Farm Machinery
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Lecture -37
Plant Protection Equipment/Machinery

Well, dear students welcome to the 37th lecture of these series on Plant Protection Equipment Machinery. Well, you know that the crop has to be protected from various elements; for example, from the weeds, from insects, pests and other harmful effects, otherwise the crop will not give us a good yield. So, what are the protection devices; what are the protection processes that we take up for any crop for that matter whether it is a cereal crop or a plantation crop or a orchard crop, whatever it is?

In fact, when we talk of this, the protection is mainly from the insect's pest. Here, we had already discussed about the weeds. We have discussed about different types of weeding devices and weeding equipment and different methods of controlling the weeds, which are unwanted plants in a in a particular crop. But when you want to protect them from other elements like diseases etcetera; then, insect pest attack and then diseases are infested these plants, are infested with the diseases and ultimately it leads to damage of the plant and the plant dies and ultimately, we do not get the yield.

So, this particular section will be dealing more on the chemical or the protection of the plant or the crop from insect's pests and sometimes when we also want that some of the growth hormones are to be applied, then how do we apply them? So, the equipment etcetera and the devices processes which are involved in these, we will discuss under this section. Let us go through the various slides, which I have prepared for you.

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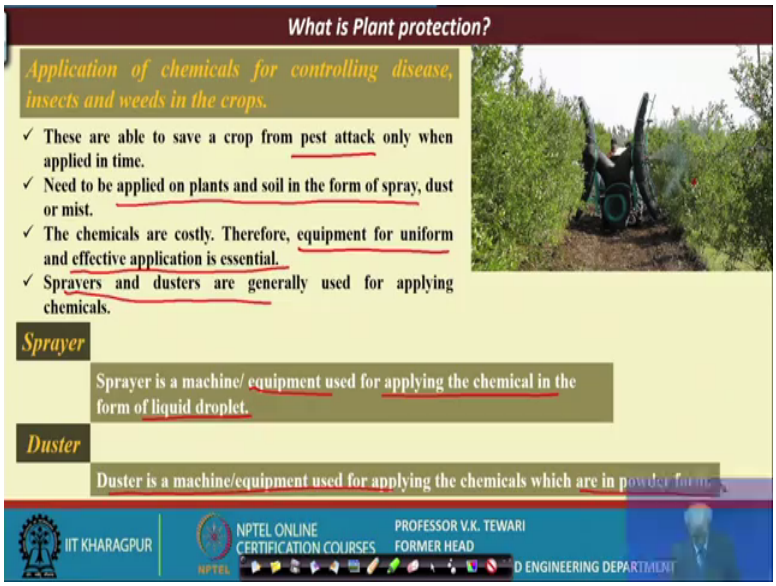

Well, what is plant protection? As I said, in fact, this has already been told what I was explaining here that see a photograph has also been shown on the side, stalks of in pomegranate a particular device which have been developed at IIT, Kharagpur.

We will talk of this slightly later. Then, this is the device which has been developed at IIT, Kharagpur and then the tested at location in Maharashtra. Well, we are trying to as I said earlier that, to we are trying to save the crop from the pest attack etcetera.

Now, the need see, need to be applied on plants and soil in the form of spray, sometimes when the chemical is there need to be applied. We are talking of the plants, sometimes on the soil; in fact, these are not for the soil. But then, when we apply they will fall on to the plants as well as on the soil as well.

Now, what are the various methods that by which we do and the therefore, the equipment for a uniform effective application is essential. What we do is we want that it should be very effectively and correctly applied on to the targeted plants. If the, if it is only a growth organ say item which has to be given to all the plants, then there is no problem we can uniformly spread over it. But then, if it is only insect pest control.

So, there may be a case where the this is not infected at all over the place, maybe an progress certain localized locations. So, there we would have to apply and that is why it is very essential to go judiciously and uniformly at the location where it is done and for

these, the Sprayers and Dusters are the ones devices or the equipment which are used; we call them sprayers and dusters for applying these chemicals. When you dusters, the name itself tells you that dust means there are dust powders which you need to be spread.

