial growth in check - radial growth in treatments}}{\text{Radial growth in check}} \times 100$$

PRACTICAL No.5

Methods of *in-vitro* evaluation of antibiotics against bacterial plant pathogen

Objective: To evaluate commonly available antibiotics against against bacterial plant pathogen

Material required

Incubator • Two- to three-day-old cultures of *Xanthomonas axonopodis pv citri* growing on nutrient agar supplemented with 0.1% w/ v d-glucose (NGA) or YPGA(0.5% peptone, 0.5% yeast extract, 1% glucose, 1.5% agar)• Petri dishes (n = 3) containing approximately 20 mL of nutrient agar amended with streptocycline at concentrations of 0, 100,200,300,400 and 500 ppm • Disposable nitrile gloves • filter paper disc (Whatman No. 42) • Parafilm • Ruler. Pencil.

Procedure

1. The bacterium *Xanthomonas axonopodis pv. citri* was multiplied by inoculating the loopful culture in 150 ml conical flask containing 50 ml of nutrient broth medium.
2. The inoculated flasks were incubated at 27±2^{0}C for 72 h
3. Amend nutrient agar with available antibiotic to achieve final concentrations 0, 100,200,300,400 and 500 ppm of medium
4. Nonamended media will serve as the control
5. Label each Petri dish with the appropriate concentration
6. The filter paper disc (Whatman No. 42) measuring 5 mm in diameter are prepared and sterilized before use.
7. The sterilized filter paper discs are soaked in the bacterial culture for five minutes and transferred onto the surface at the center of each of the six different concentrations amended medium in Petri-plates.
8. Three replicates should be used for each concentration
9. Wrap Petri dishes with Parafilm, place them
10. Measure bacterial growth (in mm) from the edge of the inoculum disc at two locations perpendicular to one another, record your data, and calculate the mean colony growth for each concentration
11. Using logarithm (base 10) graphing paper, plot the means of growth on each of the concentrations
12. Determine the effective concentration to inhibit growth by 50% (EC50 value)
13. This can be done by regressing the percent inhibition (100 – [colony diameter on amended medium / colony diameter on the control × 100]) against the log (base 10) of the fungicide concentration

Observations

Name of the given antibiotic	**Colony growth of bacterial plant pathogen at different antibiotic concentration(ppm)**					
	0.0	**100**	**200**	**300**	**400**	**500**

PRACTICAL No.6

Objective: To evaluate bio agents against fungal/bacterial plant pathogens*in vitro*

Material required

Incubator • Cultures of *P. fluorescens* isolate and *Alternaria brassicae*• Bunsen burner. • Inoculation loop. • Forceps. • Ethanol solution. • potato dextrose agar (PDA) petri plates.

Procedure

***In vitro* evaluation of bacterial bio agents**

Five to seven days prior to the experiment, start growing cultures of *Alternaria brassicae* in separate PDA plates and incubate them at 28°C.

Three to five days prior to the experiment, start growing fluorescent Pseudomonas and incubate them at 28°C.

One day before the experiment, start the "antagonism" plates. With a sterile inoculation loop, transfer Pseudomonas to new PDA plates as a ~1 cm diameter circle close to the edge of the plates Incubate bacterial plates for 24 h at 28°C.

On the day of the experiment, using a sterile pipette tip (hold from the tip end upside down), and cut an agar plug from the actively growing mycelium of *Alternaria brassicae*. With the help of a sterile loop, transfer the agar plug to the center of plates.

One of the plates will be used as a "control" for *Alternaria brassicae* growth, and another one will be used to test "antagonistic" activity of fluorescent Pseudomonas isolates.

Seal each Petri plate with Parafilm to prevent moisture loss and maintain sterility.

Incubate plates at 28°C for 4–5 days.

Observe plates daily, and once the mycelia of *Alternaria brassicae* fill the whole surface of the control plates, measure inhibition zone for each isolate.

Use a ruler to measure and record the distance between the edge of the bacterial colony facing the fungus (Rs) or oomycete (Pu), and the edge of the mycelial growth of Rs or Pu. If both edges touch each other, record as "0," and consider these isolates to be non-antagonistic to the plant pathogen

Observe if, in the inhibition halo, you can detect any color diffusing in the agar. Orange may be indicative of antibiotics such as phenazine, whereas fluorescent yellow may be indicative of siderophore production (visible under UV light at 360 nm wavelength)

***In vitro* evaluation of fungal bio agents**

Five mm discs were cut from the periphery of actively growing ten days old culture of the test fungus with the help of sterilized cork-borer, similarly *Trichoderma* discs were cut with borer
Place the discs in such a manner that both the discs lie opposite to each other (approximately 4 cm apart from each other) in petri plates (9cm diameter) seeded with PDA (approx. 20 ml/ plate).
Three replications were used for each treatment. All the plates were incubated at 27±1^{0}C. Petri plates without *Trichoderma* served as control.

Observations

Name of the given fungal bio agent	Radial growth of plant pathogen (mm)					

Calculations

$$\text{Percent inhibition of radial growth} = \frac{\text{Radial growth in check - radial growth in treatments}}{\text{Radial growth in check}} \times 100$$

PRACTICAL No.7

Estimation of ED and MIC values

Objective: Estimation of ED and MIC values for the given agrochemicals

In vitro poisoned food method is used to find out the ED50, ED90 (agrochemicals concentration at which 50 and 90 % population of the fungus is restricted) and MIC (minimum inhibitory concentration) values of different fungicides are derived by using dose response curve.

Median effective concentration (EC50): Statistically derived median concentration of a substance in an environmental medium expected to produce a certain effect in 50 % of test organisms in a given population under a defined set of conditions.

Note: ECn refers to the median concentration that is effective in n % of the test population

Median effective dose (ED50): Statistically derived median dose of a chemical or physical agent (radiation) expected to produce a certain effect in 50 % of test organisms in a given population or to produce a half-maximal effect in a biological system under a defined set of conditions.

