Soil Fertility and Fertilizers
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Lecture 51
Fertilizer Recommendation Approaches and Integrated Plant Nutrient Management

Welcome friends to this week 11 of NPTEL online certification course of Soil Fertility and Fertilizers.

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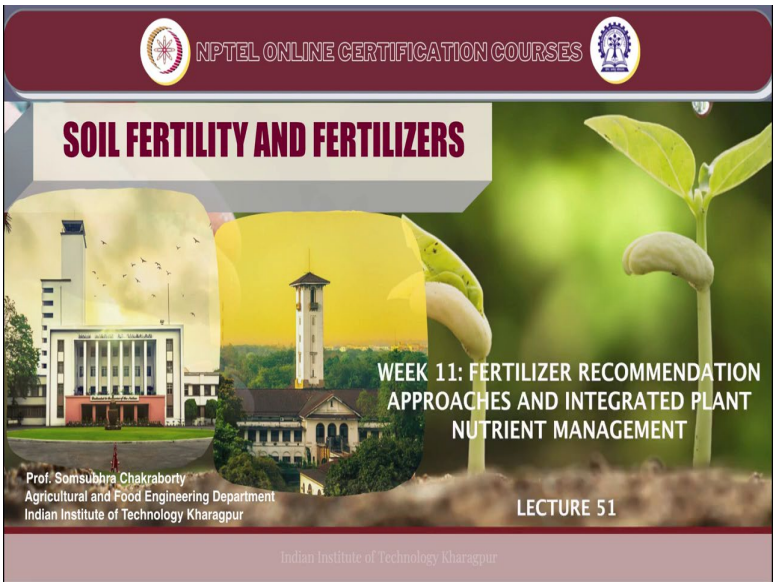

And in this week, we are going to discuss the fertilizer recommendation approaches and integrated plant nutrient management. So, in the first lecture of this week, we are going to discuss the following concept.

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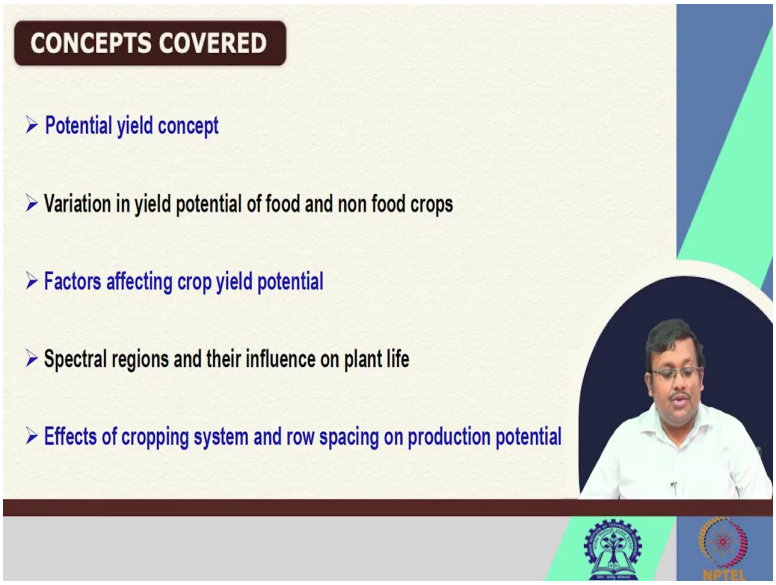

First of all, we are going to discuss the potential yield concept and then we are going to discuss the variation in yield potential of food and non-food crops. Thirdly, we are going to discuss the factors affecting crop yield potential. Fourth, we are going to discuss about spectral regions and their influence on plant life. And finally, we are going to discuss effects of cropping system and row spacing on production potential. So, these are the concepts you can see in the slide, which we are going to cover in this lecture.

We are going to start with the definition of the potential yield and how potential yield is important. What are the important aspects of potential yield and how these potential yield is governed by several factors, we are going to discuss? And then we are going to see the spectral region you have already know you already know what is the electromagnetic spectrum and what are the different types of components or regions of the electromagnetic spectrum.

So, we are going to see which one of these regions are important for specific plant physiological process. And then we are going to see the cropping system and then how manipulation of the cropping system can help in that protein enhancing the production potential.

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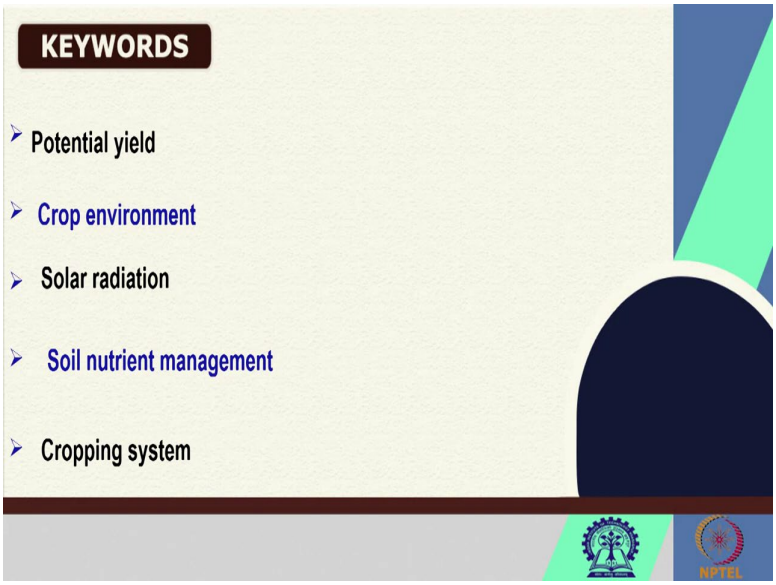

And these are the keywords like potential yield, crop environment, solar radiation, soil nutrient management and cropping systems. So, these are the keywords which we are going to discuss in this lecture number 51.

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So, let us discuss the potential yield and it is field level realization.

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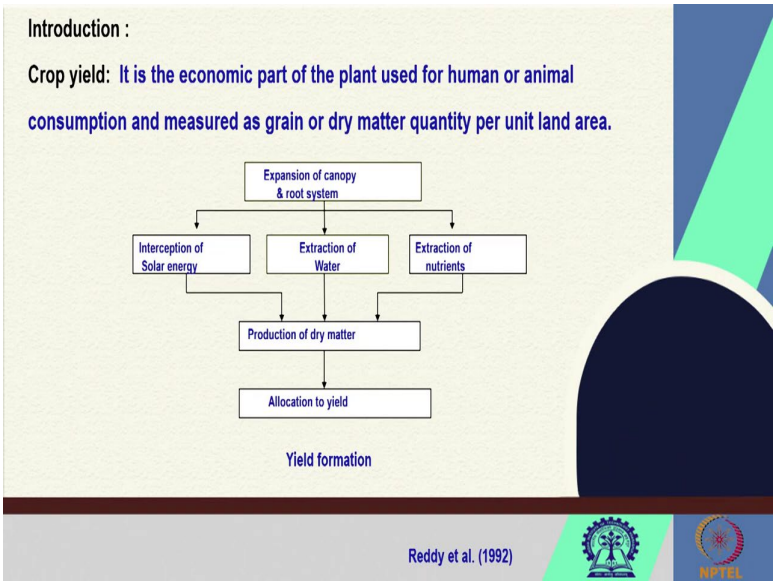

Now, before we discuss the potential yield concept, we should remember that crop yield is the economic part of the plant used for human or animal consumption and measured as grain or dry matter quantity per unit land area. So, if you see that yield formation basically starts with the expansion of canopy and root system and then we can see the intersection of solar energy with the expansion of canopy and also we can see, the roots can extract water and also extract nutrients.

