Course – M. Sc. Botany Part 1 Paper III

Topic –Disease forecasting system

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Forecasting:

Forecasting involves all the activities in ascertaining and notifying the growers of community that conditions are sufficiently favourable for certain diseases, that application of control measures will result in economic gain or on the other hand and just as important that the amount expected is unlikely to be enough to justify the expenditure of time, energy and money for control.

Miller and O'Brien (1952

History:

- 1911 - One of the first attempts at predicting forecasting was made by 'Lutman' who concluded that epidemics were favoured in wet and cold conditions.
- 1926 -' Van Everdingen' in Holland proposed the first model based on four climatic conditions necessary for disease development :
  1. Night temperatures below dew point for at least 4 hours.
  2. Minimum temperature no lower than 10 degree Celsius.
  3. cloud cover the following day.
  4. Rainfall in excess of 0.1 mm.
- 1933 - In England, Beaumont and Stanilund emphasized the importance of late blight occurrence.
- 1956 - Burke described the "Irish Rule " that describes the conditions favourable for disease forecasting.
- 1959 - Simcast is derived from a simulation model describing the effects of climate, fungicide and host resistance on Phytophthora Infestans.

Prerequisites for developing a forecast system:

- The crop must be a cash crop (Economic value)
- The disease must have potential to cause damage Yield losses)
- Disease assessment is essential to develop strategy for controlling a disease
- . Diseases like apple scab and potato common scab reduces the quality of the produce lower the value of the harvested crop and cause considerable financial loss to the growers.
- The disease should not be a regular feature (Uncertainty). The disease must vary each season in the timing of the first infections and its subsequent rate of progress.
- Effective and economic control known to farmers.
- Reliable means of communication with farmers.
- Farmers should be adaptive and have purchase power.
- Long-term warnings or predictions are more useful than short-term warning or predictions.

Informations needed for disease forecasting:

- ❖ Forecasting diseases is a part of applied epidemiology. Hence, knowledge of epidemiology.
- ❖ Epidemiology- development of disease under the influence of factors associated with the host, pathogen.
- ❖ The factors of epidemic and its components should be known in advance before forecasting is done.
- ❖ The informations required for forecasting are:

1. Host Factors:

a. Prevalence of susceptible varieties in the given locality.

b. Response of host at different stages of the growth to the activity of host.

c. Density and distribution of the host in a given locality. Dense populations of susceptible variety invite quick spread of an epidemic.

2. Pathogen factors:

a. Amount of primary initial) inoculum in the air, soil or planting material

b. Dispersal of inoculum

c. Spore germination

d. Infection

e. Incubation period

f. Sporulation on the infected host

g. Re-dispersal / Dissemination of spores

h. Perennating stages

i. Inoculum potential and density in the seed, soil and air

3. Environmental factors:

a. Temperature

b. Humidity

c. Light intensity

d. Wind velocity

Methods of disease forecasting:

- ❖ Disease forecasting requires field observations on the pathogen characters, collection of weather data, variety of the crop and certain investigations and their correlations. Usually the
- ❖ following methods are employed in disease forecasting,

1. Forecasting based on primary inoculums:

- Presence of primary inoculum, its density and viability are determined in the air, soil or planting material.
- Occurrence of viable spores or propagules in the air can be assessed by using different air trapping devices (spore traps).
- In the case of soil-borne diseases the primary inoculum in the soil can be determined by monoculture method.
- E.g. Loose smut of wheat, ergot of pearl millet and viral diseases of potato.

2. Forecasting based on weather conditions:

- Weather conditions viz. temperature, relative humidity, rainfall, light, wind velocity etc. during the crop season and during the inter crop season are measured.
- Weather conditions above the crop and at the soil surface are also recorded.

3. Forecasting based on correlative information:

- Weather data of several years are collected and correlated with the intensity of the diseases.
- The data are compared and then the forecasting of the disease is done.
- Forecasting criteria developed from comparisons of disease observation with standard meteorological data have been provided for diseases like Septoria leaf blotch of wheat, fire blight of apple and barley powdery mildew.

4. Use of computer for disease forecasting:

- In some advanced countries forecasting of disease is made by the use of computers which gives the quick result.
- One such computer-based programs in the USA is known as Blitecast' for potato late blight.

Examples of well-developed forecasting systems are:

A. Rice blast:

- In India, forecasting rice blast (Pyricularia oryzae) is done by correlative information method.
- It is predicted on the basis of minimum night temperature 20 to 26°C in association with high relative humidity of 90% or above.
- Computer based forecasting system has also been developed for rice blast in India

B. Wheat stem rust:

- Forecasting wheat stem rust epidemic is done by analyzing the rain samples which give precise data for inoculum present the air.
- Several wind trajectors are also prepared to survey the air-borne primary inoculums and its deposition.
- It has been observed that primary inoculum comes from South India, to the plains of Central and North India.