Now, what are the mechanism; what are the devices; what we do for the spraying of the chemical or the dusters, we will talk of them later. But this is what are the 2 important things; one is the Sprayer which is a equipment used for applying chemicals and the liquid droplet form and the Duster is the machine which is equipment for powder form for replication in the powder form.

So, these are the main things which we are talking with respect to plant protection. And in this section, as I said earlier we will be only talking of the plant protection of the plant from insect pests that is only. So, if you go to the next slide, what do we get? See Dusters.

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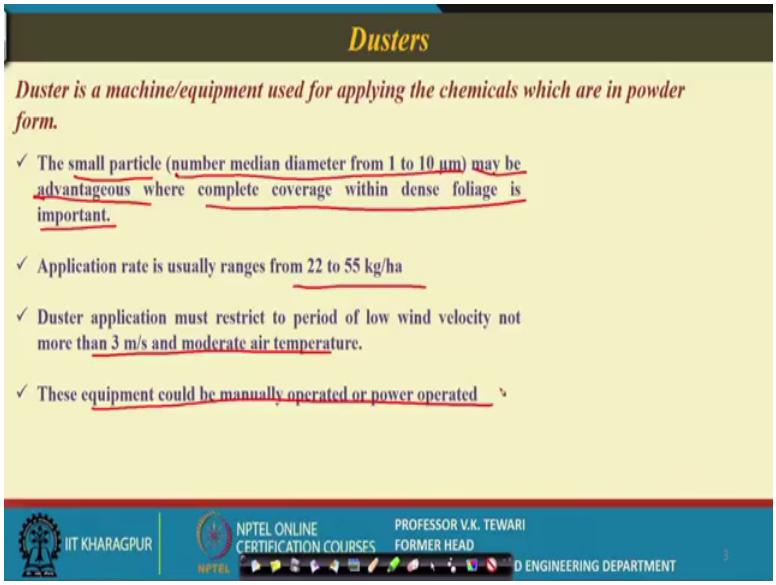

We talk of Dusters first, let does not matter which order you follow, but let us talk of Dusters, is an equipment for applying chemicals which are in powder form. Yes, what do you do for these? Well, there are certain features for this because one is you can very simple one is that you can take this and spread by hand may be that if it is infected in your hand, possibly there may be a problem in your hand, that is why maybe you will have used gloves and then, spread manually even a small area if it is required.

But when we are talking of large area, definitely we have to have a mechanism by which we should be able to apply and there not only this, we should be able to apply very uniformly. We want that it should not be one place more, the other place less and all that, there should be a uniform application of this.

So, and this that is why; so, what is done? Well, the idea is the small particle say number mean diameter go to 1 to 10 micrometer may be advantages where complete coverage within the foliage is important. Yes, in fact, then what we have to do? This dust or even the chemicals; so, we talk of dust here. Now, of the diameter of the particles which will be there, those powder particles varying from 1 to 10 micrometer.

So, these are advantage. So, it has to reach to every location in the foliage in the canopy of the plant which we are thinking of and the application rate is usually actually these are not meant for very high application rates. But the application rate which are generally followed is 22 to 55 kg per hectare.

This is the amount generally we do if it has to be given only in the powder form. If it has to be given something else, then maybe this powder has to be made into a liquid and with water and then, its relation has to be given. It depends on what we want and what is the type, nature of the crop; what is the type of infestation and what is the type of the chemical powder which is available with us?

Because many aspects are to be looked into before we go into application of this. Now generally this, see what will happen? If this is applied may be that if wind is blowing you should avoid that, but then if the wind you are not applying at a very high level, you are applying at the say 11.5 meter or the plant height. So, up to when you find that the wind speed is low particularly say about up to 3 meter or so.

So, 3 meter per second when the or moderate air temperature at that time, you can apply. Generally, these chemical applications are generally done in the early hours and in the late afternoons because to avoid many things. For example, even if it is a say daytime and it is very hot, then those the insects go underneath the leaf and they sit there.

