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Principles and Pre-Requisites of Forecasting Systems and Factors Affecting Various Components of Forecasting

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Forecasting definition given by Miller and O'Brien in 1952: 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.

Forecasting of plant diseases means predicting for the occurrence of plant diseases in a specified area ahead of time, so that suitable measures can be undertaken in advance to avoid loss. Disease forecasts are predictions of probable outbreaks or increase in intensity of disease. It is used as an aid to the timely application of the chemicals. Disease forecasting methods are available for various plant diseases.

History of forecasting systems

1. 1911- One of the first attempts at predicting late blight was conducted by Lutman who concluded that epidemics were favoured in cold and wet conditions.
2. 1926- Van Everdingen in Holland proposed first model based on 4 climatic conditions necessary for late blight development which includes:
   - Night temperature below dew point for at least 4 hours
   - Minimum temperature no lower than 10º C
   - Cloud cover the following day
   - Rainfall in excess of 0.1mm
3. 1933- In England, Beaumont and Staniland emphasized the importance of humidity for late blight occurrence. They considered a day humid when relative humidity at 3:00pm was higher than 75%, Conditions were even more favourable for late blight development with 2 consecutive humid days and when the minimum temperature was not lower than 10ºC.
4. 1953- Burke described the Irish rules that minimum temperature no less than 10ºC and relative humidity no lower than 90% for 12 hours.
5. 1956- Smith period that the 2 consecutive days with minimum temperatures above 10ºC and atleast 10 hours with relative humidity above 90%.
6. BLITCAST- Best known prediction model, is a combination of 2 LB prediction models.
7. SimCast- It is derived from a simulation model describing the effects of climate, fungicide and host resistance on Phytophthora infestans development.
8. The latest generation of forecast systems includes more factors and interactions for predicting LB (such as pathogen life cycle, weather conditions, fungicides and host resistance. Among this type of model are PROGEB, PhytoPRE, Negfry, Prophy and SIMPHYT.

Plant disease triangle: It includes Host, Pathogen, Environment and their interaction:

Environment: It is generally assumed that environment is the driving force of the diseases. Smith and Hugh-Jones (1969) analyzed the foot and mouth disease outbreak of 1967 and concluded that weather played a greater part in the spread of the disease than was previously recognized. Meteorological data can be collected on the macro-scale at synoptic weather. The benefit of the micro-scale is that it can be identified with a specific crop and is, therefore, influenced more by the microclimate from within the crop or field. The study of environmental factors plays an important role in disease epidemiology and therefore forecasting. The basic systems consider only rainfall, its frequency and intensity; the more sophisticated include temperature, both maximum, minimum and mean, humidity and leaf wetness, wind speed and direction and hours of sunshine. The duration of these events and the period in which they fall, e.g. during night and day are also important elements of data requirement.

Inoculum: In considering any forecasting scheme, inoculum is important and its source will greatly influence the type of forecasting scheme. These include inoculum that arises from within the crop, carried on the seed or on the perennating part of the plant, such as tubers and rhizomes. Seed certification schemes play an important role in restricting this source. Elimination of inoculum may involve micropropagation or treatment by physical and/or chemical means. Volunteers (plants that grow from seed or tubers left behind after harvest) carrying infection from the previous season can be an important source of inoculum for subsequent crops. Inoculum from infected crops in adjacent fields, or from longer distances – carried in air currents or rain generated aerosols, in vectors or on passive carriers – is a major source of in-season infection. It is the latter source that is generally the concern of the disease forecaster. The absence of inoculum, or delays in its initial arrival, will affect the reliability of forecasting systems dependent solely on weather.

Host: The host, in terms of its resistance and the nature of that resistance, whether it is absent, partial or total, will affect the speed of development of the disease and therefore will interact with any forecasting scheme. The habit of the host, for example the structure of the crop canopy, will influence the way disease moves about the plant and the architecture of the plant will influence the microclimate and also the amount of damage caused by the effects of wind – important where damage or wounding can aid pathogen entry.

Positive and Negative forecasts

Positive forecasts-It employs need based chemical sprays, provide adequate protection to crop and reduce damage to environment.

Negative forecasts-It avoids unnecessary chemical sprays, no risk to the crop health and no disruption of environment.

Pre-requisites for developing a disease forecasting system are:

- The crop must be a cash crop(economic value)
- The disease must have potential to cause damage(yield losses)
- The disease should not be regular(uncertainty)
- Effective and economic control known(options to growers)
- Reliable means of communication with farmers
- Farmers should be adaptive and have purchase power

Principles of disease forecasting is based on:

- The nature of the pathogen (monocyclic or polycyclic)
- Effects of the environment on stages of the pathogen development
- The response of the host to infection (age-related resistance)
- Activities of the growers that affect the pathogen or the host

Basis of forecasting

- Forecasts based on assessment of amount of initial inoculum
- Forecasts based on weather conditions favouring development of secondary inoculum
- Forecasts based on amount of initial and secondary inoculum

Models for Disease Prediction

- **Empirical models**- based on experience of growers, scientists 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 variations and epidemic parameters
- Potential for adoption of plants and pathogens

Uses of disease forecasts: Forewarning or assessment of disease is important for crop production management

- For timely plant protection measures -Information weather the disease status is expected to be below or above the threshold level is enough.
- Loss assessment
- For making strategic decision-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 measures.

Successful plant disease forecasting systems must have following key points:

- 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
- 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

Computer based forecasting programmes

- **BLITECAST**-Late blight of potato
- **EPIDEM**-Early blight epidemics in tomato
- **EPIMAY**-Southern maize leaf blight
- **EPIVEN**-Apple scab

Success of a forecasting system depends on some things given below:

- The commonness of epidemics
- The accuracy of predictions of epidemic risk
- The ability to deliver predictions in a timely fashion
- The ability to implement a control tactic
- The economic impact of using a predictive system