C. Stewarts disease forecasting system:

- ❖ Stewarts disease of corn, or Stewarts wilt, caused by is Erwinia stewartii economically important because its presence within seed corn fields can prevent the export of hybrid seed corn to countries with phytosanitary (quarantine) restrictions.
    - The corn flea beetle (Chaetocnemapulicaria) plays an important role in this pathosystem for two reasons
    - The bacterium survives the winter period in the gut of adult corn flea beetles
    - that are overwintering at the soil surface in grassy areas surrounding fields.
    - the corn flea beetle is the primary means for dissemination of the bacterium from plant to plant
    - Warmer winter temperatures during December, January, and February generally allow greater numbers of the insect vector to survive, thereby increasing the risk of Stewarts disease epidemics due to higher levels of initial inoculum (infested beetles) that will be present during the ensuring growing season.

D. Sclerotinia Stem Rot forecasting:

- ❖ Sclerotinia stem rot (Sclerotinia sclerotiorum) is one of the most important diseases on spring-sown oilseed rape.
- ❖ forecasting method of Sclerotinia stem rot has been developed in Sweden.
- ❖ The method is mainly based upon a number of risk factors, such as crop density, crop rotation.
- ❖ Level of previous Sclerotinia infestation (estimation of inoculum in soil), time for apothecia formation from sclerotia, rainfall during early summer and during flowering and weather forecast.

Models for disease prediction:

- Empirical models-based on experience of growers the scientist or both.
- Simulation models -based on theoretical relationships
- General circulation models (GCM)- based on fixed changes in temperature or precipitation has been used to predict the expansion range of some diseases- not successful

Problems with use of such models:

- ❖ Model inputs have high degree of uncertainty
- ❖ Nonlinear relationships between climatic variables and epidemic parameters
- ❖ Potential for adaptation of plants and pathogens

Successful plant disease forecasting system:

- Reliability -use of sound biological and environmental data.
- Simplicity - The simpler the system, the more likely it will be applied and used by producers
- Importance -The disease is of economic importance to the crop, but sporadic enough that the need for treatment is not a given
- Usefulness -The forecasting model should be applied when the disease and/or pathogen can be detected reliably
- Availability -necessary information about the components of the disease triangle should be available
- Multipurpose applicability -monitoring and decision-making tools for several diseases and pests should be available
- Cost effectiveness -forecasting system should be cost affordable relative to available disease management tactics.

Geographic information system:

- A GIS is a computer system designed to capture, store, manipulate, analyze, manage and present all types of spatial or geographical data
- GIS provide important tools that can be applied in predicting, monitoring and controlling diseases
- GIS can be used to determine the spatial extent of a disease, to identify spatial patterns of the disease and to link the disease to auxiliary spatial data
- Use of GIS tools on data collected to identify critical intervention areas to combat the spread of Banana Xanthomonas wilt (BXW)

success of a forecasting:

- The success of a forecasting system depends on ;
    - The commonness of epidemics (or need to intervene).
    - The accuracy of predictions of epidemic risk, like based on weather.
    - The ability to deliver predictions in a timely fashion.
    - The ability to implement a control tactic like fungicide application.
    - The economic impact of using a predictive system.

USES:

- Forecasting and assessment of disease is important for crops production management
- For timely plant protection measures
    - Information whether the disease status is expected to be below or above the threshold level.
- For loss assessment:

- Forecasting actual intensity of loss and yield reduction can be predicted.

❖ For making strategic decision
- Prediction of the risks involved in planting a certain crop.
- Deciding about the need to apply strategic control measures (soil treatment, planting a resistant cultivar, etc)

❖ For making tactical decision.
- Deciding about the need to implement disease management measure

❖ Plant pathologists and meteorologists have often collaborated to develop disease forecasting or warning systems that attempt to help growers make economic decisions for managing diseases.

❖ These types of warning systems may consist of supporting a producer's decision-making process for determining cost and benefits for applying pesticides, selecting seed or propagation materials, or whether to plant a crop in a particular area.

❖ This system is boon to growers as it encourages use of pesticide economically and as required.

❖ This not only saves the money and energy of the farmers without risking the crop health, but also avoids the environmental pollution.

CONCLUSION:

❖ A successful plant disease forecasting system is attributed to its reliability, simplicity, economic importance of crop, usefulness, availability of necessary information about the components of the disease triangle, multipurpose applicability and cost effectiveness.

❖ Plant disease forecasting systems have been developed to help growers to make important economic decisions about disease management.