So, if you where the whole foliage also they will not be getting effective; that is why it is done during the morning hours and then, the afternoon hours where the temperature is

comfortable, they can be all over the plant and so you can apply. That is why it says that say the air velocity or wind velocity should not be very high.

There are 2 aspects of it; one is that it will not the insects because insects will be also all around and it will not be lost because these weed is, if the wind is high, then even if you apply certain amount; of course, it will be spread and the wind will take away take this to another location.

So, wherever they it is not to be applied, it will be applied and in that case it may happen that there could be damage to the other plant as well, it may fall on the soil. So, there are various problems which may occur because of this and that is why we would like that the wind velocity should not be more and a moderate air temperature, we are talking of; not very high temperature, not very low temperature also.

Generally, these are these equipment which have been shown and which has been made so far or with or generally manually operated or a power operated. So, you can have manually operated power operated both depending upon what you are handling. As you said that maybe the capacity is 22 to 25 kg per hectare.

So, if it is thus, then you may not like to have a manually operated one because then that has to be carried by the man; either he will carry about 15 kg and then, finish and then come back and keep filling up and all that or you can have a equipment in which a power operated which can carry that amount once and then, the application can be given when the powder can be spread wherever it is liked and wherever; whatever be the location whatever be the height of the spread to be given, it can be done. So, this is about the dusters.

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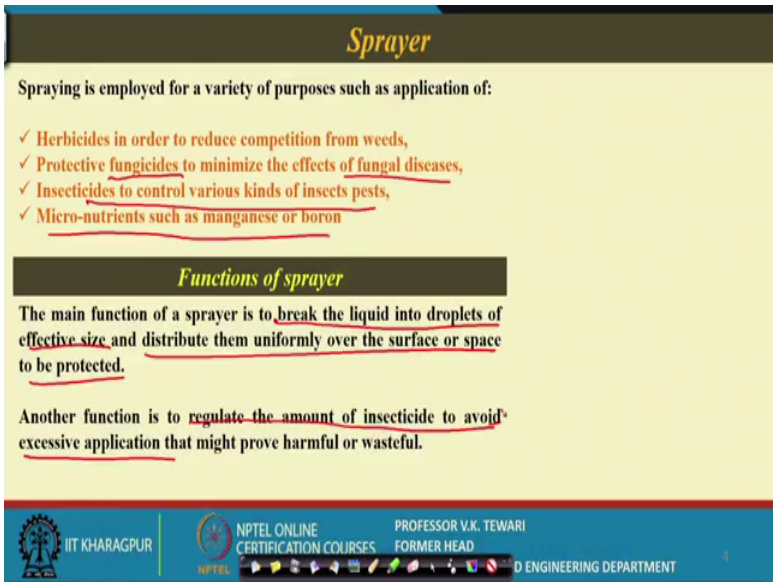

Now, this sprayers; well, this is slightly different from there from those powders because there we have a fear that with wind, it will go away. It is not that when you have a chemical, it will not go away if the wind is high. Yes, these chemicals will also go away; but then, it has some other requirements of this sprayer.

Sprayer we spray the liquid, we spray the chemical which is there and now generally we do not want to spray that chemical in the raw form. This has to be diluted to a certain percentage of dilution which is required for that particularly, because that will be a effective one, certain active ingredients are there in each chemical. And accordingly, that has to be multiplied particularly the in the volume form and hence, several 100 liters of solution have to be prepared with those chemicals.

Now, what are the ways by which this sprayer; where these sprayer are used. I have just listed them here, you can have a look at this, well these are herbicides well. So, the herbicides, in order to reduce competition from weeds, this sprayer are used have we have talked of this earlier already. Then, protection of the crop from fungicides and then, the fungal diseases, fungicides are used fungal diseases then, the control of insects and pests which is of concern to us in this particular lecture here.

And then, micronutrients yes, this is another important thing because sometimes as I said earlier that may be that we would like to apply certain nutrients or growth enhancing materials. Then, in that case also hormones, we call. So, micronutrients are to be applied.

