Sampling techniques for estimation of insect population and damage

Decision making is a key aspect of current integrated pest management (IPM) programs and will continue to play an important role as IPM programs mature. In an IPM context, decision making relies on protocols for deciding on the need for some management action based on an assessment of the state of a pest population (and ideally its natural enemies). These protocols, which we refer to as control decision, rules, consist of at least two components:

(a) a procedure for assessing the density of the pest population,

(b) an economic threshold.

Assessment of pest density usually requires obtaining actual counts of the pests, and therefore, sampling is important.

Insect sampling is usually conducted to collect population and diversity information about insect fauna of a particular area. Sampling insects requires knowledge of their biology, preferred habitats and activity patterns. It is almost impossible to collect all species of one particular taxonomic group with only one sampling technique, and it is also unlike to collect all of them even with several methods. As sampling is time consuming and expensive, one must know how to gather enough information about pest abundance to be able to make correct decisions without incurring excessive costs.

Pest survey:

An official procedure conducted over a defined period of time to determine the characteristics of a pest population or to determine which pest species occur in an area.

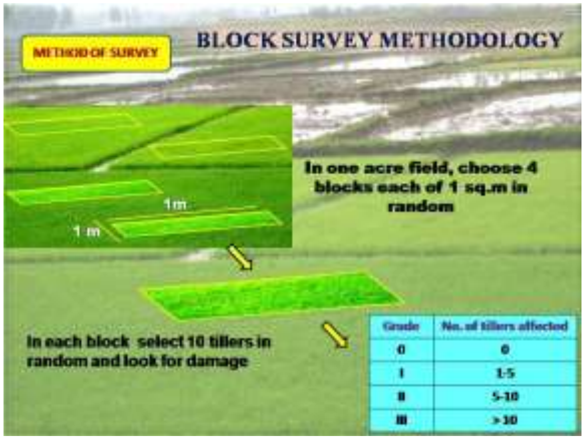
Two types of survey - Roving survey and fixed plot survey

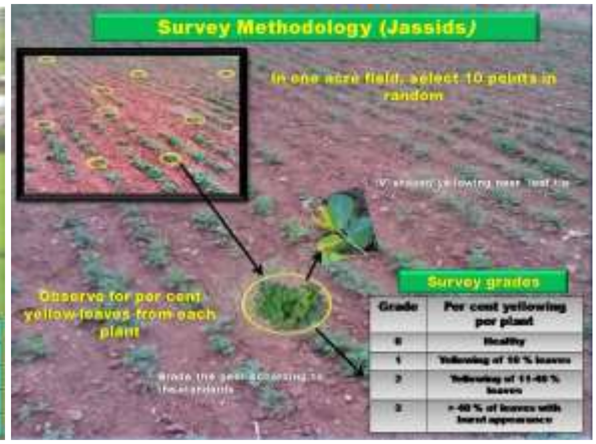
A. Roving survey

- ✓ Assessment of pest population/damage from randomly selected spots representing larger area.
- ✓ Large area surveyed in short period.

B. Fixed plot survey

- ✓ Assessment of pest population/damage from a fixed plots of a region.
- ✓ The data on pest population/damage recorded periodic from sowing till harvest.





Why Sampling?

- Make cost effective and environmentally sound insect management decision
- When (if) to apply control measures
- Avoid unnecessary treatments
- Avoid pest outbreaks/ yield loss
- Resistance management
- Apply the right control
- Determine population trends
- Determine effect of treatments

Sampling Techniques

Sampling of insects is often divided into two types; active sampling and passive sampling. Active sampling involves an active pursuit of the insects and can be done using methods such as visual observation and sweep netting. Passive collecting, on the other hand, is based on the movement of the insects towards a trapping device. Such sampling can be done with all kinds of continuous traps such as Malaise traps, pan traps, pitfall traps, fixed suction traps, sticky traps, light traps, and emergence traps. Such traps often have an attractant that attracts the insects to it.

Transect sampling and point sampling**:** In transect samples, the person taking the samples follows a predetermined sampling path and records the presence of all organisms that are to be counted within a fixed distance (i.e., 1 m, 5 m) on either side of a specified length of travel along the transect. Data is generally reported as the number of organisms per unit of ground surface, calculated as length traveled along the transect times lateral distance examined (i.e., If someone traveled 100 m along a transect and counted all ladybugs within 1 m on either side of the transect they would report data as the number per 200 m^2). In the related point sample technique, fixed sample sites are established and the person making the counts moves from site to site recording the numbers of organisms observed during a predetermined period of time (i.e., 5 min, 10 min) at each site. Sample sites should be chosen so that all habitat types within the study area are included. These data are reported as the number of organisms per unit observation time (i.e., number of butterflies per 15 min).

Components of an insect sampling program

1. Knowledge of pest and beneficial insects

•Identification: Ability to identify pest and beneficial insects. Should know what to count, whether it is a pest or beneficial? Which pest is it? What stage is it.

•Life cycle and biology: The life cycle and biology tells us when and where and how often to sample: narrows sampling effort

•Injury caused:

- ✓ Injury – The effect that the pest has on the crop or commodity.
- ✓ Damage – The effect that injury has on man's assessment of the crop's economic value.

2. Action/ economic thresholds

- ✓ Economic injury level: pest density that causes economically significant crop loss
- ✓ Economic (action) threshold: level at which pest should be treated to prevent it exceeding the EIL

3. Sampling/ monitoring plan or program

4. Sampling/ monitoring equipment supplies

How to sample

Do

- Walk a predetermined route that covers the entire field. Zig-zag or "W" shaped routes are good
- Make observations about field conditions while scouting
- We need to reliably estimate the actual density (e.g. pests per leaf). How do we find out? Count them all?
- We have to estimate the density by sampling a only portion of the population
- Estimate the density by sampling a only portion of the population
- Consider separate samples from field edges and "hot spots"
- Take separate samples for units (fields/blocks) managed differently
    - ✓ Different fertilization
    - ✓ Different varieties
    - ✓ Different irrigation
    - ✓ Different ages

- ✓ Different previous crops

Do Not

- Don’t sample from plants that are obviously more or less healthy than the field generally
- Don’t consistently sample from leaves/areas within easy reach

Sample: A representative of the “Whole”

- Samples should be unbiased, representative of the area (field/block) being sampled
- Sampling only from areas showing damage gives estimates higher than actual mean
- Sampling only from undamaged areas gives estimates lower than actual mean
- Each sample unit should have an equal chance of being selected

Sample vs. subsample

Sample unit (subsample): The individual unit from which insects are counted

Example: Single leaf, Stem, Shoot or branch, Fruits, Sweeps of an area, Beat board and Trap

Sample: All of the sample units (subsamples) are collected to estimate the population density of pest or beneficial insects or mites in a field or portion of a field

Sample vs. sample unit

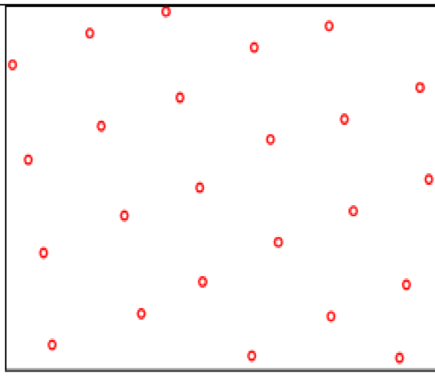
Sample size: The number of sample units (subsamples) per sample. It differs with nature of pest and crop. Larger sample size gives accurate results.