Note: EDn refers to the median dose that is effective in n % of the test population

Median lethal concentration (LC50): Statistically derived median concentration of a substance in an environmental medium expected to kill 50 % of organisms in a given population under a defined set of conditions

Median lethal dose (LD50): Statistically derived median dose of a chemical or physical agent (radiation) expected to kill 50 % of organisms in a given population under a defined set of conditions

Procedure

1. Stock solutions of the chemical was prepared and from the stock solution different concentrations such as 10, 20, 30, 40, 50,100, 200, 300, 400 and 500 ppm were prepared in sterile distilled water.
2. This was incorporated into 100 mL of sterilized carrot agar medium so as to get the required concentration and poured into petri dishes
3. *P. capsici* grows on Carrot Agar (CA) for 72 h at 24±1^{o} C. Agar plugs of 5 mm are to be taken from the edges of the actively growing culture of the pathogen and place in the center of the sterile CA plates amended with the test fungicide.
4. The required concentrations of the chemicals incorporated on to sterilized carrot agar medium and poured into sterile plates and inoculated
5. Control plates contained only CA inoculated with the pathogen alone
6. All the treatments should be replicated thrice
7. The plates were incubated for 96 h and radial growth of mycelium is measured and percent inhibition calculated as per given formula

I= C-T/C × 100

where I= percent inhibition, C= radial growth in control and T= radial growth in treatment

Activity on sporulation of *P. capsici*

1. The stock solution prepared as above was used for studying the sporulation of *P. capsici*

2. Different concentrations of the chemical were prepared in sterile distilled water
3. Inoculum plugs of 5 mm size are cut from the margin of 72 h old culture of *P. capsici* and incubated in different concentrations of the chemicals under continuous fluorescent light for 72 h at 24 ± 1^{o} C
4. There should be three replications/treatment with 5 discs/replication
5. Inoculums plugs in sterile distilled water served as control
6. Observations for sporulation were taken under the microscope
7. Three microscopic fields were counted/replication and the average number of sporangia produced was estimated and the reduction in sporulation compared to control and ED50 and ED90 values are calculated.

Observation

PRACTICAL No.8

Field evaluation of chemicals against plant pathogens

Objective: Field evaluation of chemicals against plant pathogens

Material required

Tomato seeds, Difenconazole, Propiconazole, HexaconazoleAzoxystrobin, Picoxystrobin, Pyraciostrobin and Mancozeb, Knapsack sprayer, weighing balance, measuring cylinder, fertilizers, measuring tape, field tags.

Procedure

1. One month old tomato seedlings raised in nursery were transplanted to in a plot size of 3 x 2 m
2. Plant to plant spacing were kept 45 cm and row spacing was maintained of 60 cm the experiment was laid out in randomized block design with three replications
3. All recommended agronomic practices of the zone should be adapted
4. Fungicides are Difenconazole, Propiconazole, HexaconazoleAzoxystrobinn, Picoxystrobin, Pyraciostrobin and Mancozeb sprayed at recommended doses.
5. Untreated plot will serve as control for comparing the efficacy.
6. Fungicidal application should be done by Knapsack sprayer
7. Three sprays of fungicides were applied at regular intervals 15 days, 30 days and 45 days of the initiation of the disease
8. Data on the disease severity recorded after every fifteen days intervals of each spray
9. Five plants were selected randomly in each plot and observations on severity of the disease on the foliage was recorded using 0-5 scale of Horsefall and Barette, 1945.

Disease rating scale for the assessment of early blight of tomato

Scale	Description of the symptom
0	Leaves free from infection
1	Small irregular spots covering <5% leaf area
2	Small irregular brown spots with concentric rings covering 5.1-10% leaf area
3	Lesions enlarging, irregular brown with concentric rings covering 10.1-25% leaf area
4	Lesions coalease to form irregular and appears as a typical blight symptom covering 25.1-50% leaf area
5	Lesions coalease to form irregular and appears as a typical blight symptom covering >50% leaf area

10. Percent disease index (PDI) was calculated using formula of Wheeler (1969) as given below:

$$PDI = \frac{\text{Sum of all the numerical disease rating X 100}}{\text{Total No. of leaves observed X Maximum disease rating (5)}}$$

11. In the field experiments well mature and ripen tomato fruits are to be harvested regularly.
12. Record the fruit yield per plot and extrapolated to give the value of fruit yield in tons per hectare.

PRACTICAL No.9
Field evaluation of antibiotics against bacterial plant pathogens

Objective: Field evaluation of antibiotics against bacterial plant pathogens

Material required

Streptocycline, Bacterinol, sprayer, measuring cylinder, weighing balance, measuring tape.

Procedure

The antibiotics Streptocycline and Bacterinol, are to be evaluated at concentrations of 250 and 500 ppm *in vivo* against *X. axonopodispv. punicae*.

Design: RBD
Replications: Three
Total two sprays of all the treatments will be undertaken at an interval of 15 days, starting first spraying at first incidence of disease. One replication was maintained as unsprayed control without receiving any chemicals. Observation on leaf bacterial blight disease will be recorded and after each spraying and last observation on leaf bacterial blight to be recorded at 15 days after last spraying. Five trees per treatment per replication are to be selected randomly and tagged. Trifoliate leaves (bottom, middle and top) from main branch on each observation and per cent leaf bacterial blight disease recorded as per the scale mentioned in sampling methodology.

Based on numerical rating / scale observed, per cent disease index / intensity were worked out applying the formula given by Mckinney (1923).

$$PDI = \frac{\text{Summation of numerical rating}}{\text{No.of leaves /plant observed x Maximum rating}} X\ 100$$

Further per cent disease control (PDC) was worked out by formula.

$$PDC = \frac{\text{PDI in control plot} - \text{PDI in treatment plot}}{\text{PDI in control plot}} X\ 100$$

Observation

S. No.	Treatments	Conc. (ppm)	PDI* before spraying	PDI* after spraying		Mean PDI	PDC* after spraying		Mean PDC
				First	Second		First	Second	
1	Streptocycline	250							
2	Streptocycline	500							
3	Bacterinol	250							
4	Bacterinol	500							
5	Control	-							

PRACTICAL No.10

Field evaluation of bio agents against fungal/bacterial plant pathogens

Objective: Field evaluation of bio agents against fungal/bacterial plant pathogens

Material required

Pseudomonas fluoroscens and *Bacillus subtilis* culture, sprayer, measuring cylinder, weighing balance, measuring tape

Procedure

Two Bioagents namely *Pseudomonas fluoroscens* and *Bacillus subtilis*, will be evaluated*in vivo* against *X. axonopodis*pv. *punicae* at concentrations of 250 and 500 ppm.

Design: RBD

Replications: Three

Total two sprays of all the treatments will be undertaken at an interval of 15 days, starting first spraying at first incidence of disease. One replication was maintained as unsprayed control without receiving any bioagents. Observation on leaf bacterial blight disease will be recorded and after each spraying and last observation on leaf bacterial blight to be recorded at 15 days after last spraying. Five trees per treatment per replication are to be selected randomly and tagged. Trifoliate leaves (bottom, middle and top) from main branch on each observation and per cent leaf bacterial blight disease recorded as per the scale mentioned in sampling methodology.