So, all these processes like interception of solar energy, interception of water and extraction of water and extraction of nutrients can help in the production of dry matter. And ultimately, the production of dry matter can help in the allocation to the yield. So, this is how crop yield basically is governed.

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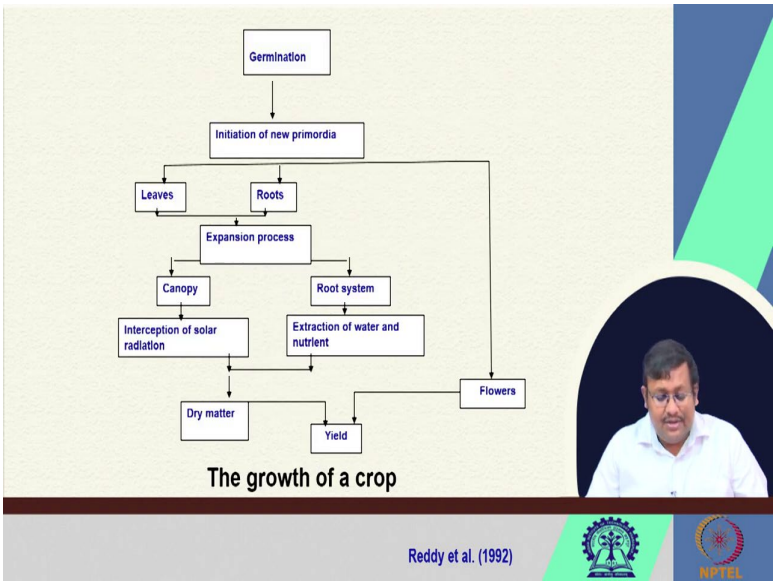

Now, if we see the growth of a crop of course, it starts with the germination and then it goes to initiation of new primordia. And then, we can see the development of leaves and roots, leaves and roots expands and form the canopy. And of course, we can see as we have seen in our last slide, this canopy helps interception of solar radiation and the root system helps in the extraction of water and nutrient. And ultimately also there is a third component called flowers. So, all these interception of solar radiation extraction of water nutrient and dry matter can create the dry matter and finally, the yield. So, this is an important flowchart that shows the growth of a crop and ultimately to produce the yield.

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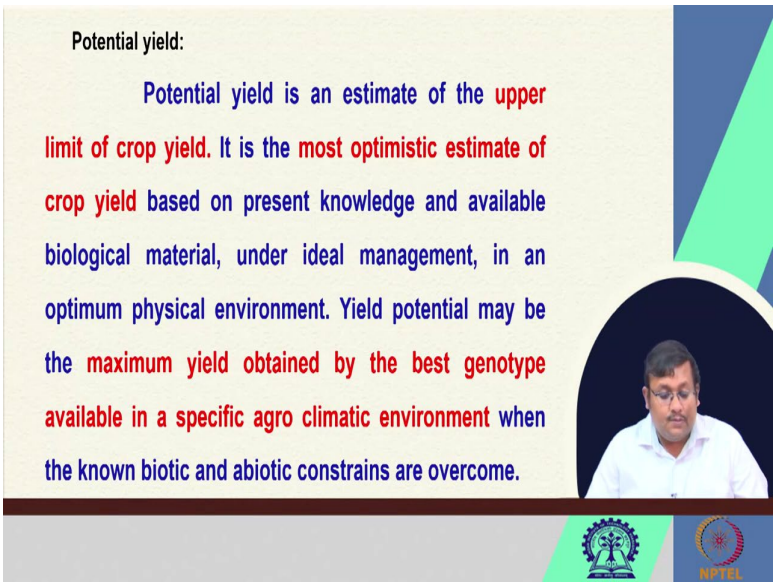

Now, what is potential yield? So, potentially is an estimate of the upper limit of the crop yield. Now, it is the most optimistic estimate of crop yield based on present knowledge and available biological material under ideal management in an optimum physical environment, so, these are very important under ideal management in an optimum physical environment. Why we are highlighting these under ideal management and optimal physical environment we will see when we will compare the potential yield with attainable yield and actually level.

So, right now, you should remember that potential yield is an estimate of the upper limit of the crop yield and it is the most optimistic estimate of crop yield based on the present knowledge and available biological materials under ideal management in an optimum physical environment.

Now, yield potential may be the maximum yield obtained by the best genotype available in a specific agro climatic environment when the known biotic and abiotic constants are overcome. So, here we are not considering the biotic and abiotic constraints, when we will consider these biotic and abiotic constraints will move to other yield levels like attainable yield as well as actual yield, which we will discuss in our next lecture. But in this lecture, we can see this is the most optimistic estimate of the crop yield.

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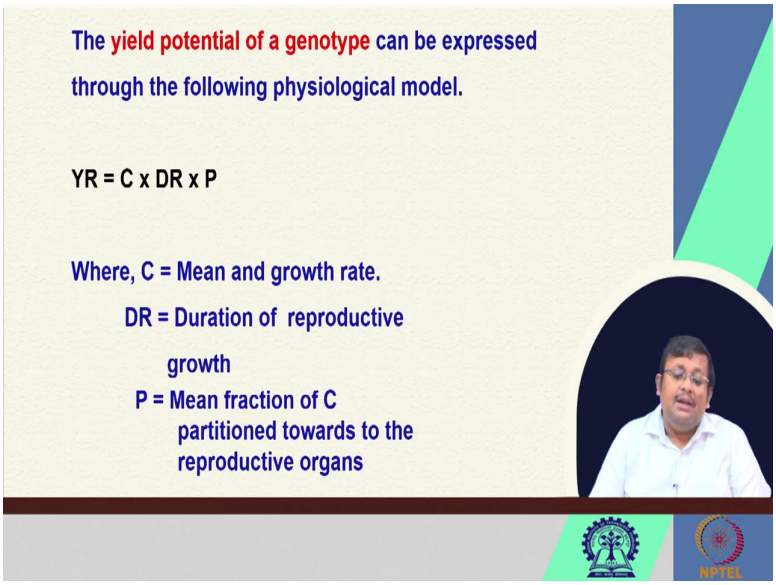

Now, the yield potential of the crop can be expressed to the following physiological models. So, yield potential can be considered as a where C is the mean growth rate, DR stands for the duration of reproductive growth and P stands for the mean fraction of C that is the mean

fraction of this mean growth rate partition towards the reproductive organs. So, this is how we can calculate the yield potential.