Example:

- 10 leaves per vine from each of 20 vines, Sample size =200,
- 5 sweeps per site from each of 5 sites : Sample size =25

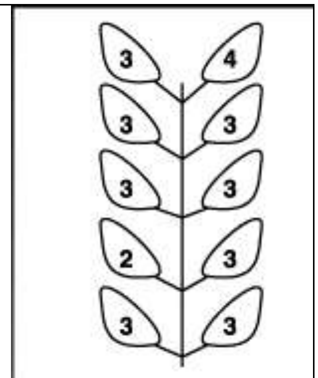
Always sample from more than one tree, vine, area per field or block

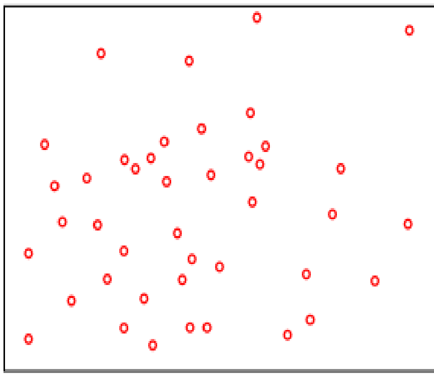
Possible Insect distributions in fields or on plants



Uniform
Mean>> variance Mean
Few samples needed: rare

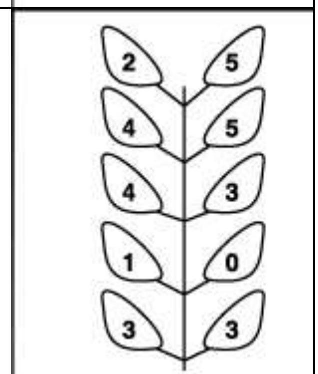
Mean=3
Variance: 0.6

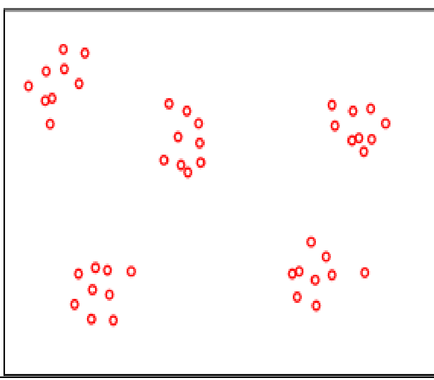




Random
Mean≈variance
Many samples needed: uncommon

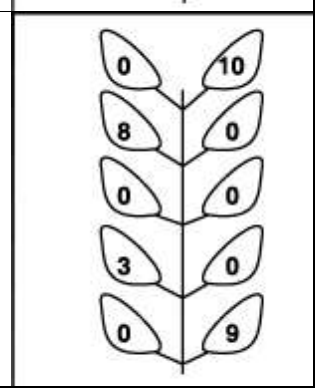
Mean= 3
Variance= 2.6





Clumped
Mean<< variance
Very many samples needed: common

Mean=3
Variance= 18.2



Details information is needed about the mean to variance relationship is required to know the number of samples need to be taken

- It changes with each pest and crop combination
- It changes as density increases for each pest
- It changes for different stages of same pest

Sampling Plans

Most sampling plans use a fixed number of samples to provide a conservative estimate of the mean. Mean to variance relationship can also be used to develop sampling plans that don't rely directly on the sample mean.

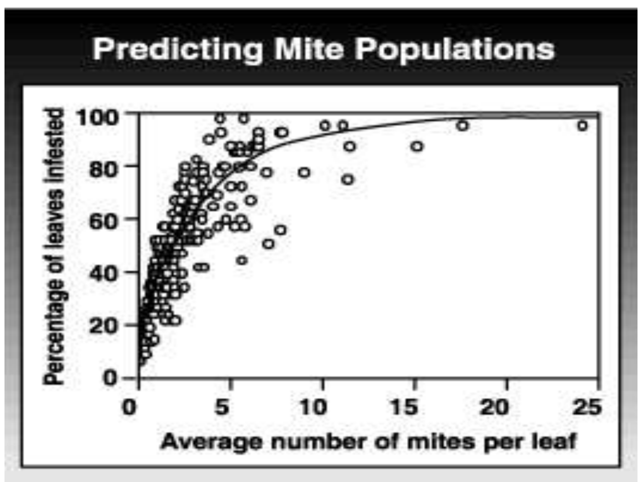
1. Presence-absence (binomial) sampling plans

2. Sequential sampling plans

1. Presence absence (binomial) sampling

In this case we can tally the number of leaves infested instead of counting pests (% infested leaves can provide an accurate estimate of the mean)

• It gives a relationship between the percentage of infested sampling units (e.g. leaves) at different pest densities. Estimate becomes unreliable when infestations are high (≥ 80%)



Example :

- ✓ Consider the case of European red mite in apple
- ✓ Examine 5 leaves from each of 10 trees per block
- ✓ Sum the number of infested and un infested leaves from each tree
- ✓ Calculate the % infested leaves in the entire sample (27/50)*100 = 54%
- ✓ Read estimated density from table

Binomial (Presence-Absence) Sampling Scheme for European Red Mite

% of mite-infested leaves	Estimated density (mites/leaf)	95% confidence interval lower	95% confidence interval upper
40	0.7	0.25	1.20
45	0.9	0.35	1.45
50	1.1	0.45	1.75
55	1.3	0.60	2.13
60	1.6	0.80	2.65
65	2.0	1.05	3.25
70	2.6	1.35	4.10
75	3.4	1.85	5.35
80	4.7	2.55	7.25
85	6.8	3.85	10.55
90	11.4	6.50	17.55
95	26.4	15.30	40.30

Choose 5 to 10 leaves from 5 to 10 trees scattered throughout a block. Scan the leaves with a hand lens to determine whether or not mites are present. Keep track of the total number of leaves scanned, and the total number of leaves infested by one or more mites. Divide the number infested by the total number scanned and multiply by 100 to calculate the percentage of infested leaves. Use the nearest value from the first column of the table above and read across to obtain the estimated number of mites per leaf for the orchard block.

EXAMPLE

Tree	Infested leaves	Uninfested leaves
1	||	|||
2	|	||||
3	|||	||
4	||	|||
5	||||	|
6	|||	||
7	|	||||
8	卌	0
9	卌	0
10	|	||||
Total	27 +	23 = 50

Keep a tally sheet of infested and non-infested leaves, similar to the one above, as you go through the orchard. For example, you find 27 infested leaves and 23 uninfested leaves, for a total of 50 leaves. Divide 27 (the number of infested leaves) by 50, which is 0.54. Then multiply by 100 to obtain the percentage of infested leaves, which is 54 percent. According to the table, 54 percent infested leaves is equivalent to 1.3 mites per leaf.

From the *Tree Fruit Production Guide 1992-1993*, Penn State College of Agricultural Sciences

2. Sequential sampling

In sequential sampling, a sequence of one or more samples is taken from a group. Once the group has been sampled, a hypothesis test is performed to see if you can reach a conclusion. If you can't, the whole procedure is repeated. A characteristic feature of sequential sampling is that **the** sample size **is not set in advance,** because you don't know at the outset how many times you'll be repeating the process.
Sequential sampling is often used in fields like Integrated Pest Management.