In that case also, you can use the sprayer, but then a proper volume of solution has to be prepared. So, what are the functions of the sprayer then?

Now, you see this liquid has to be applied. It must be applied uniformly. Well and then, it cannot be poured simply you have say 2 liter per hour per minute or per hour or things like that. But it has to be spread in the form of small droplets, we are talked of the droplets. So, this is important how what sort of things are done; what are the functions that the sprayer does? Sprayer what does it do? It breaks the liquid into droplets forms. Yes, this is important because it has to broken into small particles. This droplets when then when they get deposited they will be effective in that.

So, how to create that this is one challenge, when you design a sprayer, how to create that so that effective size and distribute them uniformly over the surface or the space to be protected. So, this is the main function of the sprayer which you will design.

In now it is a different thing that what mechanism you apply to design and so, such that the droplets are of a particular size. Another function is to regulate the amount of the amounts of the chemical in the insecticide pesticide or fungicide that we want to apply want to the you need to apply so, that excessive application to avoid excessive application.

So, this is very important. So, when a duster is there; what we are trying to do? We are trying to spread the dust, dust particles in a certain sized form and so, uniformly to the targeted places. When we talk of sprayers, we are talking of these droplets to be created and those droplets and it must be created in a exact amount. So, that we are we do not lose this. So, this is the job of the spray. Now, what are the other components of this, let us have a look at it.

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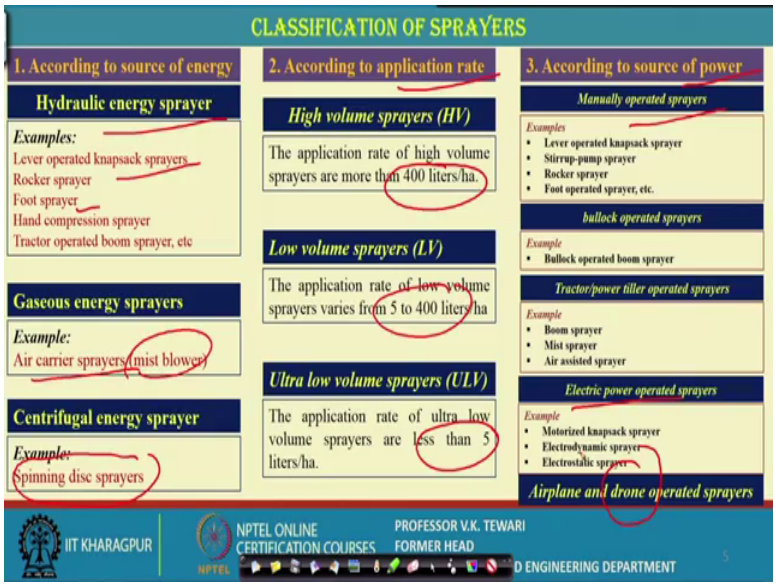

Well, you we know that we have to try, we have to make the droplets, we have to create droplets out of the liquid solution which we have. How do we do it you must have read already earlier that an you will have to have pressure, you must have thought heard about the engine, in the engine what we do when the diesel or petrol is thrown into the engine combustion chamber. How it is thrown?

In fact, it is atomized over there and through high pressure when it is pushed through high pressure through a particular nozzle, then it comes into various into in the dust in the very you can say a particle form, smaller particles and that atomized particles will get connected and mixed with the with the whole heated gas and the actually things happen in the engine.

Now, similar thing happens here. You need to have a pressure created. So, what are the different types of systems which are employed for a pest sprayers, will have a look at this. See, the Hydraulic energy; what sort of energy? You can say that Lever operated knapsack sprayers, you must have seen this sprayer which are carried at the back and then the person operates with the lever; it could be a foot operated, it could be a rocker operated and Hand compression, Tractor operated boom sprayers, these are the sprayers which are there say this Hydraulic energy sprayers.

Now then, Gaseous energy. Now, this is very important actually some of these particles, we would like to use the air blowers so that like a mist it comes out in the. So, there also

the particle size will very small and it will go and cover the whole plant. So, many times it has been found particularly orchards once that the air carrier particularly the mist blowers are the ones which are very effective this.