Based on numerical rating / scale observed, per cent disease index / intensity were worked out applying the formula given by Mckinney (1923).

$$\text{PDI} = \frac{\text{Summation of numerical rating}}{\text{No. of leaves / plant observed x Maximum rating}} \text{X } 100$$

Further per cent disease control (PDC) was worked out by formula.

$$\text{PDC} = \frac{\text{PDI in control plot} - \text{PDI in treatment plot}}{\text{PDI in control plot}} \text{X } 100$$

Observation

S. No.	Treatments	Conc.(ppm)	PDI* before spraying	PDI* after spraying		Mean PDI	PDC* after spraying		Mean PDC
				First	Second		First	Second	
1	*Pseudomonas fluoroscens*	250							
2	*Pseudomonas fluoroscens*	500							
3	*Bacillus subtilis*	250							
4	*Bacillus subtilis*	500							
5	Control	-							

PRACTICAL No.11

Study of structural details of sprayers

Objective: Study of structural details of sprayers

Material required

Sprayer is a machine used to apply liquid chemicals on plants to control pest and diseases. It can also be used to apply herbicides to control weeds and to spray micro-nutrients to enhance plant growth

The main functions of a sprayer are

- Breaking the chemical solution in to fine droplets of effective size.
- Distributing the droplets uniformly over the plants.
- Applying the chemicals with sufficient pressure for positive reaching the plants
- Regulating the amount of liquid applied on plants to avoid excessive application.

Desirable quality of a sprayer

A good sprayer should possess the following qualities

- It should produce a steady stream of spray material in desired droplet size so that the plants to be treated may be covered uniformly.
- It should deliver the liquid at sufficient pressure so that the spray solution reaches all the foliage and spreads uniformly over the plant body.
- It should be light in weight yet sufficiently strong, easily workable and repairable.

TYPES OF SPRAYERS

Based up on the volume of liquid handled ,sprayers may be classified in to

1. High volume sprayer (more than 400 litres /ha)
2. Low volume sprayer (5 to 400 litres/ hectare)
3. Ultra low volume sprayer (ULV) spray (less than 5 litres /ha).

The selection technique depends up on type of vegetation, kind of pests and approach to the field.

BASIC COMPONENTS OF A SPRAYER

Components of a sprayer are as follows

a)Pump b) Chemical tank c) agitator d) Air chamber e) pressure gauge f) Pressure regulator g) valves h) Strainer i) suction line j) delivery line k) nozzles

Pump : A pump is a device used to move fluids, such as liquids or slurries, or gases from one place to another. A pump displaces a volume by physical or mechanical action. Most hydraulic sprayers are equipped with positive displacement pumps capable of developing pressure, required for many spraying jobs. The discharge capacity of these pumps is approximately proportional to the speed. A pressure relief valve or by-pass valve is required to protect these positive acting pumps from damage when the discharge line is closed and for the convenience of the operator.

Tank: It is the container to hold the chemical solution. It is made up of PVC, Brass, etc. It is usually made of metal sheet or synthetic rubber or plastic having good resistant quality against corrosion, erosion, and similar actions. The size of the tank varies according to the pump capacity and the requirements.

Agitator: It is the device which stirs the solution and keep the contents in homogenous condition. Positive agitation of spray material in the tank is essential to permit using the full range of spray materials including powdery emulsions,

fungicides, cold water paints or other spray material. The propeller or paddle type mechanical agitators or hydraulic agitators are very common.

Air chamber: In a reciprocating type pump, an air chamber is provided on the discharge line of the pump to level out the pulsations of the pump and thus providing a constant nozzle pressure.

Pressure gauge: It is a dial gauge which indicates the pressure at which the liquid is delivered from the pump.. A pressure gauge properly calibrated, within the pressure range of the pump is provided on the discharge line to guide the operator for making proper adjustment of the pressure at site.

Pressure regulator: The pressure regulator serves several important functions. It is the means of adjusting the pressure as required for any spray job within the pressure range of the pump. With the positive displacement type of pump, it also serves as a safety device in automatically unloading the excess pressure by directing the unused discharge flow from pump back to the tank.

Valves: A valve is a device that regulates the flow of a fluid (gases, liquids, fluidized solids, or slurries) by opening, closing, or partially obstructing various passageways.

Cut-off valve is provided in the delivery line to control the flow from the pump.

By-pass valve is provided in the delivery line to by-pass the flow from pump to tank when flow in delivery line is reduced than the pump capacity.

Relief valve - It is an automatic device to control the pressure of fluid or gas within a range a predetermined pressure.
Strainer : It is a small circular plastic ring with nylon wire mesh to filter any dust particle coming with the chemical solution It is included in the suction line between the chemical tank and the check valves. In some sprayers strainers are provided at the mouth of the chemical tank. Eg.Knapsack sprayers.

Nozzles : It is the component which breaks the fluid in to fine droplet . Automation of spray fluid is usually achieved by discharging the liquid through an orifice called nozzle under pressure. Atomization is also achieved by breaking up the jet of liquid with a blast of air.

Spray gun - It is a hand held metallic of PVC pipe to one end of which the nozzle is fitted and a flow cut off valve and a handle are fitted at the other end. The delivery hose is connected to the spray gun. It conducts the fluid from the delivery hose to the nozzle. The operator holds the gun and does the spraying job. Area of coverage by a spray gun is less compared to the coverage of a spray boom. Spray guns are used with low power sprayers E.g. Knapsack sprayers, rocker sprayer.

Spray boom - It is a long metallic or PVC pipe to which several nozzles are fitted with. The delivery hose is connected to the spray gun. High power and high capacity sprayers use spray booms. The coverage is larger compared to spray guns. Booms are usually mounted on suitable structures and used. E.g. Tractor operated sprayers, power tiller operated sprayers
Over-flow pipe - It is a conduit pipe through which excess fluid from a pump is by-passed in to chemical tank by the action of a relief valve or pressure regulator.

COMPONENTS A OF NOZZLE
Nozzle body - It is the main component which encloses all other components of a nozzle.

Swirl plate - It is metal disc with two tangential holes which imparts a swirl or rotation to the liquid passing through it.

Nozzle disc - It is the component which breaks the fluid in to fine droplet. It is a flat disc with an orifice at the centre. When the spray solution reaches the disc from the swirl plate the disc builds up further pressure on the fluid and when the fluid passes out of the orifice, it breaks in to fine droplets . The disc has a specific design to impart a hollow cone or solid cone or a flat fan type of discharge to the outgoing fluid.
The popular nozzles are a) hollow cone b) solid cone c) fan or flat type.

Strainer- It is a small circular plastic ring with nylon wire mesh to filter any dust particle coming with the chemical solution.

Spacer: There are two number of runner/ plastic rings placed in between nozzle plate and swirl plate and between swirl plate and strainer for effective travel of the solution.

Draw a well labelled diagram of given sprayer

PRACTICAL No.12

Study of structural details of dusters

Objective: Study of structural details of dusters

Material required

Duster is a machine used to apply chemicals in dust form. Dusters make use of air stream to carry pesticides in finely divided form on the plants.

Types of dusters

1. Plunger type
2. Knapsack type
3. Rotary type
4. Power operated duster

Plunger type - it is a simple duster with a small piston. The piston drives a current of air over the dust in the hopper. The dust is carried away through a delivery spout. Small hand pump dusters of this type are available and are suitable only where the area to be dusted is small like vegetable gardens

Knapsack type - It is a duster with the powder container carried on the back of the operator. Knapsack dusters have a hopper through which a current of air is blown to pick up the dust. The air current is produced by a lever operated leather bellows. Shoulder straps are used to carry in the field. These dusters are suitable for small areas.