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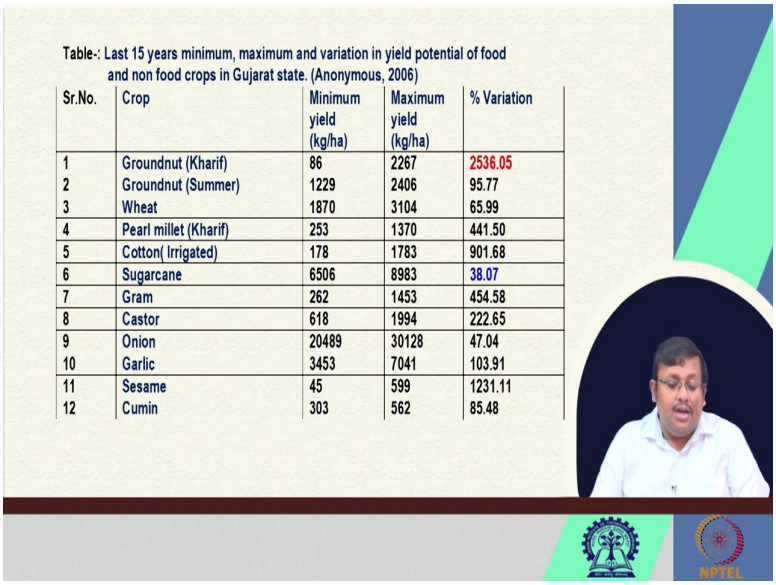

Now, if you see the last 15 years of minimum, maximum and variation in yield potential of food and non-food crops in Gujarat state of India, we can see that the minimum yield and maximum yield are quite variable according to different seasons and as per different crops also you can see in case of groundnut when it is a kharif crop, we will see the 2,536 percent of variation in the yield however, in summer there is only 95 percent variation.

In case of wheat, we can see 65 percent variation, in pearl millet we can see 441 percent variation, in case of cotton, we can see 901 percent variation, in case of sugarcane 38 percent variation, in case of gram 454 percent variation, in case of castor 222 percent variation, in case of onion 47 percent variation, in case of garlic 103 percent variation, in case of cesium 1231 percent variation, in case of cumin is only 85 percent variation. So, you can see the person variation in yield varies from one crop to crop and also within a crop based on the season also.

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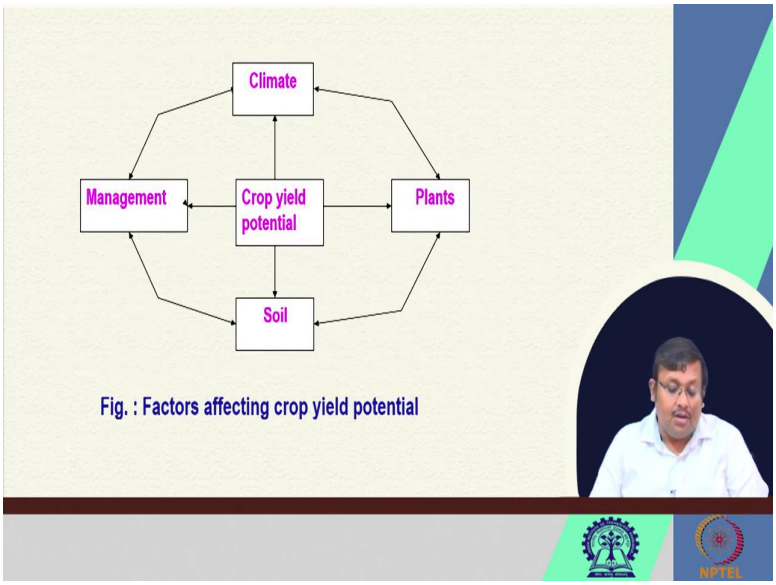

So, what are the factors which affect the crop yield potential. Now, the crop yield potential are dependent on four major factors that is climate, plants, soil, management. So, not only the climatic factors, but also plant factors, soil factors and management factors are important for maintaining the crop yield potential.

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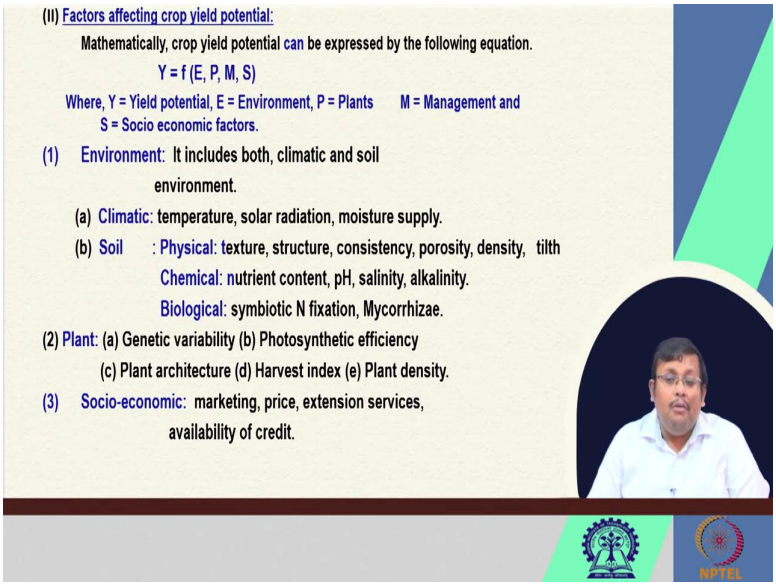

Now, what are the factors affecting crop yield potential? So, mathematically, the crop yield potential can be expressed by the following equation like Y equal to function of E, P, M, S where Y is the yield potential, E stands for the environment, P stands for the plant factors, M stands for the managing factors and S stands for the socio-economic factors. So, what are the environmental factors? So, it includes both climatic and soil climatic factors or soil

environment. What are the climatic factors? Temperature, solar radiation, moisture supply, these are important climatic factors.

Among the soil factors, we can see physical factors like texture, structure, consistency, porosity, density, tilth. These are important soil factors, physical factors. What are the soil chemical factors? We can see nutrient content pH, salinity, alkalinity, so, these are important nutrient chemical soil chemical factors. Among the soil biological factors, we can see symbiotic nitrogen fixation, Mycorrhizae. So, these are soil biological factors. Among the plant factors we can see genetic variability then photosynthetic efficiency then plant architecture, harvest index, plant density, these are important plant factors.

And among the socio-economic factors, we can see marketing factor, price factor, extension service factor and availability of the credit factors are important for determining the crop yield potential.

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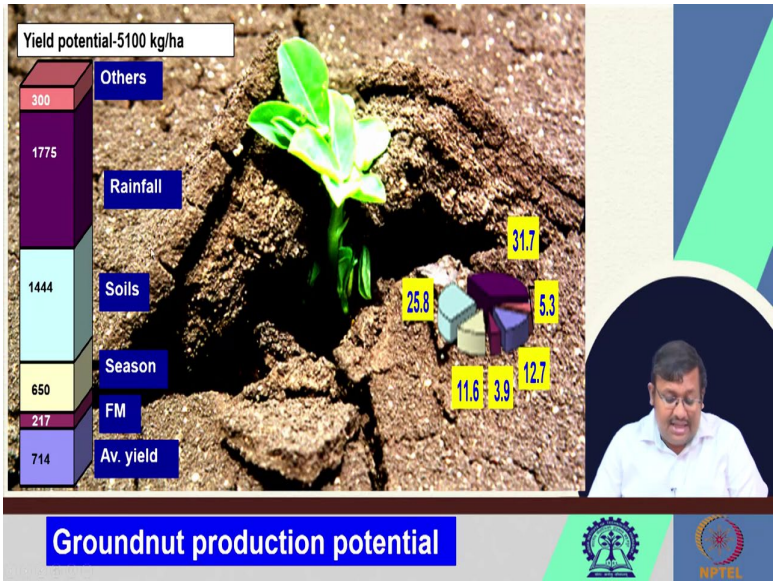

So, if you see the ground production potential it depends on several factors like rainfall, soils, average yield and so on. So, ultimately the yield potential when there is a 5100 kg per hectare rainfall, accounts for the majority followed by soil.