The second in the Spinning disc type of your centrifugal energy is used. Well the this is one even similar thing can be also used for the dusters as well; some of them are made manual dusters are there, where centrifugal energy is used and you can spray the dust.

Now, do we need to have a certain a pressure or that what are the different pressures which are followed in that for crops depending upon whether it is a cereal crop or a orchard crop or a plantation crop or high trees when you have to spray. So, there you can see the volume on the basis of the, you can see the application rate, the on the basis of power and also on the basis of the pressure that we create.

So, we will talk of pressure slightly later. Let us see about the application rate and the source of power. So, source of power could be say manually operated; yes, manually operated one you can have, where it could be a liberal as I said manually operated levers, rockers, foot operated all these. Then, animal operated; yes, you could have a animal operated system which is of course, in some locations you might see, but because the situation is changing over now. So, these are not very much in vogue now but thus, yes can use the animal energy. It is a question of only using the source of power.

So, the high volume ones are 400 liters per hectare. Then, the low volume ones are less than 400, 5 to 400 liters per hectare and then, ultra lower you can have as low as say 1 to 5 liters per hectare or so. So, these are on the basis of the application rate and on the basis of the source of power, you can say that manually animal energy and then, powers; whether you use a tractor of power or a power tiller or you can you can also think of the electrical power used.

Many of the devices, which are coming on the electrical power use where electrostatic because there we will discuss this later but then, here I can only say that these this particles actually are charged. So, when the negative charge is on to the plant so, they get deposited. So, their efficiency deposition efficiency is very high and that means the effectiveness of the chemical when it is put in the electrostatic charged particles, it is very high.

So, one way it is very good, but there are other difficulties with this and drawbacks and limitations because which it is not very extensively used, but yes it is also used. And now, it has come back. Well, it was started long back and now, it has come back. People are using it and several modifications of this have come up.

Now, when the when large areas particularly you might have seen in west in US and other places where the forms are very large and you have to apply these chemicals, then airplanes are flown on they carry the chemical and maybe the height above the ground particularly from the plant you will say about 1 to 8 meters.

The whole aircraft moves and then, it will spray over the whole area and it has an weightage from the point of view of the economics is because of the large areas say about 50, 60, 100 hectares, 200 hectares like that. And hence, the plane can go and cover the whole area very short duration of time and there may not be losses because they can adjust the time.

Now, but over maybe about last 10 years or so, people are thinking of few this is a small planes or small roads which are in fact, are called as Drones. So, these Drones can also do the same task and that's why we have written here that you can also think of the Drone operated sprayers.

The drone can do the task we will discuss this in another lecture; what drones can do? They can do wonders and this will be useful for small forms and particularly a elevated locations, where the person cannot go on. Orchards which are there on elevations, they this drones can help us and they have been helping.

So, it is possible that you can think of these high technology to be used for use of these sprayers drone operated sprayers or road operated sprayers, we can we can think of. So, on the basis of the classification of the sprayers, we can see that it could be a manually operated, animal operated or power operated; you can think of tractor or power tiller or you can think of motor operated electrical motors or electrical energy could be applied.

Then, on the basis of the volume; yes, over even larger volumes, medium volumes and ultra low volumes, small volumes where the some of the chemicals are needed to be applied in large volume only, those active indirectly they are applied, no solution, I mean no mixing of water. Those are some of them are applied sometimes and then, if you are

talking of the energy, type of energy used. One is the hydraulic energy where you are using have the hand compression is sprayers and maybe tractor operated system or you can think of air carriers you have so, that you get in the form of mist. So, this is what we are talking with respect to this sprayer and dusters as a concept of understanding what they are, these are.

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Well, the pressures which I wanted to show you in the other one we have kept here now, you can see that the pressures what are the because for creating those small particles you need pressure as I said earlier. So, lever operated sprayers the pressure operating pressure is maintained about 1 to 3 kg per centimeter square and the discharge rate is normally 500 ml per minute. Then, stirrup pump sprayers, these are also of a similar type and a similar discharge and pressure is also required.