Rotary duster – Hand rotary dusters are useful to apply chemicals which are in powder form. It consists of a hopper, a fan, gear box, handle, delivery hose and a deflector plate. When the handle is rotates the fan rotates at high speed and draws air from outside. The chemical from hopper is fed in to the air stream in the suction side of the fan. The chemical mixes with the air, passes through the delivery line and is applied on the plants. The rate of delivery can be regulated It is used to apply powdery chemicals to vegetables, sorghum etc. crops.

Power operated duster- Power operated duster mainly consists of a power driven fan, a hopper and a delivery spout. The fan creates strong air flow which causes the dust to blow off from the hopper to a considerable distance vertically or horizontally. Direction of dust is regulated by a movable spout suitably fitted with the unit. This type of dusters is used for large areas.

Arial duster or crop duster - an aircraft is used for dusting or spraying large acreages with pesticides. Aerial spraying and dusting permit prompt coverage of large areas at the moment when application of pesticide is most effective and avoid the need for wheeled vehicles that might damage crops. The technique was greatly improved in the 1960s with the development of ultra-low-volume applicators, in which concentrated pesticides are distributed in amounts as small as 1 ounce per acre (70 grams per hectare).

A duster essentially consists of

1. Hopper
2. Agitator
3. Feed control
4. Fan or blower
5. Delivery nozzle

Draw a well labelled diagram of given duster

PRACTICAL No.13

Physical methods of plant disease management

Objective: To study physical methods of plant disease management

Material required

Seed, vegetative propagative material

Principles of physical methods

This method includes soil solarization and hot water treatments.

i. Soil solarization: Soil solarization or slow soil pasteurization is the hydro/thermal soil heating accomplished by covering moist soil with polyethylene sheets as soil mulch during summer months for 4-6 weeks. Soil solarization was developed for the first time in Israel (Egley and Katan) for the management of plant pathogenic pests, diseases and weeds.

ii. Soil sterilization: Soil can be sterilized in green houses and sometimes in seed beds by aerated steam or hot water. At about 50^0 C, nematodes, some oomycetous fungi and other water molds are killed. At about 60 and 72^0 C, most of the plant pathogenic fungi and bacteria are killed. At about 82^0 C, most weeds, plant pathogenic bacteria and insects are killed. Heat tolerant weed seeds and some plant viruses, such as TMV are killed at or near the boiling point (95-100^0 C).

iii. Hot water or Hot air treatment: Hot water treatment or hat air treatment will prevent the seed borne and sett borne infectious diseases. Hot water treatment of certain seeds, bulbs and nursery stock is done to kill many pathogens present in or on the seed and other propagating materials. Hot water treatment is used for controlling sett borne diseases of sugarcane [whip smut, grassy shoot and red rot of sugarcane (52^0 C for 30 min)] and loose smut of wheat (52^0 C for 10 min).

Hot water treatment for managing loose smut of wheat

1. The wheat seed was treated in cheesecloth bags with ample room to allow for swelling of the grain.
2. A 250-liter tank, used for treatment, equipped with two motor-driven propellers which kept the water thoroughly agitated and at a uniform temperature.
3. Thermostatically controlled electric heaters were employed to maintain the temperature of the 10-minute bath, which was held at 54° C. in all cases with a plus or minus variationshould not exceed 0.2°C.
4. The wheat seed is
   (1) Presoaked for 4 to 5 hours in cold water,
   (2) Dipped momentarily in water at about 49°C,
   (3) Immersed in water at 54°C for 10 minutes.
5. Immediately after treatment the seed was spread in a thin layer to cool, and in order to reduce its moisture content to about that of the untreated seed, it was left to dry for 5 days or more at room temperature.

6. Soil-germination tests in the greenhouse were made by sowing 100 seeds per flat 1x2 feet.
7. Uniform spacing and depth of sowing were insured by pressing into the soil 100 one-inch pegs inserted in a board equidistantly.
8. The kernels were dropped into the holes so made and then covered.

PRACTICAL No.14

Soil Solarisation

Objective: To study effect of soil solarisation technique against soil borne plant pathogens

Material required

Plastic sheets, ultraviolet (UV)-resistant glue, thermometer

Principle

Soil solarization is a non-pesticidal method of controlling soilborne pests by placing plastic sheets on moist soil during periods of high ambient temperature. The plastic sheets allow the sun's radiant energy to be trapped in the soil, heating the upper levels. Solarization during the hot summer months can increase soil temperature to levels that kill many disease-causing organisms (pathogens), nematodes, and weed seed and seedlings. It leaves no toxic residues and can be easily used on a small or large scale. Soil solarization also improves soil structure and increases the availability of nitrogen (N) and other essential plant nutrients.

When clear polythene film is placed over moist soil during sunny summer days, the temperature at the top 5 cm of soil may reach as high as 52^{o}C compared to a maximum of 37^{o}C in unmulched soil.

If sunny weather continues for several days or weeks, the increased soil temperature from solar heat, known as solarization inactivates (or kills) many soilborne pathogens, viz., fungi, nematodes, and bacteria near soil surface, thereby reducing the inoculum and its potential for causing disease.

Procedure

Soil Preparation

Solarization is most effective when the plastic sheeting (tarp) is laid as close as possible to a smooth soil surface.

Preparation of the soil begins by disking, rototilling, or turning the soil by hand to break up clods and then smoothing the soil surface.

Remove any large rocks, weeds, or any other objects or debris that will raise or puncture the plastic.

Laying the Plastic

Plastic sheets may be laid by hand or machine.

The open edges of the plastic sheeting should be anchored to the soil by burying the edges in a shallow trench around the treated area.

Complete coverage

1. In complete coverage, plastic sheeting is laid down to form a continuous surface over the entire field or area to be planted.
2. The edges of the sheets may be joined with an ultraviolet (UV)-resistant glue or anchored by laying adjacent strips of plastic and burying both edges in soil.

3. Anchoring the edges in the soil may be more cost effective initially than gluing the edges together but may also result in untreated soil being close to subsequently planted crops.
4. The ends of the sheets should be held in place by burying them in the soil.
5. If beds are formed after complete coverage, care must be taken to avoid deep tillage that could bring untreated soil to the surface.
6. Complete coverage is recommended if the soil is heavily infested with pathogens, nematodes, or perennial weeds, since there is less chance of reinfestation by soil being moved to the plants through cultivation or furrow-applied irrigation water.

Strip coverage

1. In strip coverage, plastic is applied in strips over preformed beds. Strips should be a minimum of 30 inches (75 cm) wide; beds up to 5 feet (1.5 m) wide are preferred because several crop rows can be planted per bed.
2. In some cases, strip coverage may be more practical and economical than complete coverage because less plastic is needed and it is not necessary to join the edges of the plastic sheets together.
3. Strip coverage effectively kills most pests and eliminates the need for deep cultivation after solarization.
4. It is especially effective against weeds, since the furrows are cultivated.
5. With strip coverage, however, long term control of soil pathogens and nematodes may be lost because pests in the untreated soil in the rows between the strips can contaminate and reinfest treated areas.