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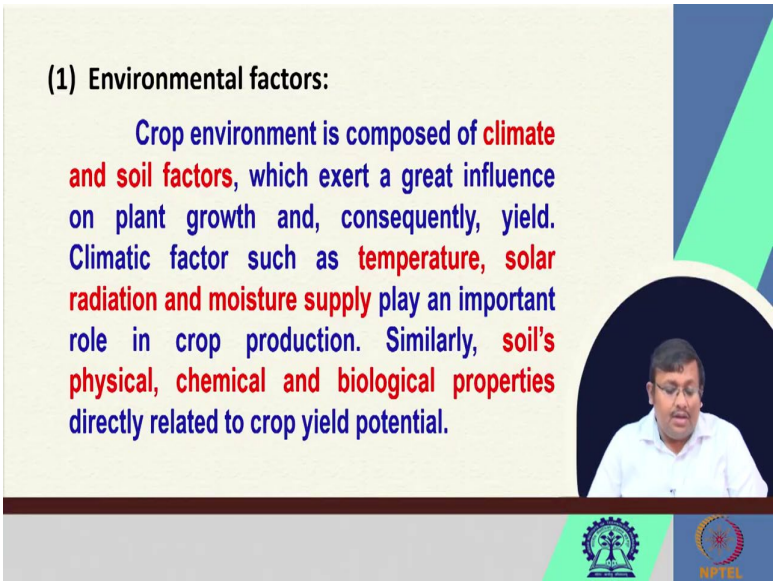

Now, if we focus on the environmental factors, so, the crop environment is composed of climate and soil factors, which exert a great influence on plant growth and consequently yield. We have already seen that depending on the kharif or summer, the groundnut production yield there is a groundnut yield shows a wide variation in Gujarat in our previous slides we have seen. So, climatic factors such as temperature, solar radiation and moisture supply play an important role in crop production.

Similarly, soils, physical, chemical and biological properties directly related to crop yield potential. so, these are environmental factors.

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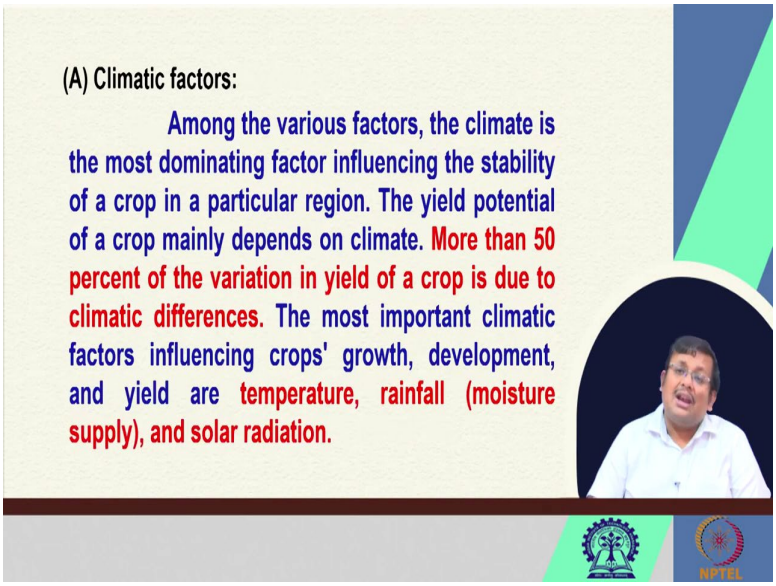

Now, climatic factors among the various factors the climate is the most dominating factor influencing the stability of the crop in a particular region. Now, the yield potential of a crop mainly depends on climate more than 50 percent of the variation in yield of a crop is due to climatic differences we have seen. So, the most important climatic factors influencing crops grow up influencing the crop yield crops growth development are basically the temperature, rainfall and solar radiation.

So, temperature rainfall and solar radiation are the most important climatic factors that influence crop growth, development and ultimately their yield.

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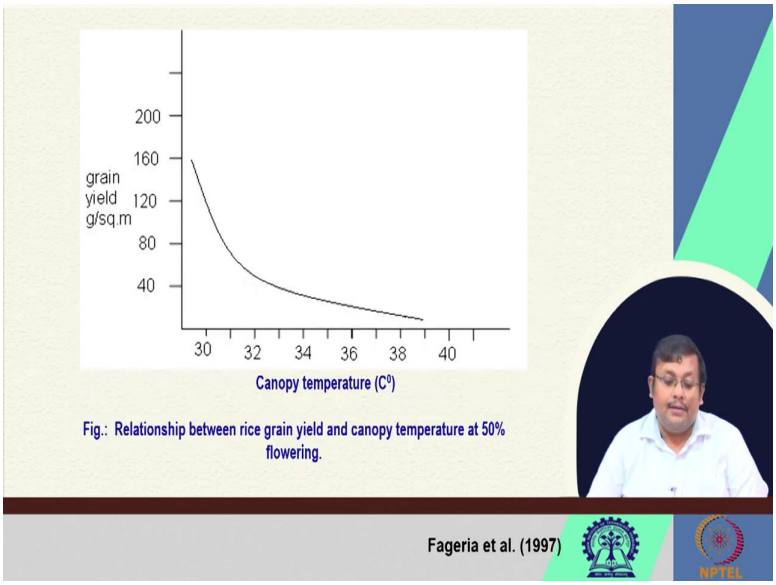

So, if we see these graph it can be it shows the relationship between the rice grain yield and canopy temperature at 50 percent flowering, we can see that as the canopy temperature increases, there is a gradual decline in grain yield per square meter. So, that shows that increase in the canopy temperature has a deleterious or inverse effect in the grain yield.

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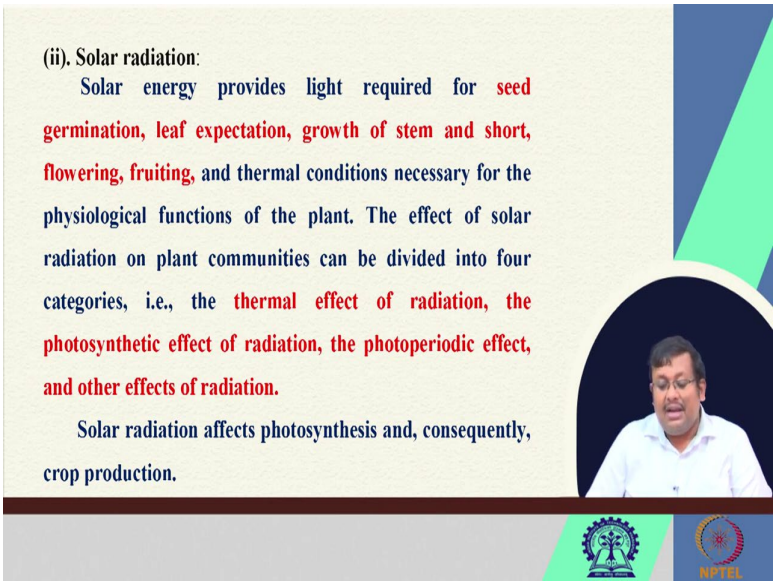

So, another important factor is the solar radiation. So, solar energy provides light which is required for seed germination and the leaf expectation, then growth of stem and short-flower growth stem and short and then flowering and fruiting and then thermal conditions which are necessary for the physiological functions of the plant. Now, the effect of solar radiation on plant communities can be divided into four categories that is thermal effect of radiation, the photosynthetic effect of radiation and the photoperiodic effect and the other effects of radiation. Now, solar radiation affects photosynthesis and consequently crop production also.