Rocker type ones slightly higher because they are the discharge rate is high and the pressure at the moment the discharge is high and you want to make the same type of particles. Then there you will have to have a high pressure and now the pressure is about 14 to 18 atmosphere or kg percent in square which we say. Then, foot operated sprayers could be, because foot operators operated sprayers or many which are used for even big orchards or big trees, where about 20-30 feet, you want to push the chemical.

So, there you move the optimum pressure is very high. But 17 to 21 or even 21 to 55 when you are thinking of a tractor operated sprayer because we are we are thinking of

high 150 to 190 liters per minute. So, much of volume, these are required particularly for tall trees and all that. So, various methods have been employed for all this and then, what we are getting is that on the basis of this pressure, on the basis of the volume and on the basis of the energy employed and the type of power source, these sprayers and dusters etcetera are all classified and understood.

Now, the main thing in this what I want to say you is that it is the droplets; whether you are talking of liquid or you are talking a powder, you have to think of what is the size of the droplet or the size of dust particle which is powder in case of a powder which will go and get deposited. And once it is deposited appropriately at the right place and in the right quantity, you will get the benefit of that.

And that is why these are various types of are available. I have shown you one of the one which is available here and we are trying to modify into electronic one. This is one which is available mist type, but then we want to see whether it is possible to use this so that we can economize on the total chemical which is being applied.

This is important because you may have the system which is applying such that the volume is too high and in fact, the ones which are available in the market are like that that once you start the system and the pressure is pressure is created because of the power source then it continues until you stop it. Now, that way it may not it may be good for a continuous cereal crop, where the tractor can go.

But if you are talking of orchard crops, where the plants are at a certain distance; then, it has been seen many cases that the canopy and the next canopy there is a difference and there those areas, if it when it when it applies those are waste.

So, that is why we have to think of the power source and think of this. So, as an engineer what is your knowledge; what you should contribute? You should try to design keeping in view the requirement of the plant or the tree which is there or the orchard which is to be considered and then, the power source and the total quantity to be applied and the type of the chemical or the powder to be applied.

So, you need to consider all these things and then, this design which one will be beneficial. So, that we are all talking today about precision agriculture. We are talking of

how we can minimize on the inputs and get maximized. So, for production protection of the plants, these are very important.

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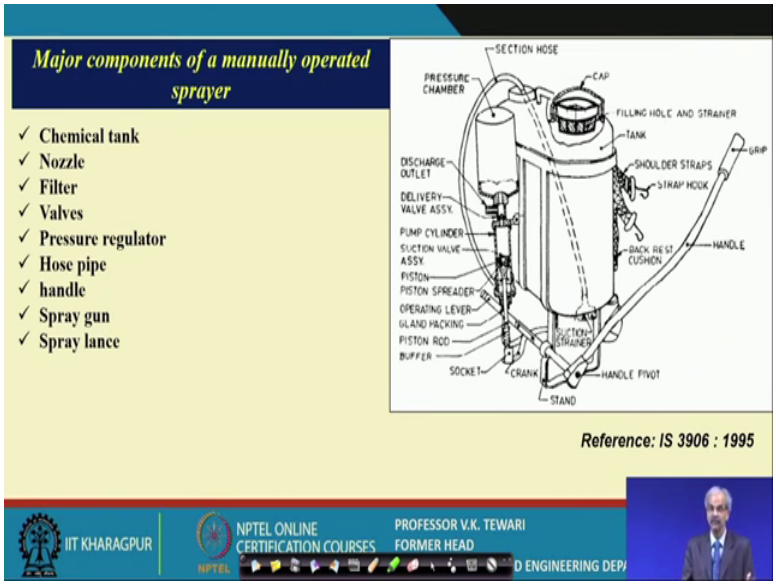

Well, I have shown you manually operated sprayer where all these details are given to you. You can see this that all details are explained over here. You definitely it will have a tank sure where the chemical will be there, then there will be a lever which has to be operated and there will be a plunger. Now, we will talk of what are the different types of components will talk slightly later.