This method is designed for two clear choices. For example:

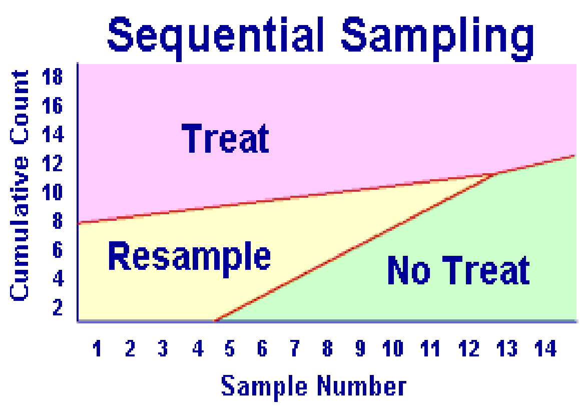
- Is the density of pests is below or above a critical level? Stop sampling if the density is above critical level as well as below critical level. If it is close to the critical level, but not over it, continue sampling if more samples are needed to make decision.
- Pesticide spray should be done or not: Pests could be counted on a plant. If there are a large number of pests, spray pesticide. If there are a small number of pests, do not spray pesticide. If there are a middling number of pests, sample another plant.

Sequential samples can either be:

- *Item-by-item*: One sample at a time.
- *Group*: Sample sizes of two or more.

With traditional sampling methods, a hypothesis test has one of two possible results: you either reject the null hypothesis, or you do not. With sequential sampling, one will have *three* possibilities:

1. Reject the null hypothesis (end the experiment),
2. Do not reject the null hypothesis (end the experiment),
3. Fail to draw any conclusion (draw another sample and repeat the test).



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Sequential sampling example: *Campylomma* plant bugs in apple

- Minimum sample: 10 samples per block
- Maximum sample: 50 samples per block
- Alternative fixed sample plan: 20 samples per block

Sequential Sampling Plan for Campylomma

Red Delicious (threshold 4 per tap)

Total taps	Cumulative no. of nymphs Upper	Cumulative no. of nymphs Lower
10	53	27
11	58	30
12	62	34
13	67	37
14	71	41
15	76	44
16	80	48
17	85	51
18	89	55
19	94	58
20	98	62
21	103	65
22	107	69
23	112	72
24	116	76
25	121	79
26	125	83
27	129	87
28	134	90
29	138	94
30	143	97
31	147	101
32	151	105
33	156	108
34	160	112
35	164	116
36	169	119
37	173	123
38	177	127
39	182	130
40	186	134
41	190	138
42	195	141
43	199	145
44	203	149
45	208	152
46	212	156
47	216	160
48	221	163
49	225	167
50	229	171

Golden Delicious (threshold 1 per tap)

Total taps	Cumulative no. of nymphs Upper	Cumulative no. of nymphs Lower
10	15	5
11	17	5
12	18	6
13	19	7
14	20	8
15	21	9
16	23	9
17	24	10
18	25	11
19	26	12
20	27	13
21	29	13
22	30	14
23	31	15
24	32	16
25	33	17
26	34	18
27	36	18
28	37	19
29	38	20
30	39	21
31	40	22
32	41	23
33	43	23
34	44	24
35	45	25
36	46	26
37	47	27
38	48	28
39	49	29
40	51	29
41	52	30
42	53	31
43	54	32
44	55	33
45	56	34
46	57	35
47	58	36
48	60	36
49	61	37
50	62	38

To use the chart, take a minimum of 10 taps. If the total number of nymphs is above the upper limit, control is warranted. If the number is below the lower limit, no control is needed and sampling may be discontinued. If the number lies between the two limits, continue sampling. If 50 taps are taken and no decision is reached, sample again in 5 to 7 days.

Plan developed for 90% confidence interval, 1st generation nymphs, in a 1.2 acre block of a conventionally managed commercial orchard (H.M.A. Thistlewood. 1989. Environmental Entomology 18(3):398).

Methods of sampling

A. In situ counts - Visual observation on number of insects on plant canopy (either entire plot or randomly selected plot)

B. Knock down - Collecting insects from an area by removing from crop and (Sudden trap) counting (Jarring)

C. Netting - Use of sweep net for hoppers, odonates, grasshopper

D. Narcotised collection - Quick moving insects are anaesthetized and counted

E. Trapping –

1. Pitfall traps
2. Malaise traps
3. Flight interception traps (also called Barrier traps)
4. Lindgren funnel traps
5. Bait traps (various types)
6. Japanese beetle traps
7. Blacklight traps
8. Pan traps
9. Berlese Funnel
10. Light trap - Phototropic insects
11. Pheromone trap - Species specific
12. Sticky trap - Sucking insects
13. Emergence trap - For soil insects

F. Crop samples: Plant parts removed and pest counted e.g. Bollworms

Classification of Insecticide on the basis of Toxicity

(As per The Insecticides Act, 1968 and Insecticides Rules, 1971)

Level of Toxicity	**LD_{50} (Oral, Rat) mg/Kg body weight**	**LD_{50} (Dermal, Rat) mg/Kg body weight**	**Level mentioned on the Bottle/Packet of Pesticides**	**General Example**
Extremely Toxic	1-50	1-200	 Colour: Bright Red	Monocrotophos Methyl Parathion Aluminium Phosphide Zinc Phosphide
Highly Toxic	51-500	201-2000	 Colour: Bright Yellow	Chlorpyriphos Imidacloprid Cypermethrin Fipronil
Moderately Toxic	501-5000	2001-20000	 Colour: Bright Blue	Carbaryl Malathion Permethrin Dicofol
Slightly Toxic	>5000	>20000	 Colour: Bright Green	Allethrin Prallethrin Azadirachtin *Bacillus thuringiensis -Bt*

Insecticides & their Formulation

- Insecticides can exist in three forms: **Pure Form**, **Technical Form** and **Formulation.** The pure form is synthesised by the scientists working in laboratories for the purpose of analytical and toxicological studies. The technical form refers to the toxicant manufactured in bulk after the laboratory test is over with a positive and satisfactory result. After the commercial manufacture of insecticide is completed, various additives are used to prepare the formualtion of insecticide.
- Formulation of insecticides have some certain advantages over the other forms. These are – easy to use, even to apply, less toxic, targeted application, extra potentiality, extra shelf life & cheap.
- That is why the scientists are more interested to study about **Insecticide Formulation** rather than **Pure Form** & **Technical Form**.
- **Diluents** are used here to lessen the density of active ingredient of the insecticide. They are **Filler/Carrier** when the ingredients are solid & **Solvent** when the ingredients are liquid.
- Add to these there are **SAA** (Surface Active Agents) like **Wetting/Dispersing/Suspending Agents/Emulsifying Agents (=Emulsifiers)**, **Stabilizer**, **Maskers/Deodorants** which are added for specific purposes.
- Insecticide Formulation are of 3 types: **Solid, Liquid & Gaseous**. There are many types of formulation under them. But only the important and commonly used are being given below. These are as follows:
- **Solid**:

(1) Powder for Dusting: **DP**
(2) Granular : **G** or **GR** and Encapsulated Granule: **CG**
(3) Wettable Powder: **WP**
Water Soluble Powder or Soluble Powder: **WSP** or **SP**
Water Dispersible Powder: **WDP**
(4) Tablet: **Tab**
(5) Others:
Water Dispersible Granule: **WDG** or **WG**
Bait: **B**
Concentrated Bait: **CB**
Ready to Use Bait: **RB**

- **Liquid**:

(1) Emulsifiable Concentrate: **EC**
(2) Soluble Liquid: **SL**
(3) Suspension Concentrate: **SC**
(4) Flowable Concentrate: **FC**
(5) Ultra Low Volume or Ultra Liquid Concentrate: **ULV** or **ULC**
(6) Aerosol: **Asr**
(7) Others:
Liquid: **L**
Solution: **Sol**
Flowable Concentrate for Seed Treatment: **FS**

- **Gaseous**: Under this only one formulation is availbale which is Fumigant: **F**