Irrigation

1. Wet soil conducts heat better than dry soil and makes soil organisms more vulnerable to heat.
2. The soil under the plastic sheets must be saturated to at least 70 percent of field capacity in the upper layers and moist to depths of 24 inches (60 cm) for soil solarization to be effective.
3. Soil may be irrigated either before or after the plastic sheets are laid.
4. If the soil is irrigated beforehand, the plastic must be applied as soon as possible to avoid water loss; if heavy machinery is used to lay the plastic, however, the soil must be dry enough to avoid compaction.
5. If the soil is to be irrigated after the plastic is laid, one or more hose or pipe outlets may be installed under one end of the plastic; drip lines may be installed before the plastic is laid; or irrigation water may be run underneath the plastic in furrows or in the tracks made by tractor wheels if the plastic sheets were applied by machine.
6. Fields treated by strip coverage can be irrigated by drip lines on or in the bed.
7. The soil does not usually need to be irrigated again during solarization, although if the soil is very light and sandy, or if the soil moisture is less than 50 percent of field capacity, it may be necessary to irrigate a second time.
8. This will cool the soil, but because of the increased moisture the final temperatures will be greater.

Duration of Treatment

1. The plastic sheets should be left in place for 4 to 6 weeks to allow the soil to heat to the greatest depth possible.
2. To control the most resistant species, leave the plastic in place for 6 weeks.
3. There is little or no need to take the temperature of the soil.

4. The greatest concern is to solarize the soil during a period of high solar radiation with little wind or cloud cover.

Removal of the Plastic and Planting

1. After solarization is complete, the plastic may be removed before planting or, the plastic may be left on the soil as a mulch for the following crop by transplanting plants through the plastic.
2. Clear plastic may be painted white or silver to cool the soil and repel flying insect pests in the following crop.
3. A disadvantage of leaving the plastic on the soil is that it may degrade and be difficult to clean up.
4. Treated soil can be planted immediately or left fallow without the plastic until the next growing season.
5. If the soil must be cultivated for planting, the cultivation must be shallow-less than 2 inches (5 cm)-to avoid moving viable weed seed to the surface.

PRACTICAL No.15

Methods of soil fumigation under protected cultivation

Objective: Methods of soil fumigation under protected cultivation

Principle

Soil fumigation is a chemical control strategy used independently or in conjunction with cultural and physical control methods to reduce populations of soil organisms. Soil fumigants can effectively control soil-borne organisms, such as nematodes, fungi, bacteria, insects, weed seeds, and weeds. Some are pest-specific, while others are broad spectrum biocides and kill most soil organisms. Because of treatment costs, applicators use soil fumigants primarily on high value crops, such as vegetables, fruits, and ornamentals. Very careful attention must be paid to the details of how the fumigation is done in order to guarantee excellent control of the targeted organisms and complete safety for workers and other persons close to the treated area, while also limiting the impact the product could have on our environment

Types of Soil Fumigants

Soil fumigation uses pesticide formulations that volatilize from a liquid or solid into a gas state. Soil fumigants are applied to the soil as liquefied gases, volatile liquids, or granules. Due to the high volatility of these compounds, the fumigant must be incorporated into the soil during or immediately following application. At or shortly after application, these chemicals volatilize, allowing toxic molecules to move through the air pores in the soil. Soil pests are killed when they come in contact with a toxic concentration for a long enough exposure period. For all fumigants, enough concentration and contact time with target pests are required to obtain good results.

Methyl Bromide

Methyl bromide is a broad-spectrum fumigant that controls many weeds and soil-borne insects, nematodes, fungi, and bacteria. However, it does not adequately control all species. Methyl bromide is toxic to all stages of insect life. It is registered for use on a variety of crops, including ornamentals, vineyards, deciduous fruit and nuts, nursery sites, greenhouse soils, peppers, tomatoes, and strawberries.

Methyl Bromide and Chloropicrin Mixtures

Proprietary materials are available that contain both methyl bromide and chloropicrin. Such combinations are more effective than either material alone in controlling weeds, insects, nematodes, and soil-borne pathogens.

Metam Sodium

Metam sodium is recommended as a pre-planting treatment to control soil-borne pests that attack ornamentals and other crops. Do not apply to crops. It controls soil-borne fungal diseases (e.g., Fusarium, Pythium, Phytophthora, Sclerotinia, oak root fungus, Verticillium, clubroot of crucifers, and Rhizoctonia), nematodes, symphylids, and germinating weed seeds of annual grasses, chickweed, dandelion, ragweed, henbit, lamb's-quarters, pigweed, purslane and suppression of perennial weeds such as quackgrass.

Chloropicrin

Chloropicrin is a broad-spectrum fumigant that controls some soil-borne insects, fungi, and bacteria. It provides limited control of some weed seeds and nematodes. Although chloropicrin is often added to other fumigants in low concentrations

as a warning agent, it is also added at higher concentrations (up to 75%) to increase the overall spectrum of pest control. Chloropicrin is often formulated with methyl bromide, iodomethane, DMDS, and 1,3-D. It may be formulated as the sole active ingredient.

Methyl Iodide

The effectiveness of methyl iodide is similar to methyl bromide, rendering it a potential replacement. Methyl iodide offers broad-spectrum activity like methyl bromide, but there is not the concern on impacts to the ozone layer.

Dimethyl Disulfide

DMDS is toxic to some weeds, soilborne nematodes, bacteria, and fungi. DMDS is a widespread natural product and is labeled for use on vegetables (tomatoes, peppers, eggplants), cucurbit crops (cucumber, squash and melons), strawberries, blueberries, and field-grown ornamentals.

1,3-Dichloropropene

1,3-dichloropropene (1,3-D) provides nematode control, but does not provide broad spectrum weed control. The "C" formulations include chloropicrin for pathogen control.

Factors Influencing Soil Fumigation

Many factors affect soil fumigation and its effectiveness for pest control. The pest and its habits will affect fumigant selection, application rate, fumigant placement, and necessary length of exposure. Soil factors also play a key role in fumigation. Soil texture, soil condition, debris, soil moisture, and soil temperature may affect the volatility, movement, and availability of the fumigant once applied. Fumigant dosage is both pest- and soil-dependent. The following section discusses some of these factors in greater detail. After fumigation, aeration is important to make sure phytotoxicity does not occur.

Soil Texture

Soil texture influences fumigant movement and availability due to its effects on the amount of soil pore space (air spaces) and the number of adsorption (binding) sites. Fine-textured soils, such as clay, have many adsorption sites per unit area and many pore spaces.