But these are the ones which are there the Tank, the Nozzle, the Filter, the Valves which will there, the Pressure regulator, the Hose pipes, the handle, Spray gun and the Spray lance which are there these are all shown here. So you, if you look into it, you will be able to understand; here, not much to explain and discuss so, that is why I have given you we have taken from the literature.

Remember that what we are discussing here is we are talking whatever is available in some of the books as well as the research publications and some of the look work that we have done at IIT, Kharagpur and done elsewhere which are beneficial for different types of crops; cereal or plantation or whatever.

So, those are the things which we are. So, I request you that you must also go into the literature available to have sufficient and you can say that add up to the knowledge which we are trying to give you here. Let us go to the other slides.

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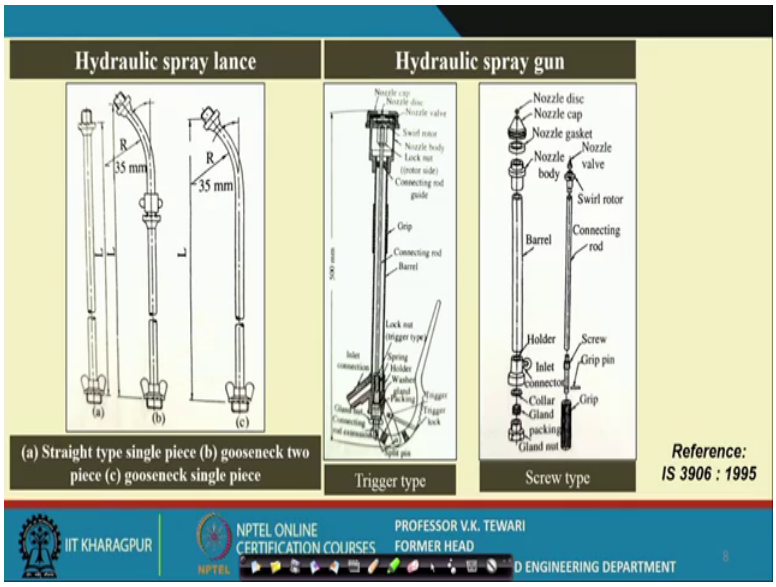

Well, some of the details of this Hydraulics spray lance, the Hydraulics spray gun; what are the details these are also very self explanatory because we have given the dimensions, we have given the values etcetera in such a way that anyone can understand these concepts and these types which are available and it also helps you because once you understand where is the nozzle disk whether in nozzle cap and what where is the nozzle body and what is the barrel and things like that. For all these trigger type and screw type, then these designs help you in understanding what is the way by which we are able to make the droplets of different sizes, this is this very important.

Now, the references we have given the reference because these are things which we have taken from proper references of the course and it is worth mention that those should be told to you where we have taken it from.

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Well, the major components are power operated; you will see whether it is a power operated or a manually operated. The components will remain more or less simply except that the because of the power source.

So, the chemical tank, definitely a tank has to be there where you will keep now what will be the size of the tank, this will vary from the power source. Then, what is the type of pump; how what should be the size of the pump; what should be specification of the pump; then, type of nozzle that we would like to say the Filters, Valves Pressure regulators, Spray boom and the Agitator. Now some cases you will write to agitate the whole chemical if it is there because sometimes the oil emulsions are there which are not directly they cannot be put. So, I think these are the components which you require.

So, just as in a representative, we have given you here and then I wanted to through this lecture, I wanted to introduce to you what is spraying and water is a dusting and what are the various types of devices which are available and where you can think about; what is the design portion? Design portion is the pressure to be maintained the volume to be taken and the particle size.

So, we will discuss about the different particle size. But then, you need to create particles, you need to atomize you need to create mist, which will go and spread on to the plant or the canopy and then, it will be effective in controlling the insect pest whatever is

there. So, that is why so, this we have discussed I think we will discuss other things later so.

Thank you for this.