Formulation & Use of Some Important Insecticides

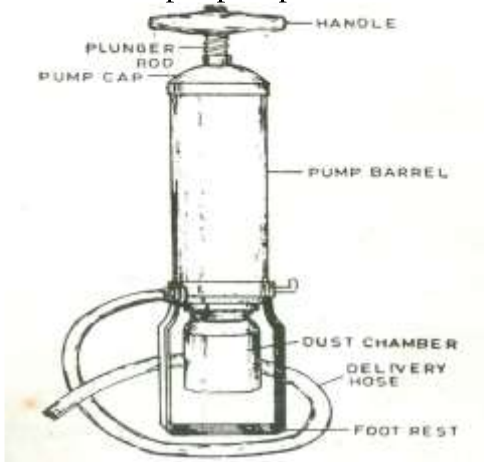
Sl. No.	Chemical Name of Insecticide(s)	Trade Name of Insecticide(s)	Formulation (with % of a.i.)	Name of the pests controlled/salient features of the insecticide(s)
1.	Cartap Hydrochloride	Padan, Fast, Kritap, Patap etc.	50% SP	Inseticide of animal origin. Nereistoxin analogue. Contact & Stomach poison.
2.	Chlorpyriphos	Strike, Dursban, Nuchlor, Durmet etc.	20% EC	Contact & Stomach Poison. Soil insecticide, i.e. popularly used to control soil inhabitants like Termites.
3.	Methyl Parathion	Metacid 50, Paratox, Metpar etc.	50% EC	Contact & Stomach poison. Quick knock-down effect. Destructive for Honey Bee if acts as pollinator. Banned in case of Fruits & Vegetables.
4.	Carbaryl	Sevin, Agrovin, Parivin, Dhanuvin etc.	50% WDP	Contact & Stomach poison. Not to use during initiation of blooming of flowers. Used popularly against ectoparsites of cattle like ticks, lice etc.
5.	Cypermethrin	Ustad, Cypervip, Cymbush, Cyperkill etc.	10% EC	Mainly Contact Poison. Synthetic Pyrethroid insecticide. Quick knock-down effect. Destructive for bio-control agents, Honey Bee & Fish.
6.	Profenophos	Carina, Profex, Profos, Prefer etc.	50% EC	Contact & Stomach poison. Shows ovicidal effect & acts as antifeedant. Acts effectively against Lepidopteran pests.
7.	Fipronil	Regent, Refree, Getter etc.	5% SC	Systemic+ Contact+ Stomach poison. Phenyl Pyrazole insecticide.
8.	Imidacloprid	Confidor, Tatamida, Anumida etc.	17.8% SL	Chloro-nicotinyl insecticide. Systemic poison. Used for seed treatment as well as soil insecticide.

Insecticide Appliances and their different types

Insecticide appliances are essential for the following reasons – (a) To avoid the wastage of the insecticides (b) to spread the insecticide particle evenly over the target/foliar surface (c) to minimise the involvement of time and labour and (d) to reach to every target irrespsective of its height/distance ; e.g. tall trees.
These appliances are of 2 types – (1) Duster (for spraying of Dust/Solid formulation of insecticide) & (2) Sprayer (for spraying of solution/emulsion/suspension or any liquid formulation).
Functionally these are only with a simple difference – the dusters work through air blast whereas the sprayers work through air blasts and hydraulic force.
Both of them are composed of five basic units with some differences in their construction. These are as follows – (a) Driving force is blower/fan in duster whereas blower/fan and pump both in sprayer. (b) Container is called hopper in duster whereas Container is called tank in sprayer. (c) Both are provided with Agitator or a stirring device to prevent caking in dust formulations or sedimentation in spray liquids. (d) A delivery or discharge tube is there to guide the formulations out of the appliances. (e) A nozzle fixed at the end of the delivery tube to break or atomize the formulations into proper sized particles or droplets.
Apart from these there are several accessories like – Strainers to filter the spray liquids Valves to maintain the flow in one direction Pressure or air chamber to allow a continuous flow Spray lance to regulate the discharge of the flow Boom to increase the number of nozzles .

(A) Hand operated dusters are, again, of the following types –

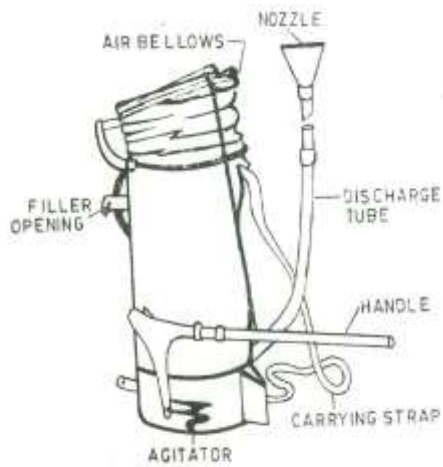
(1)Plunger type duster: This is a simple pump to which a dust chamber is connected. It is used for dusting



Plunger Duster

the kitchen gardens, poultry houses, cattle sheds etc. It helps in fumigation of the burrows of rodents.

(a) Bellows Duster: Works with the force of air taking help of a bellow.



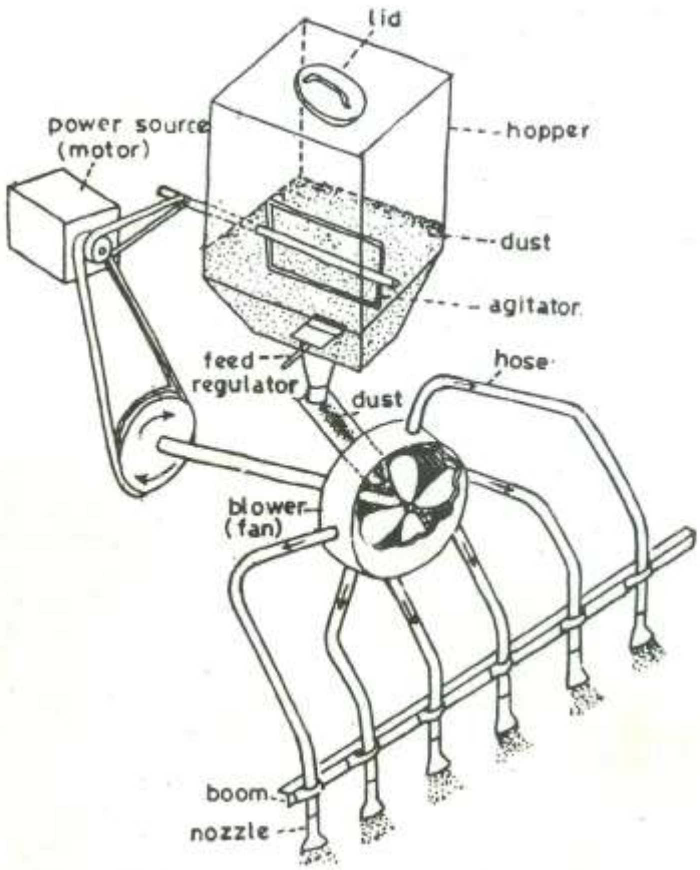
These are generally used for dopmestic purposes or for kitchen garden.

(b) Rotary or Crank duster: This duster is operated with the help of slow rotation of a handle or crank attached to the blower (fan) enclosed in a box.

These are useful for treating small acerage and row crops like potato, tobacco, cotton etc.

(ii) Power operated duster:

These dusters are attached with a petrol-driven motor . The blower present inside produces the blast of the air which carries the dust particles to the delivery tube and expelled out through the nozzle.