Soil Tilth

Soil tilth is the physical condition of soil. It usually relates to the suitability of soil for planting or growing a crop. Factors include clods, moisture content, degree of aeration, rate of water infiltration, and drainage. The tilth of a soil can change rapidly, depending on environmental factors such as changes in moisture.

Soil Moisture

Soil moisture impacts the movement of a fumigant through the soil and off-gassing into the air. Improper soil moisture at the time of application can lead to poor control of target pests and could result in off-gassing. Soil moisture requirements vary depending on the fumigant. Additionally, these requirements may vary depending on a variety of factors, including soil texture, application method, and application depth.

Soil Temperature

Soil temperature correlates directly with fumigant volatility and movement. Soil temperature determines the fumigant state (solid, liquid or gas). As temperatures increase, fumigant volatility and diffusion increase.

Application Rates

Application rates depend on several factors. Higher pest densities and targeting multiple pest species may require using higher fumigant application rates noted on the label. Furthermore, certain difficult-to-control pests and those with high population densities require using the higher rates. Pest location is also important. For example, 1,3-D rates differ depending on whether the target pest is an insect, fungus, bacterium, or nematode, and even by species of organism.

Application Methods and Soil Sealing

Fumigants can be applied to soil in many different ways. The diverse chemical characteristics of soil fumigants largely determine how the products are applied. However, the application method is also determined by it formulation, the target pest, the cost and the area or site to be fumigated. (For example, fumigating a greenhouse soil versus fumigating a mound of potting soil.)

Shank or Spray Blade Application

For shank soil injection applications, knifelike blades called shanks or chisels are mounted vertically on a toolbar behind a tractor and pulled through the soil to deliver the fumigant. A tube carrying the fumigant runs down the back of each shank. Fumigant travels from the tank to the tubing through a pressurized system. Shank traces (the grooves the shanks make in the soil) are covered with soil.

Chemigation Application

Several fumigants can be applied through irrigation systems; however, some fumigants restrict their use only to drip irrigation (chloropicrin, iodomethane, DMDS, 1,3-D). To fumigate soil by chemigation, meter and inject a liquid fumigant into irrigation water. Fumigant chemigation is applied through several types of irrigation systems. Equipment includes an injection pump and nurse tank system.

Hot Gas Application

The hot gas, no-till application method is used for methyl bromide and chloropicrin mixtures. Heat the fumigant by passing it though a heat exchanger. Then, deliver it to the soil surface through a system of tubing or piping.

PRACTICAL No.16

Formulation of Agro-chemicals

Objective: To acquaint with different formulation of Agro-chemicals

Formulation is a mixture of the active and inert ingredients in the pesticide/fungicides. The active ingredients are the chemicals that affect the target pathogen. The inert ingredients are all other ingredients in the formulation. Inert ingredients are used to dilute the active ingredient or make it safer, easier to handle, and more effective. Some formulations are ready to use, others must be further diluted by air (air-blast sprayer), water, or a petroleum-based solvent. The **active ingredients** are the chemicals that affect the target pathogen. The **inert ingredients** are all other ingredients in the formulation. Inert ingredients are used to dilute the active ingredient or make it safer, easier to handle, and more effective. Some formulations are ready to use, others must be further diluted by air (air-blast sprayer), water, or a petroleum-based solvent.

Types of formulations:

I. Liquid Formulations

1. Emulsifiable Concentrates (EC or E) contains a liquid active ingredient, one or more petroleum-based solvents, and an agent that allows the product to be mixed with water to form an emulsion. An emulsion is a mixture of two or more liquids that are not soluble in one another. Each gallon of EC usually contains 25 to 75% (2 to 8-lbs) active ingredient. These are among the most versatile formulations and are adaptable to many application equipment types from small, portable sprayers to hydraulic sprayers, low volume ground sprayers, and mist blowers.

Advantages:

• Relatively easy to transport, handle, and store.

• Little agitation required (will not settle or separate when equipment is running).

• Non-abrasive.

• Does not plug nozzles or screens.

• Little visible residues on treated surfaces.

Disadvantages:

• Highly concentrated, making it easy to over- or under-dose by mixing and calibration errors.

• May cause phytotoxicity.

• Easily absorbed through skin.

• Solvents may damage rubber or plastic hoses, gaskets, pump parts, and metal or painted surfaces.

• Flammable – must be stored away from open flame or heat/ May be corrosive.

2. Solutions (S) – pesticide active ingredients that readily dissolve when mixed with a solvent such as water or a petroleum-based solvent. These formulations form a solution that will not settle out or separate once mixed.

- Solutions usually contain the active ingredient, the solvent, and one or more inert ingredients.

Advantages:

- Relatively easy to transport, handle, and store.

- Little agitation required (will not settle or separate when equipment is running).

Disadvantages:

- Easily absorbed through skin.

3. Concentrate solutions (C or LC) – Solutions sold as concentrates that must be further diluted with a liquid solvent. The solvent may be water but more often is refined oil or petroleum-based.

- **Advantages:**
- • No agitation needed.
- **Disadvantages:**
- • Less formulations of this type.
- Other advantages and disadvantages vary depending on the solvent used, the concentration of the active ingredient, and the type of application.

4. Flowables (F or L) –

Finely ground active ingredients (in this case, soluble solids) are mixed with liquid along with inert ingredients to form a suspension.

- A suspension is a substance that contains undissolved particles mixed throughout a liquid.
- Flowables are mixed with water for application and are similar to EC or WP formulations for ease of handling and use.

Advantages:

Seldom clogs nozzles.

Easy to handle and apply.

Disadvantages:

Requires moderate agitation to maintain solids in suspension.

May leave a visible residue.

II. Dry Formulations:

1. Dusts (D) – ready to use formulations containing a low percentage of active ingredient (0.5 to 10%), combined with a fine, dry inert carrier made from talc, chalk, clay, nut hulls, or volcanic ash. The size of the dust particle is variable. A few dust formulations are available as concentrates, containing a high percentage of active ingredient, which must be mixed with inert carriers before they are applied. Dusts easily drift onto non-target areas.

Advantages:

- Usually ready to use with no mixing involved.
- Effective where moisture from a spray may be harmful.
- Requires simple equipment.

Disadvantages:

- Easily drifts off target during application.
- May irritate eyes, nose, throat, and skin.

- Does not stick to surfaces as well as liquid formulations do.
- Difficult to achieve even distribution of particles on surfaces.

III. Granules (G) – similar to dust formulations except granules have larger and heavier particles. These coarse particles are composed of absorptive materials such as clay, corn cobs, or walnut shells. The active ingredient either coats the outside of the granules or is absorbed into them.

IV. Fumigant formulations used for storage of grains.

Role of stickers, spreaders and other adjuvants

Adjuvants:

Inert materials added to the spray material, to alter the size of the spray droplets. Non-ionic surfactants, crop oil concentrates, methylated seed oils, buffering agents, antifoam agents, drift control agents, and fertilizers.