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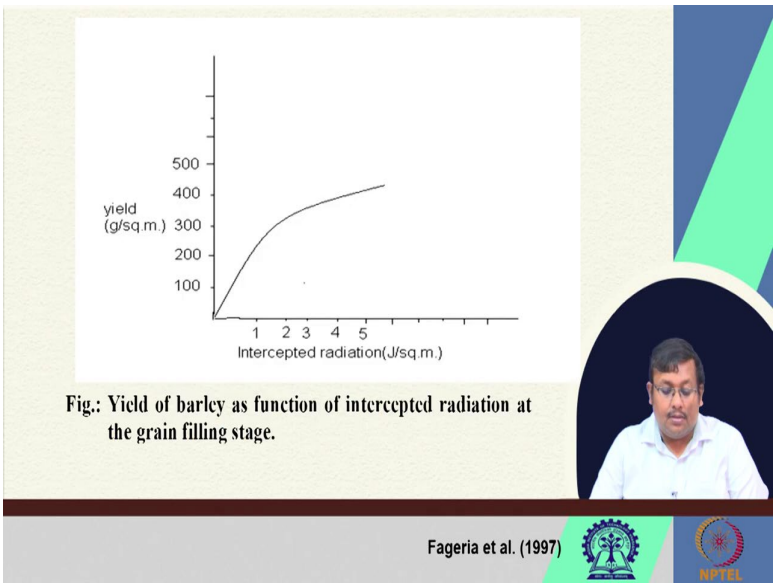

So, if you see this relationship between interceptive radiation and then yield you can see there is a positive relationship between the yield of this barely as a function of intercepted radiation at the grain filling stage.

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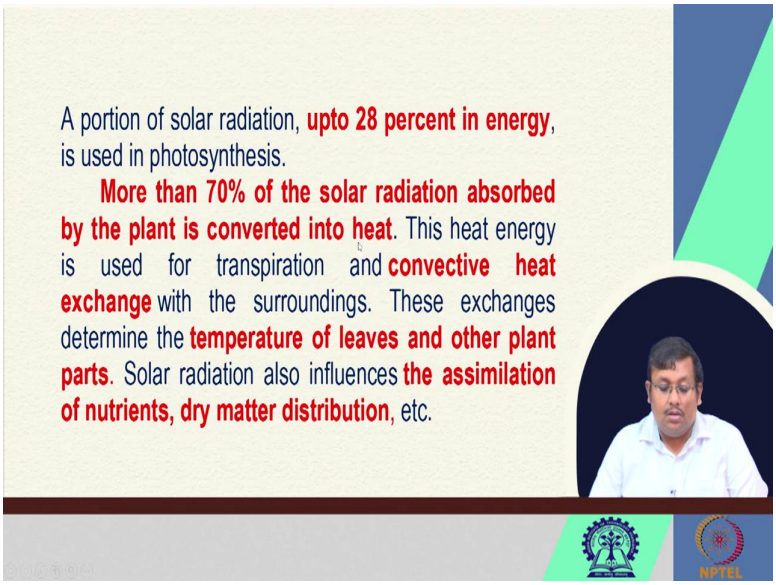

So, a portion of the solar radiation up to 28 percent in energy is used in photosynthesis. More than 70 percent of the solar radiation absorbed by the plant is converted is basically converted into heat. So, this heat energy is used for transportation and convective heat exchange with the surrounding. So, these exchanges determined the temperature of the leaves and other plant parts. Remember that solar radiation also influences the assimilation of nutrients, dry matter distribution etc.

So, not only that the solar radiation is useful for determining the temperature of the leaves and other plant parts, but also it influences the assimilation of the nutrients and dry matter distribution and when there will be dry matter accumulation distribution that will cause the yield.

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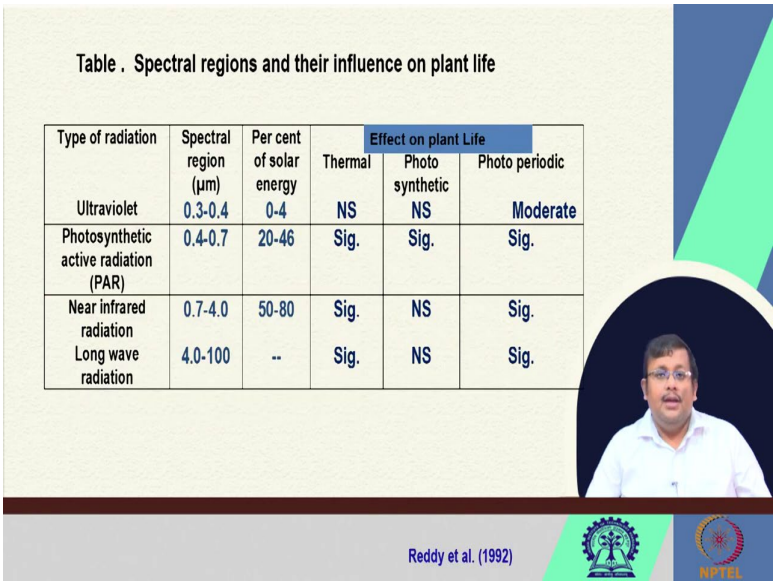

Now, if we see the spectral regions and their influence on plant life, we will see that ultraviolet radiation which is an important component of electromagnetic radiation, which is spectral region of 0.3 to 0.4 micrometer which is having 0 to 4 percent of the solar energy has moderate impact on photoperiodism of the plant, however, that have no significant impact in photosynthetic activities or thermal activities.

Now, photosynthetic active radiation or PAR, which has a spectral region of 0.4 to 0.7 micrometer, which accounts for 20 to 46 percent of the solar energy has a significant impact on thermal process, photosynthetic process and photoperiodic process of plant. In case of near infrared radiation which varies from 0.7 to 4 micrometer, which accounts for 50 to 80 percent of the solar energy can has the significant impact on thermal as well as photoperiodic properties of the plant. However, they have no significant impact on photosynthesis.

However, in case of longwell radiation, which varies from 4 to 00 millimeter, they have significant impact on thermal properties or photoperiodic properties however, they have non-significant impact in photosynthetic properties of the plant. So, these are the important concepts the important influences of solar radiation on the plant growth and ultimately on plant yield.

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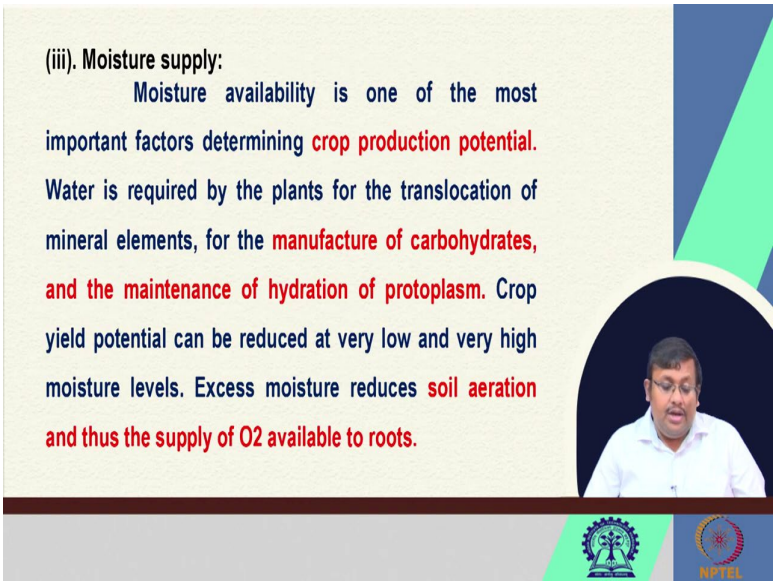

Now, moisture supply also is one of the most important factors determining crop production potential. Now, we know that water is required by the plants for the translocation of mineral elements for the manufacture of carbohydrates and the maintenance of the hydration of the protoplasm.