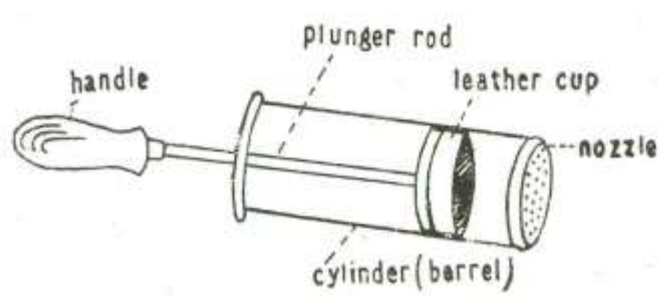


- Sprayers are of 2 types just like duster: (1) Hand operated and (2) Power operated. Again the Hand operated sprayers are divided in the following three -

(a) Hydraulic: Exults pressure through a piston to force the spray liquid out of the sprayer.
(b) Pneumatic/compression: Creates compression of a layer of air through a plunger that ultimately presses the insecticide particles to be ejected.
(c) Air blast: Forces the liquid out with the help of a air blast.

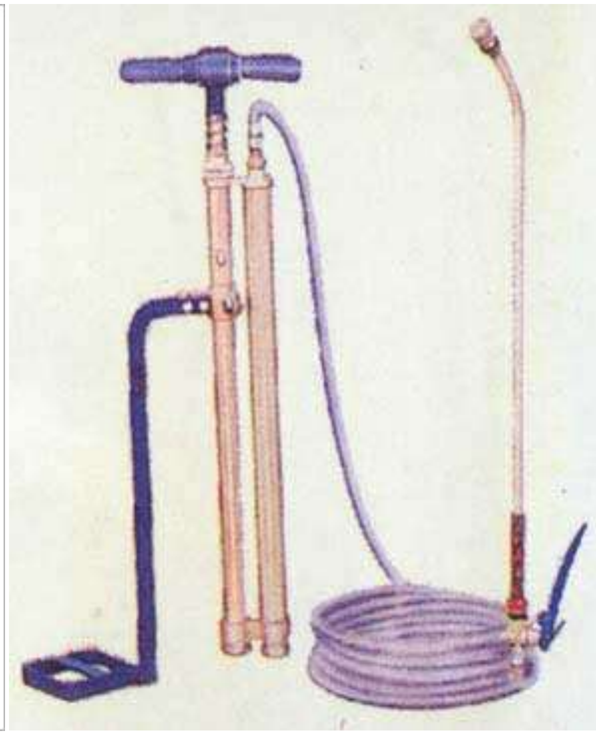
(a) Hydraulic sprayers are again classified under the following –

(i) Syringes/ Syringe spryer: The simplest hydraulic sprayers consisting of a cylinder and a plunger.



These are suitable only for household gardens, flower beds and kitchen garden.

(ii) Bucket/Stirrup pump sprayers: These are composed of a plunger with a handle (D or T shaped)



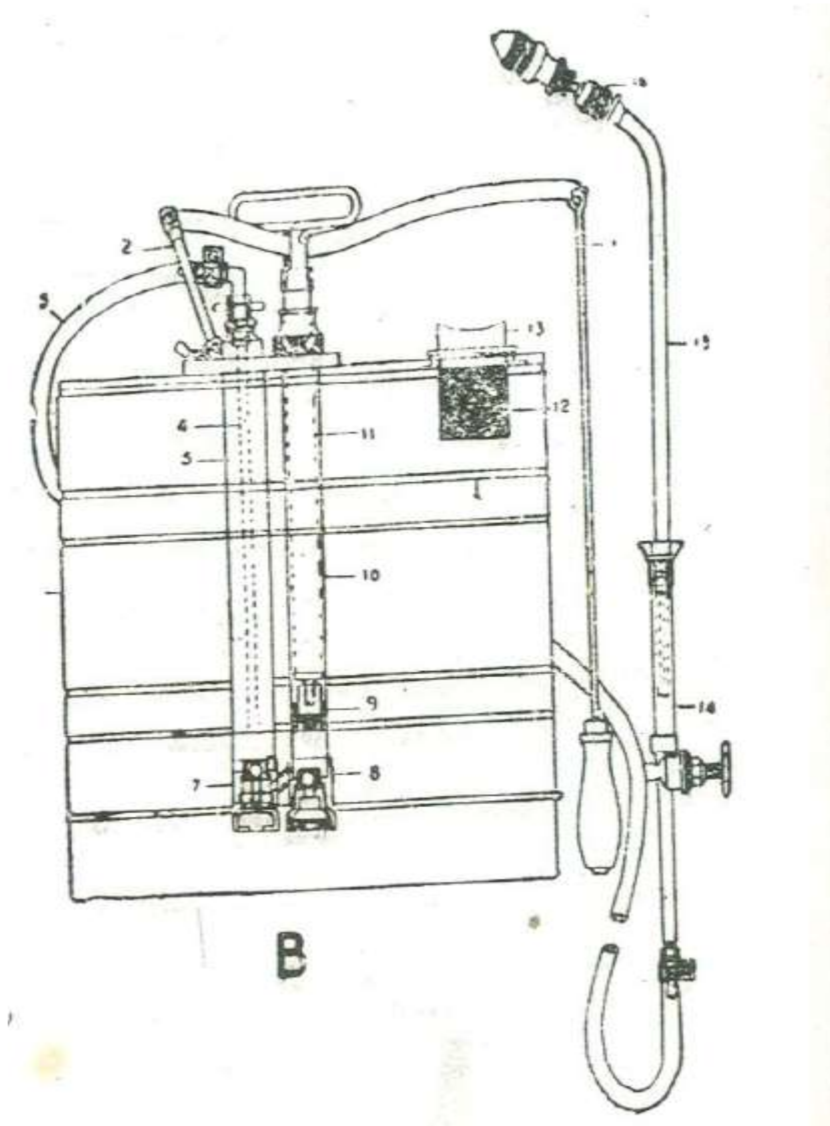
One or two cylinders, a stirrup and a footrest. Invovement of two persons are neede for this type of sprayers. These are suitable for spraying shrubs, low crops and nurseries.

(iii) Hydraulic Knapsack Sprayer:

This is the most commonly used sprayer in the farmers' field. The important parts of this sprayer are as follows:

(a)	Filter-hole cap: Covers the spray liquid so that the sprayer remain in a air tight condition.
(b)	Strainer: Strains the unwanted dirty particles to enter the spray liquid.
(c)	Tank: Spray material remains inside this part.
(d)	Pressure chamber: Here the pressure of the spray liquid is maintained (increases/decreases) accordingly.
(e)	Delivery tube: The liquid prepares to exit after it is forced by the hydraulic pressure.
(f)	Agitator: It prevents the active ingredients to form a cake.
(g)	Delivery-valve assembly: Combination of valves to ease the delivery of the liquid.
(h)	Pump lever: A handle (=lever) that helps in pumping to increase the hydraulic pressure.

(i) Delivery hose: The pipelike structure through which the liquid is ejected from the tank.



(j) Extension rod: It is made for easy flow of the spray liquid upto the nozzle.

(k) Nozzle: It atomizes the spray fluid into the proper-sized droplets and regulates the discharge of the spray per unit time at a known pressure.