Three primary adjuvant categories: surfactants, oil based adjuvants, and spray utility

A. Surfactants(spreaders, stickers, emulsifiers, wetting agents) increase surface contact, reduce runoff, and increase leaf penetration. Surfactants are activator agents that enhance fungicide performance.

i. **Safener:** A chemical which reduces the phytotoxicity of another chemical. Copper sulphate –lime, Glyceride

ii. **Spreaders:** A material which improves the contact between the fungicide and the sprayed surface. Eg. Mineral oils, glyceride oils and soap. Reduces surface tension and improves contact between the fluid and the sprayed surface so that the fluid does not collect into large drops and run-off easily

iii. **Stickers:** A substance added to spray or dust which improves its adherence to plant surfaces eg. Gum Arabic, dextrin, oils, Kaolin

B. Spray utility agents

Change the physical characteristics of the spray solution. Spray utility agents include buffering agents, and drift control agents.

i. **Buffering agents** are used to lower the spray solution pH to stabilize fungicide activity. Most fungicide activity is enhanced when the pH of the spray solution is between 4.0 and 6.5.

ii. **Drift control agents** (DRAs) are adjuvants labeled to minimize drift by increasing droplet size and reducing driftable fines.

Activity: Calculation and calibration of fungicides

I. When recommendations is in kg a.i./ha

1. **For WP, WG, dust etc. (solid forms)**

Parameters required

- area to spray
- concentration of a.i. in formulation
- recommended rate as kg a.i./ha

Formula: Kg of WG/WP/dust= $\frac{\text{Recommended rate x spray area (sq.m)}}{\text{concentration of a.i. in WG/WP/dust x100}}$

Q1. Calculate the quantity of Captan 50 WG to apply in the one-hectare area if the rate of application is 0.75kg (750 gm) a.i./ha.

Q2. Find out the quantity of Carbendazim 50WP to be sprayed in three (3) hectare area if rate of application is 3 kg a.i. /ha.

II. When recommendations is based on a.i.(%) in the spraying fluid/liquid

For wettable powders (when dilution with water)

Parameters required

- Spray volume in lt/ha
- Desired concentration as a.i.(%) in the spray
- Concentration in the commercial product (a.i.%)

$$WP = \frac{\text{ai \% desired x spray vol. (litre)}}{\text{ai \% in commercial WP}}$$

Q1. Calculate the amount of Indodil M-45 (50WP) @0.2% required to spray 1 hectare area

- Seed treatment Wt. of commercial material =Wt. of the chemical to be applied a.i

  % of a.i expressed as decimal

Q2. Calculate amount of Thiram @0.2% required for seed treatment of 8kg seeds.

PRACTICAL No.17

Methods of application of chemicals and bio control agents

Objective:

- To destroy the seed borne pathogens
- To protect against the soil in habiting fungi

Important terms:

1. *Seed disinfestation*: Disinfestation is the control of spores and other forms of disease organisms on the surface of seed.

2. *Seed disinfection*: Disinfection is the elimination of a pathogen that has penetrated into living cells of seed, infected it, and become established. The purpose of seed disinfection is to eradicate seed-infecting pathogens from the seed coat, the embryo, or both

3. *Seed protection*: The purpose of seed protection is to prevent seed rots and damping-off caused by soil-inhabiting fungi. Seed protection is the application of a chemical to protect seed from disease organisms in the soil.

1. Seed Treatment

A. Dry seed treatment: The required amount of seeds is mixed with the fungicidal powder 2hours before sowing.

B. Seed dip method*:* Preparing a suspension of fungicides in water in specific ratio and dipping the seed materials either dry seed or propagative part for recommended time.

2. Soil treatment

Objective: to eliminate the inoculums or reduce the inoculum to achieve disease control target.

Methods of Soil treatment with chemicals:

a. Soil drenching : Fungicides are commonly use as water solvent in specific concentration for spraying and applied to the soil surface either before or after sowing / plant emerge. The fungicides suspension is applied in recommended ratio with sprayer low volume pressure so that fungicides reach a depth up to 8-12 cm.

b. Broadcasting: Fungicides spread over the field with help of soil or fertilizer as buffer uniformly and mixture in soil with the help of farm equipment. This method consumes excess quantity of fungicides than the other methods.

c. Furrow application: This method requires much less amount of fungicides per hectare than the broad cast. In this method fungicides are applied either dust or liquid form at the time of sowing.

*For the control of disease caused root and basal part of the plant.

d. Fumigation: Application of fumigant chemical as fungicides used specially for nematode control and some of soil is habitant fungi. In this method, usually produce gas and inserted inside the soil by narrow pipe. This method is applied in very restricted area, where valuable crop will be grown. Methyl bromide is applied by this method.

3 Spraying: This is most applicable general method for spraying of fungicides on crops. Water is most commonly used as solvent with wettable powder fungicides. Spraying of this method was done by two way; first high volume i.e. power machine and second hand sprayer i.e low volume. These two term described the amount of liquid applied on crop.

4 Dusting : Dust are applied as dry powders for covering the host surface of leaves, fruit and stem of desirable plants. In this method dusting material will be applied when plant have some moisture by dew or fine rain. The dust component is diluted and sticked with a suitable carrier finally for better protective action.

PRACTICAL No.18

Mass multiplication and bio-formulation of bio-control agents

Objective: Mass multiplication and bio-formulation of bio-control agents

"Biological control of plant diseases may be defined as any condition or practice whereby survival or activity of a pathogen is reduced through the agency of any other living organism (except man itself), with the result that there is a reduction in the disease caused by the pathogen"

Characteristics of an ideal formulation

i) Should have increased shelf life.

ii) Should not be phytotoxic to the crop plants.

iii) Should tolerate adverse environmental conditions.

iv) Should be cost effective and should give reliable control of plant diseases.

v) Should dissolve well in water.

vi) Carriers must be cheap and readily available for formulation development.

vii) Should be compatible with other agrochemicals.

Model methods for the mass multiplication of bio-control agents are as follows:

i. Talc formulation :

*Trichoderma*is grown in the liquid medium is mixed with talc powder in the ratio of 1:2 and dried to 8% moisture under shade. The talc formulations of *Trichoderma*has shelf life of 3 to 4 months. It has become quite popular in India for management of several soil-borne diseases of various crops through seed treatment at 4 to 5 g/kg seed. Several private industries produce large quantities of talc formulations in India for supply to the farmers. The annual requirement of *Trichoderma*has been estimated as 5,000 tones to cover 50 per cent area in India.

ii. Vermiculite-wheat bran based formulation

Vermiculite is a hydrous phyllosilicate mineral. It undergoes significant expansion when heated. Exfoliation occurs when the mineral is heated sufficiently.