Now, crop yield potential can be reduced at very low and very high moisture levels. So, both these extremes are not good for plant growth and excess moisture reduces soil aeration and the supply of oxygen available to root. So, that also creates negative impact for the plant growth.

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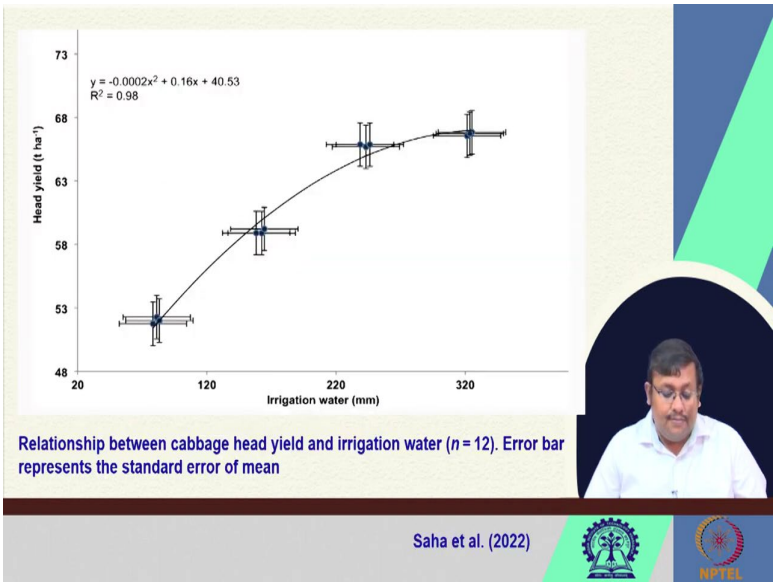

So, if we see the relationship between cabbage head yield and irrigation water, where these error bars are showing the standard error mean we can see there is a positive relationship between irrigation water availability and head yield. So, that shows the impact of water availability for the ultimate yield of the crop.

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What are the importance of soil factors? Now, soil physical, biological and chemical properties directly or indirectly affect plant root growth, absorption of water and nutrients and consequently plant growth and yield potential. We know that soil physical properties play an important role in the growth and development of the plants. So, the important soil physical properties which affect plant growth and textures are basically the soil texture, soil structure, soil consistency, soil pore space, soil density, soil tilth and soil colour.

So, a plant must have a good soil structure specifically either gram or granular soil structure for their better growth. They should have favorable soil texture so, that there should be good aeration and water movement. They should have optimum pore space which can help in water holding capacity as well as water and air movement. They should have good soil tilth whose physical condition after tillage. So, all these and they should have also the lower bulk density and this lower bulk density we can achieve by different methods, one of them is application of soil organic matter. So, the soil factors are very important for the growth of the plant or the yield of the plant.

Now, among all soil factors, soil nutrient management is the most crucial factor affecting the crops production potential. So, how bait how we can manage the soil nutrient can determine

the crops production potential. Judicious application and better management of fertilizers to the crop both chemical fertilizer as well as manual when we apply that will govern the growth and yield of the crops. So, soil factors both physical, chemical and biological factors are very much important for the growth and yield of the crops.

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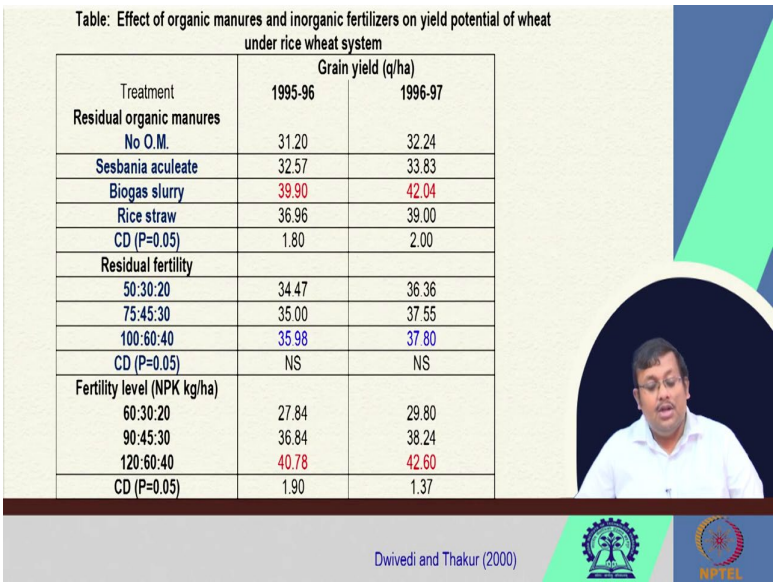

So, if we see the effect of organic manures and inorganic fertilizers or yield potential of wheat under rice wheat system you can see that there are different treatment where there is no organic matter sesbania then biogas, rice straw. We can see when we are using the biogas slurry Dwived and Thakur has shown that with the use of biogas slurry, there is an increase in the grain yield in 1995-96. And in the 1996 97 season, we can also see there is an increase in the grain yield.

If we see the residual fertility, when we apply these fertilizer 100 60 40 we can see also there will be higher grain yield and also higher in both the seasons, the highest gain in both the season we can see. And also the different types of fertility levels when you use like 120 60 40 we can get the highest grain yield in both the seasons. So, that shows the effect of organic manure and inorganic fertilizer on yield potential of the crop.

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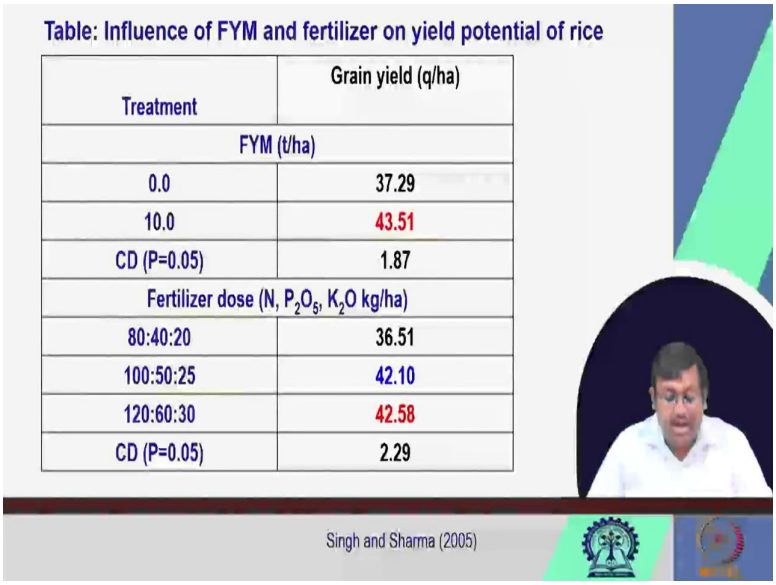

Now, if we also see the influence of FYM in fertilizer on yield potential of rice, we can see that when we are giving 10 ton per hectare FYM in the field that can increase the grain yield to 43.512 quintal per hectare. And when we are applying fertilizer dose in different ratio, when we are applying at 120 60 40 that is giving us the highest yield.