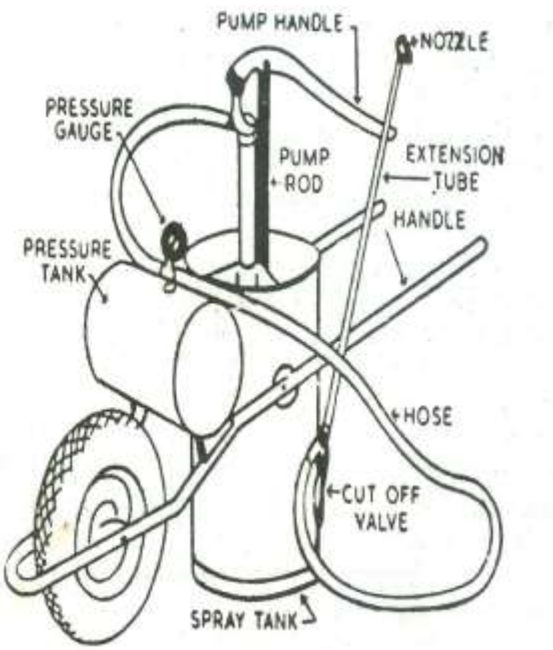
(iv) Foot/pedal pump sprayer: The piston of this sprayer is operated by foot. The pump can spray

upto a height of 20 ft. The pump is suitable for spraying trees in the orchards.

(v) Rocker Sprayer: This sprayer functions like foot sprayers, but the piston is connected to a lever instead of a pedal. It is more easy to access.

The use is same like the foot sprayer.

(vi) Wheelbarrow Sprayer: This is a modified rocker or pedal pump sprayer where either of these two are mounted on a trolley provided with a tank.



The operator is relieved from carrying the weight of the machine here.

(b) Pneumatic/Compression sprayer:
(i) Pneumatic hand sprayer: These are kept partly empty to provide space for development of air pressure.

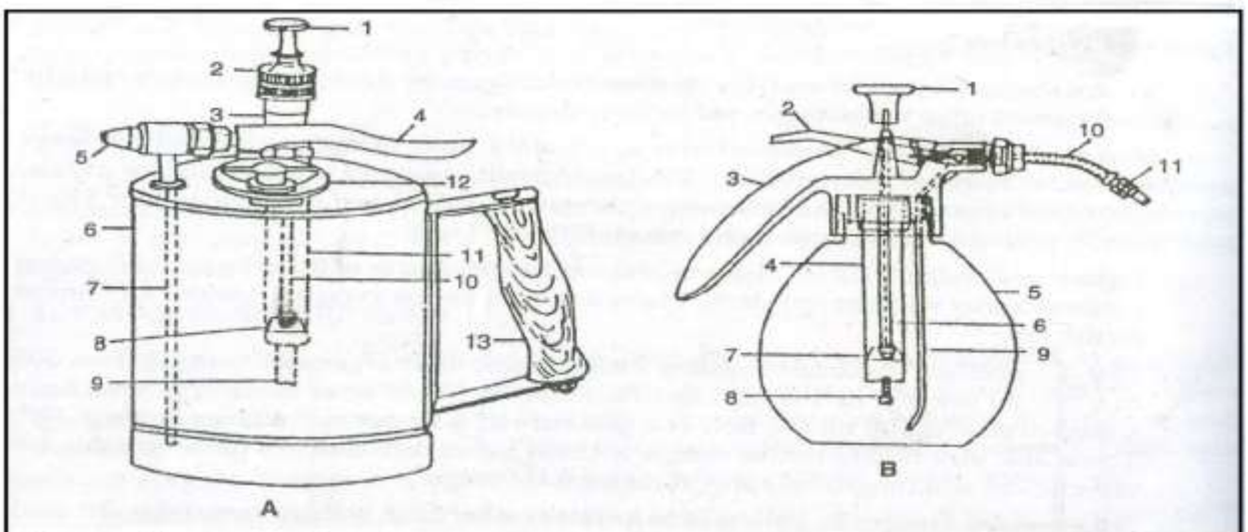
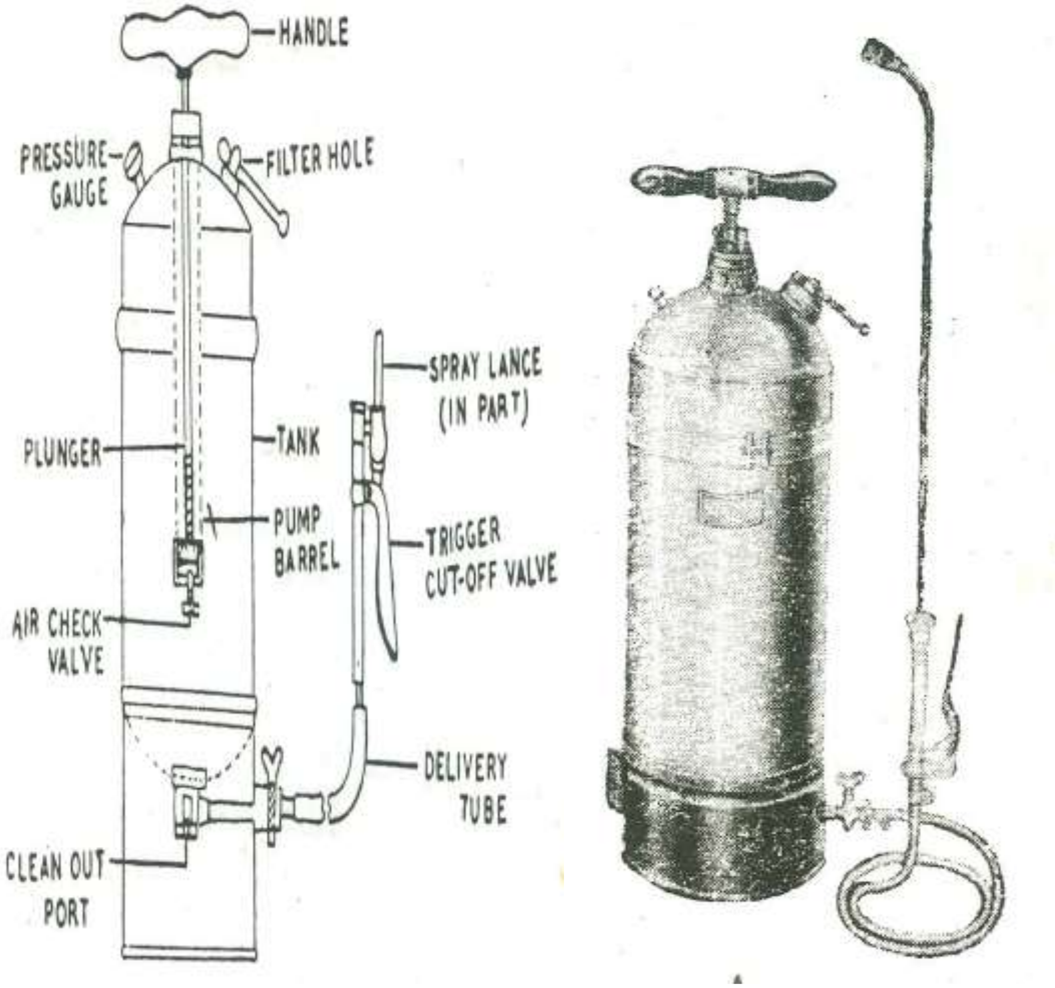


Fig. Two types of hand compression sprayer **A.** 1-Knob, 2-Cap, 3-Air pump, 4-Cut-off lever, 5-Nozzle, 6-Tank, 7-Delivery tube, 8-Bucket assembly, 9-Air-check valve assembly, 10-Pulnger rod, 11-Pump barrel, 12-Filter hole, 13-Handle.
B. 1-Knob, 2-Cut-off lever, 3-Handle, 4-Pump barrel, 5-Tank, 6-Plunger rod, 7-Bucket assembly, 8-Air-check valve assembly, 9-Delivery tube, 10-Spray lance, 11-Nozzle

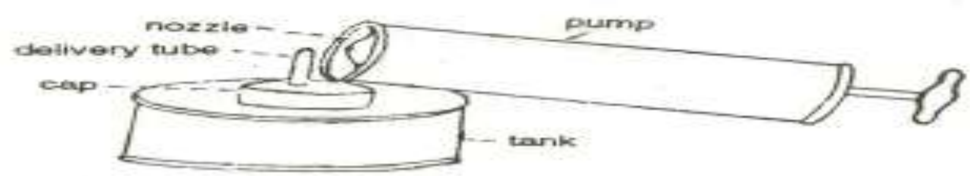
These sprayers are suitable only for the household and kitchen gardens.