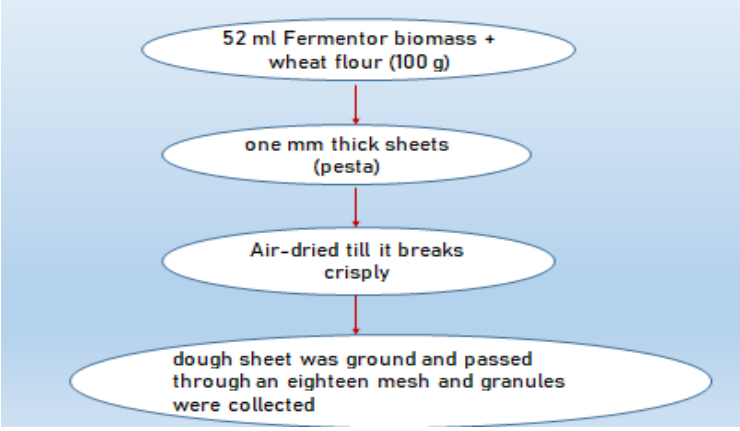
Medium: Culture on molasses-yeast medium for 10 days.

100 g vermiculite + 33 g wheat bran are sterilized in an oven at 70°C for 3 days.

+20 g of fermentor biomass + 0.05 N medium and concentrated or entire biomass with HCl are added, mixed well and dried in shade **(Lewis, 1991).**

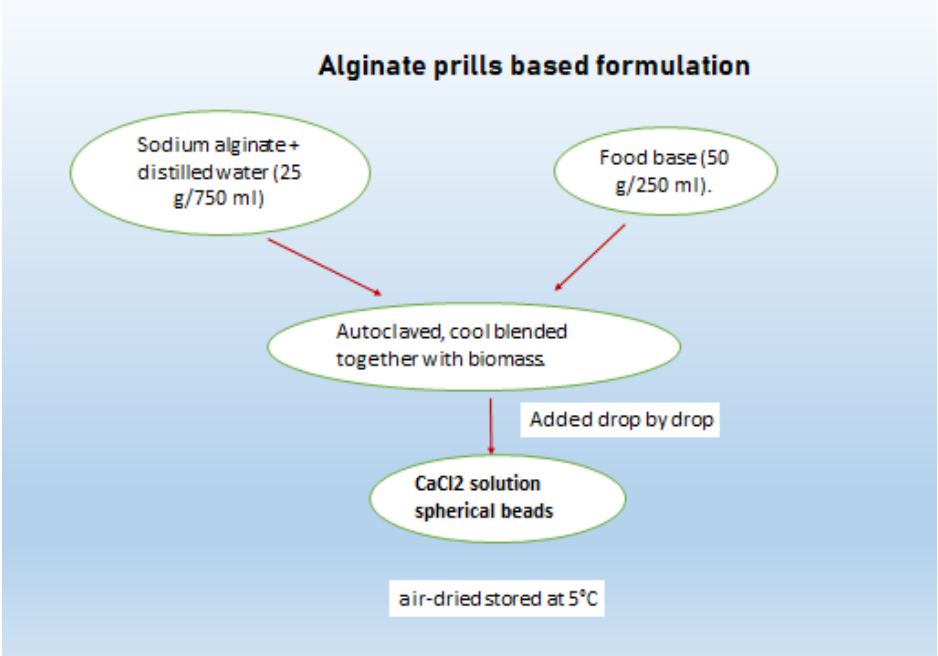
iii. Pesta granules based formulation

Pesta," a new granular product for use with entrapped biocontrol agents, is based on a cohesive dough made of wheat flour, fillers, and other additives**.**

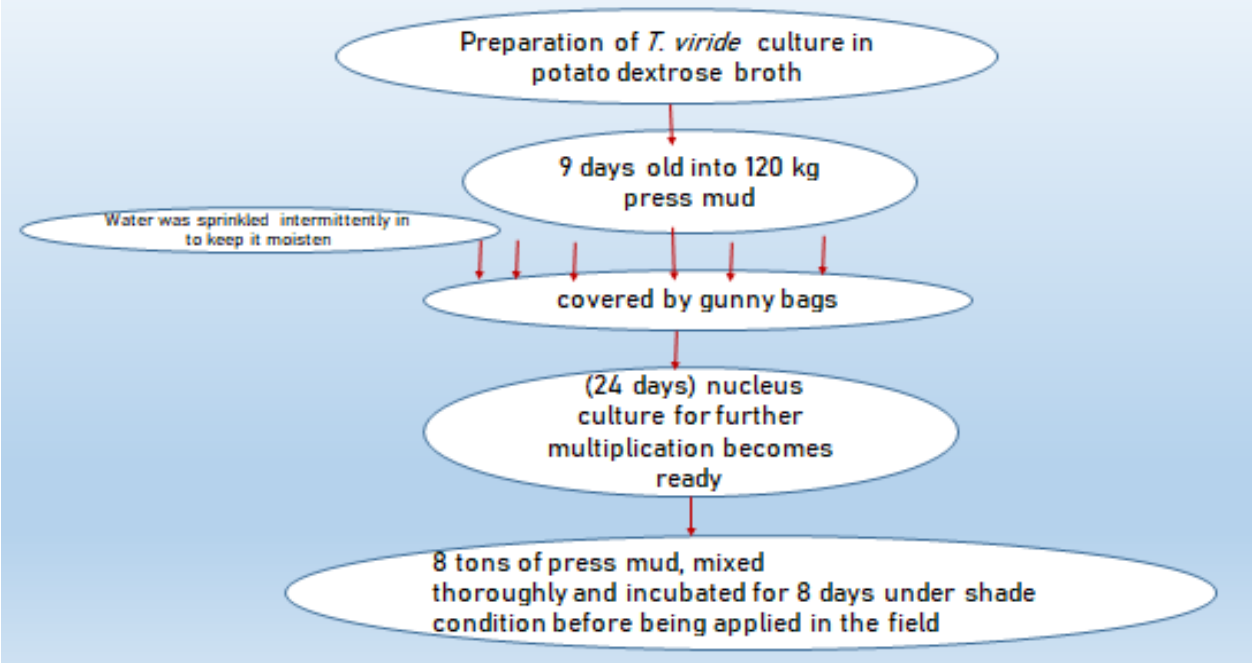


Pesta granules based formulation

iv. Alginate prills based formulation



v. Press mud is available as a byproduct of the sugar factory and this can be used as a substrate for mass multiplication of *Trichoderma*.



Oil-based formulations

Conidia harvested from the solid state/liquid state fermentation + Combination of vegetable/mineral oils in stable emulsion formulation. Microbial agents are suspended in a water immiscible solvent such as a petroleum fraction (diesel, mineral oils), and vegetable oils (groundnut etc.) with the aid of a surface active agent. This can be dispersed in water to form a stable emulsion. The oils used should not have toxicity to the fungal spores, plants, humans and animals.

Activity:

Set up an experiment using available substrate for mass multiplication of *Trichoderma asperellum* having bio-control potential and prepare Talcum- based formulation.