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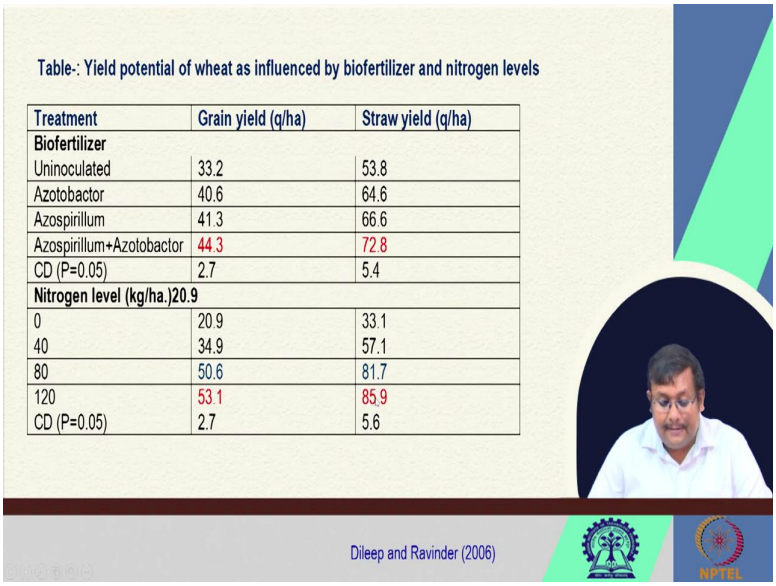

Also in this table, we can see the yield potential of wheat as influenced by biofertilizer and nitrogen level we can see when we are applying the combination of Azospirillum and Azotobactor by fertilizers together, they are giving the highest grain yield of 44.3 quintal per hectare and also they are giving the highest yield of 72.8 quintal per hectare. When you are

applying the 120 kg of nitrogen per hectare, that also gives us the highest production for both yield and straw.

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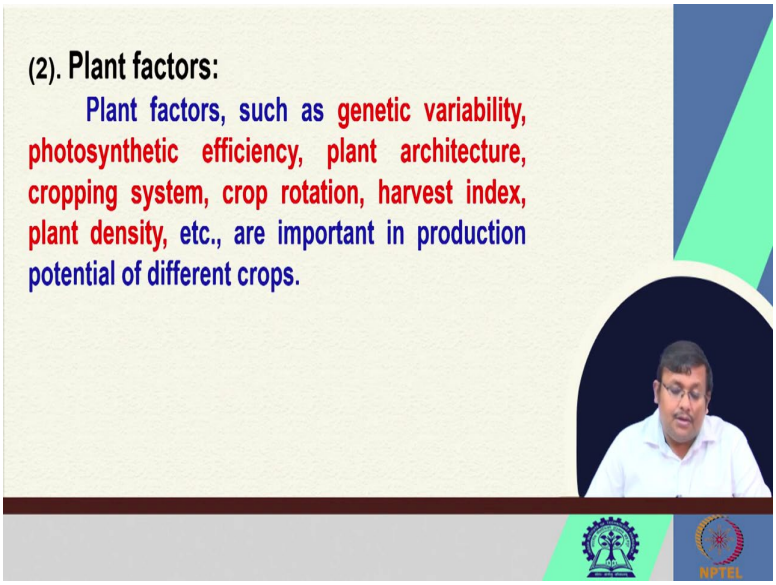

So, let us now discuss what are the important plant factors. So, plant factors such as genetic variability, photosynthetic efficiency, plant architecture, cropping system, crop rotation, harvest index, plant density et cetera are also important in production potential of different crops.

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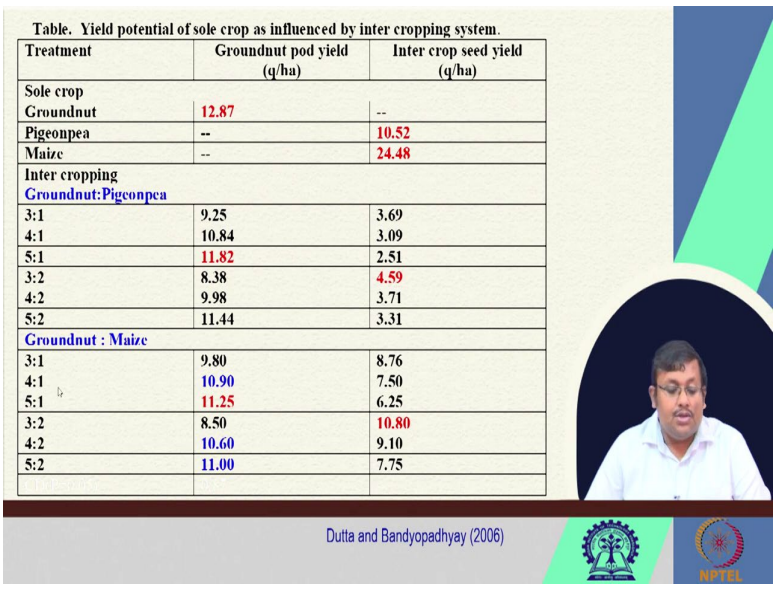
Table. Yield potential of sole crop as influenced by inter cropping system.

Treatment	Groundnut pod yield (q/ha)	Inter crop seed yield (q/ha)
Sole crop		
Groundnut	12.87	--
Pigeonpea	--	10.52
Maize	--	24.48
Inter cropping		
Groundnut:Pigeonpea		
3:1	9.25	3.69
4:1	10.84	3.09
5:1	11.82	2.51
3:2	8.38	4.59
4:2	9.98	3.71
5:2	11.44	3.31
Groundnut : Maize		
3:1	9.80	8.76
4:1	10.90	7.50
5:1	11.25	6.25
3:2	8.50	10.80
4:2	10.60	9.10
5:2	11.00	7.75

So, if you see the yield potential of sole crop as influenced by intercropping system, so, here we can use several sole crop like groundnut, pigeonpea, maize but when we are using these

intercropping using for by combining groundnut and pigeonpea we can see that we are getting the highest ground nut pod yield in as 11.82 quintile per hectare. And also we can see in case of intercropping we are getting the highest seed yield also 4.59 quintal per hectare. Also when we mix the groundnut and maize in an entire cropping we can see the highest pod yield we can see at this ratio and also, we can also see the yield highest crop seed yield when we are having the ratio of 3 is to 2.

So, that shows that when we are intercropping some of the crops in the existing crop that has the capability of enhancing the yield and that can be attributed to several factors. First of all, when we are adding or when we are introducing these crops like pigeonpea let us say this pigeonpea is a leguminous crop and when we are adding a legume in the as an intercropping that can also add not only the nitrogen to biological nitrogen fixation, but also that can add the organic matter into the field that can enhance the soil fertility and as a result that can also improve the yield of the crop. So, that is why intercropping can help in the yield of the crop.