(ii) Pneumatic Knapsack sprayer: This sprayer is built up of brass or copper tank, very hardy and



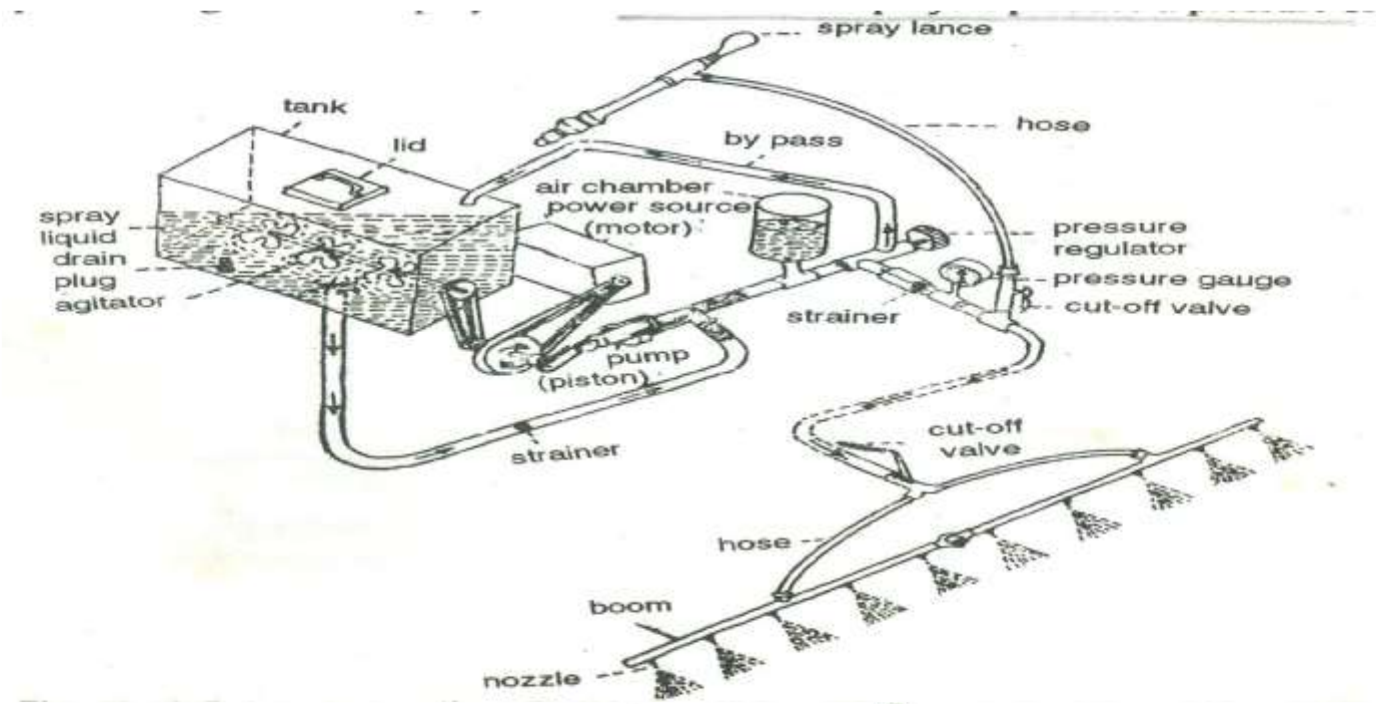
very useful for spraying to control the public health insects like mosquito, houseflies etc.

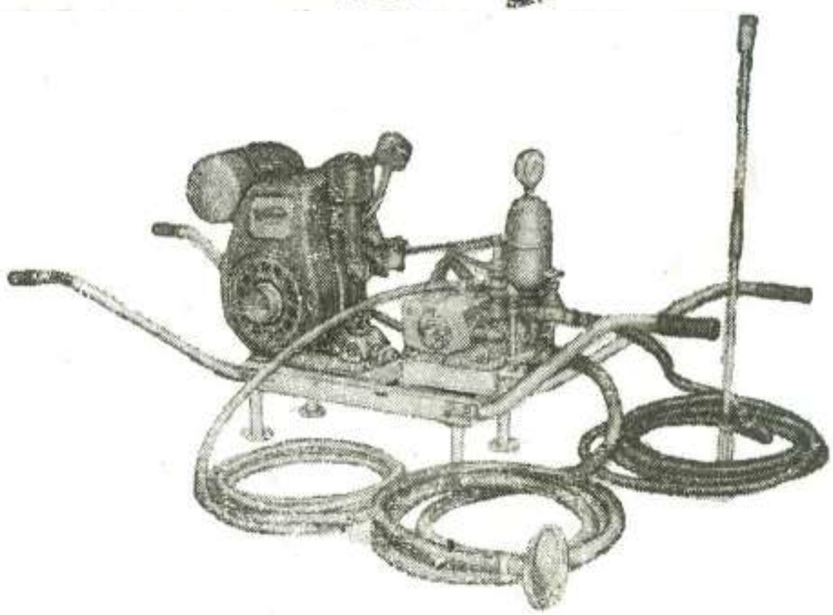
(c) Air blast sprayer:
Hand Atomizer or Flit pump: This is the simplest air blast sprayer where the spray particles are



broken into minute droplets. The working of pump is a tiring process and so limited to use in kitchen garden and household purposes.

(2) Power opearted sprayers:

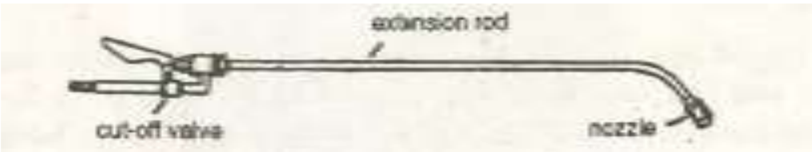




These are provide with the powerful motors which enable the sprayers to make it more accessible to a long distant and target oriented spray. If the sprayers are moved on uneven/muddy terrain, these are called as skid sprayer.

6.2.3 **Components of sprayers**

Spray lance: It is the terminal attachment of the delivery line that discharge of the spray liquid. It has three parts – cut-off valve, extension rod and nozzles.

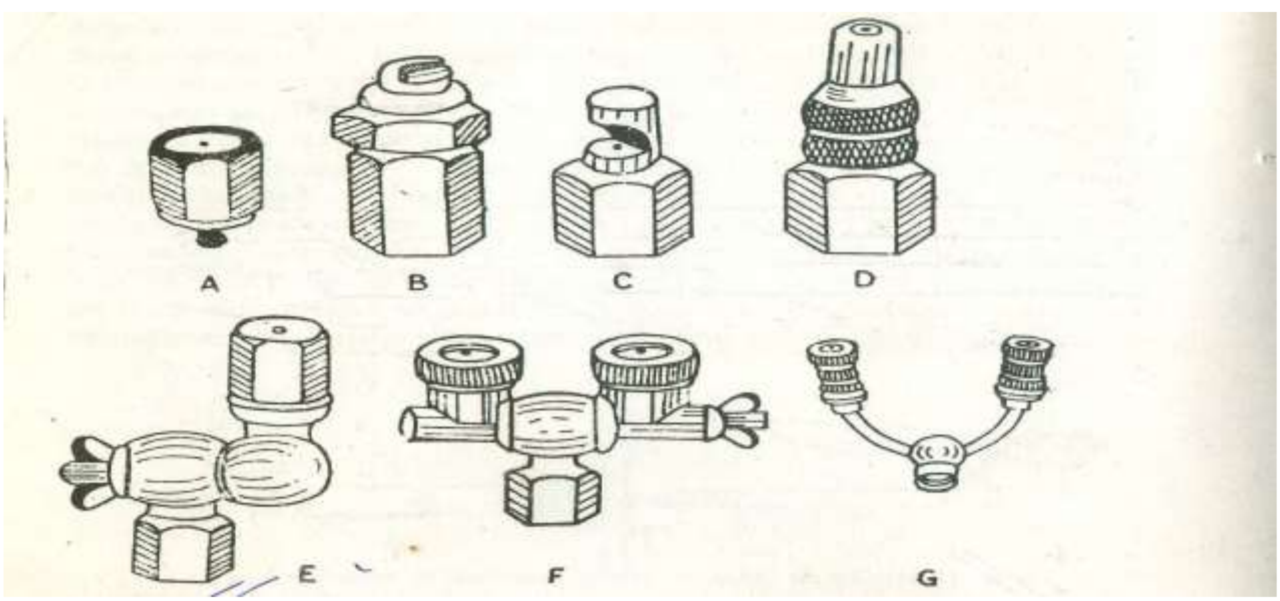


Spray Lance

The cut-off valve is meant to stop or release the spray coming through the delivery line. It could either be spring-activated or knob-operated.

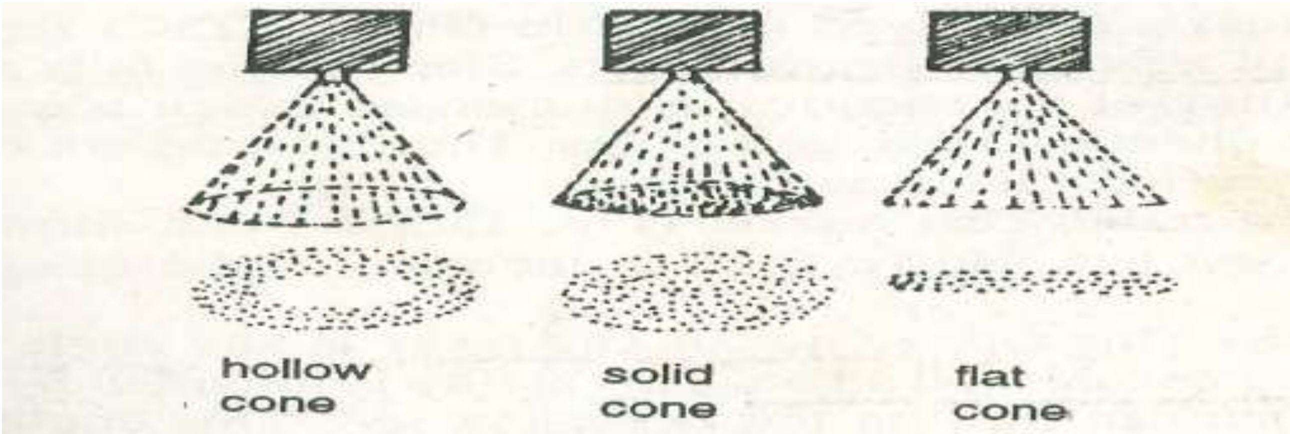
A) Spring Activated B) Knob operated

Nozzle: It is the most important part of the lance fixed at its diatal end. It performs three functions – (a) atomises the spray into proper sized droplets, (b) imparts the desired shape and angle to the outgoing spray and (c) regulates the discharge of the spray per unit time at a known pressure.
There are several; categories of nozzles –
(i)cone nozzle, (ii) flood jet nozzle, (iii) adjustable nozzle, (iv) swivel nozzle , (v) fixed nozzle etc.



A – C: Cone Nozzle, D: Flood jet Nozzle, E – F: Swivel Nozzle, G: Fixed Nozzle

(i) Cone nozzle: This nozzle discharges the spray in the form of a cone which could be hollow, solid or flat.



Hollow or solid cone nozzles are used for spraying on bushes and crop plants, whereas the flat cone (or fan) nozzles are used for fertilizer or herbicide spraying. The droplet size of the fan nozzle is larger than that of the hollow or solid cone nozzle.

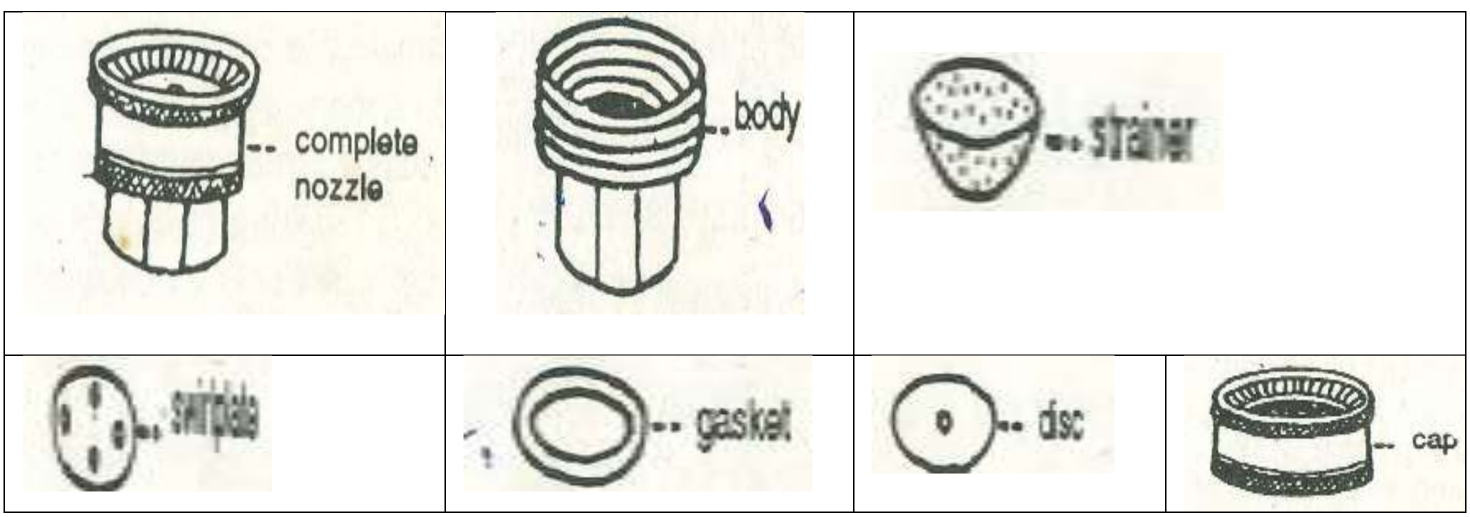
(ii) Flood jet nozzle: In this nozzle the drifting of the chemicals is minimised and are used in the case of using herbicides.

(iii) Adjustable nozzle: This nozzle can be converted to either into cone nozzle or jet nozzle.

(iv) swivel nozzle: This type of nozzle can spray at any angle from 0 - 180^0 and can be locked at any desired angle. This may be a single swivel nozzle or a double swivel nozzle where both the nozzles can be independently turned to any direction for covering wider surfaces of the plants and bushes.

(v) Fixed nozzle: here the nozzles are fixed at a certain point to have a particular target area to be covered with spray liquids.

Parts of a Nozzle: The parts of a nozzle are body, strainer, whirl or swirl plate, gasket, disk and cap.



Different parts of a nozzle