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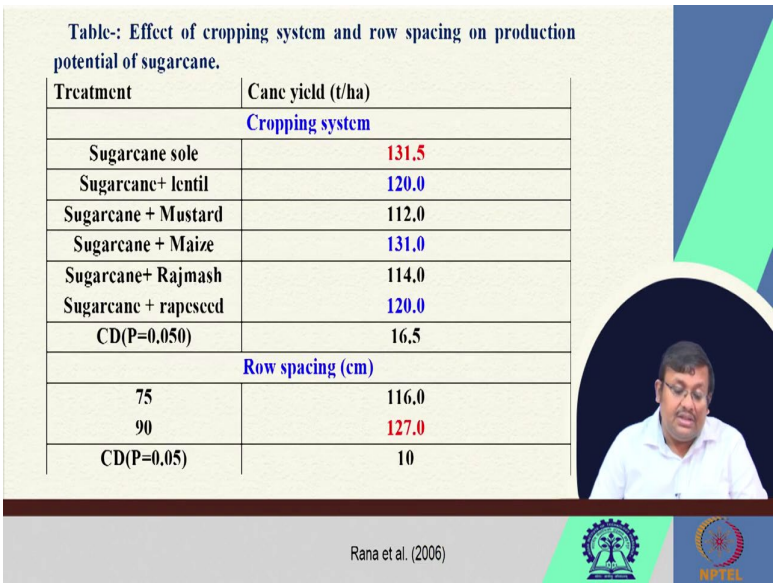

We can also see effective cropping system and row spacing on production potential of sugarcane, you can see here when we are using different cropping system like sugarcane lentils, sugarcane mustard, sugarcane maize, sugarcane rajmash and then sugarcane rapeseed. We can see when we add when we are using the sugarcane mage cropping system and also sugarcane sole cropping system. So, we are also getting very good bouquet yield we are getting, but when we are using also the row spacing you can see from 75 to 90 we are getting the 127 ton per hectare of cane yield.

So, although sugar we are using sugarcane as a sole crop we are getting 131.5 tonnes per hectare when we are adding different types of crop in the cropping system. In this example, we are not getting any significant higher or higher crop cane yield. However, the row spacing change can has influence on the cane yield. So, that shows how we select a crop, whether we go grow it in as a sole crop or whether we can grow in a that crop in a cropping system determines the yield sometime and also row spacing has an influence on the crop yield also.

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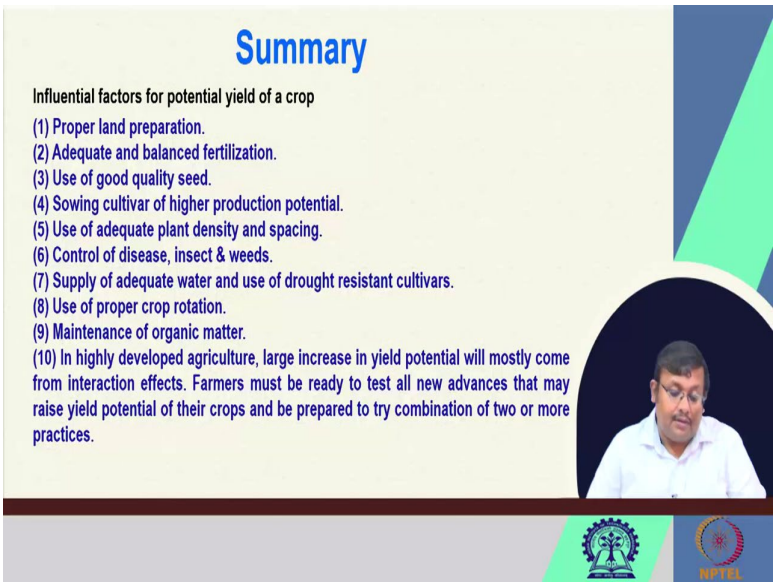

So, to summarize this lecture, we can see that there are several influential factors of potential yield of a crop and we should be very very careful while selecting those factors while considering those factors and so, that because those factors can influence the crop yield and basically a better combination of those factors needs to be selected. So, that we can ensure that we have optimum cropping.

First of all, we need to ensure that there are proper land preparations, also adequate and balanced fertilizers this very important and adequate balance fertilization, we have already discussed which is a combination of both chemical fertilizer as well as organic manure. We should use the good quality seed. We should saw the cultivar of higher production potential. We should use adequate plant density and spacing as we have seen in our last slide. We should control the disease insects and weeds so that there is no harmful impact on yield potential.

We should supply the adequate water and also we should use the drought resistant cultivars. We should use the proper crop rotation and we should always maintain the soil organic

matter. In highly developed agriculture, large increase in yield potential will mostly come from interaction effects and farmers must be ready to taste all new advances that may raise yield potential of their crops and be prepared to try combination of two or more practices. So, these are the summary of this is basically the summary of this whole lecture number 51.

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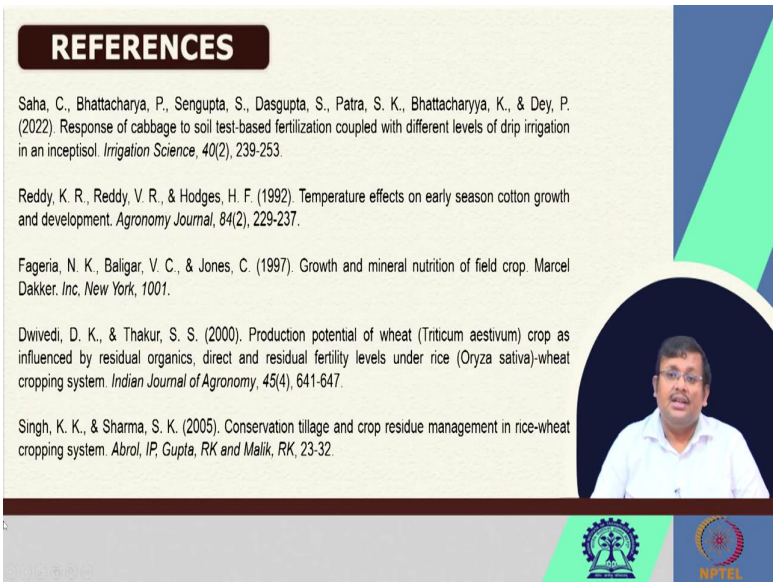

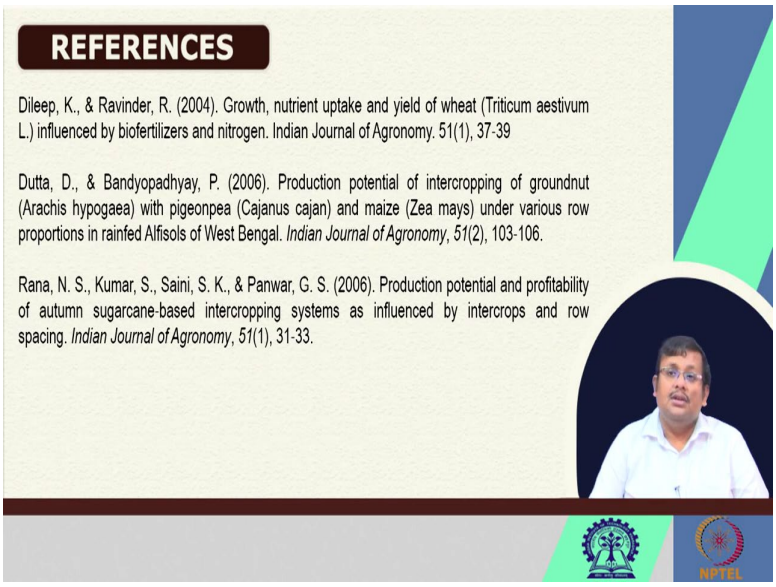

I hope that you have got some good knowledge and important knowledge and you have gotten more insight on plant yield and potential yield concept. So, these are the references which I have used for this lecture and please go through these different references and sources to see effects of different factors on plant yield potential. And if you have any difficulties, please let me know, in our forum. And also you can ask me this question in our live introduction session also.

And I will be more than happy to answer your queries. Thank you very much.

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