SCIENTIA AGRICOLA

EDITORIAL

Production of food and fibre in the natural environment has had an intimate relationship with climate and weather for as long as humans have been cultivating crops. Over time, humans developed practices that were based on their understanding of weather and climate patterns. They were of course, mystified and frustrated by the variability of seasons and even the day-to-day weather and climate patterns.

Agricultural meteorology, abbreviated as agrometeorology, is an interdisciplinary science that interprets and advances the science of meteorology to serve agricultural activities. A more inclusive definition of agricultural meteorology deals with water, heat, air, and related biomass development, above and below ground, in the agricultural production environment, including the impacts of pest and diseases that also depend on these factors.

The classic disease triangle recognizes the role of climate in plant diseases as no virulent pathogen can induce disease on a highly susceptible host if climatic conditions are not favourable. Farmers now recognize that a sensible form of protection is to base application of the pesticides on weather conditions and know the relationship between the development of the disease and other environmental factors. Progress made in the understanding of disease epidemiology through a systematic approach consisting of a stepwise analysis of the events determining an epidemic has revealed the need for a more precise knowledge of the relationship between climate, pathogen, host and the resultant disease. Climate influences all stages of host and pathogen life cycles as well as development of disease. Pathologists have for many years included leaf wetness with climatic variables to indicate the likelihood of changes in disease levels in crops.

To account for the impact of weather and climate variability on disease and pest incidence, information on agrometeorological variables such as relative humidity, maximum and minimum air temperature, soil temperature, total solar radiation, total rainfall and wind direction and wind speed is vital. Microclimate, a mixture of climatic factors (e.g. temperature, humidity, wind, and quantity of energy, etc.) near the ground, is the climate where plants and animals live and affects considerably the disease severity. The climatic factors affect the distribution, development, survival, behaviour, migration, reproduction, population dynamics and outbreaks of insect pests and diseases and their severity over a period can fluctuate according to climatic variation since climatic factors control the population growth rate of pathogens and insects. If climatic factors are not adverse enough to cause extinction, their populations can rise exponentially.

Aphids and plant hoppers are the principal vectors of plant viruses. The seasonal life cycle of insects vary with climate and also from year to year. In temperate and moist tropical climates, temperature is the most important regulating factor, whereas rainfall is vitally important in the arid climates. Viruses spread fastest under conditions optimal for insect multiplication and activity.

Experience over the past few decades has shown that the high performance of plant production in most of the developed countries would not have been possible without a well organized plant protection service securing the identification of pests and diseases and supported by scientists with a good understanding of population dynamics and epidemiology and capable of running a forecasting service based on surveillance network and agrometeorology. This represents the minimal structure to assist the growers and advise them on pesticide usage.

Agrometeorology can be applied to the analysis and modelling of plant disease development and creating a Decision Support System (DSS) for the operational management of crop protection. Mathematical models have been developed to understand and forecast the cycle of pests based on climate data. For example, leaf wetness duration (LWD) is a key parameter related to epidemiology of many important crops, controlling pathogen infection and development rates. Predicting consecutive multiple day periods of LWD above a threshold value is important for forecasting diseases. Because LWD is not widely measured, several methods have been developed to estimate it from weather data. Among the models used to estimate LWD, those that use physical principles of dew formation and dew and/or rain evaporation have shown good portability and sufficiently accurate results. These models were used to compute the probability of particular episodes occurring in any month, the return period of extreme episodes and the average temperature associated with different lengths of leaf wetness duration, but their complexity is a disadvantage for operational use. Alternatively, empirical models have been used despite their limitations. The simplest empirical models use only relative humidity (RH) data e.g., constant and extended RH thresholds and dew point depression.

In the past decade, a large number of Decision Support Systems (DSS) have been developed to assist extension agents, consultants, growers, and other agricultural clientele in the management of plant diseases e.g., WISDOM for potatoes (University of Wisconsin), RADAR for apples (University of Maine), PAWS for several crops (Washington State University), and a DSS used for a variety of crops on the West Coast (Fieldwise.com). The DSSs vary in complexity, with production guides at the simple end of the spectrum and a full-expert system at the complex end. While the advantages of a simple DSS include: low cost, low technology, generic application, ease of delivery in multiple ways, and limited time requirements for learning and use of the DSS, the more sophisticated DSS can provide greater integration of knowledge and allow growers to choose management tools and their associated risks. The selection of an appropriate DSS for a given cropping situation often depends upon the pathogen–pest complex as it interacts with crop and grower preference factors. A large number of simple DSS tools are not widely used because they address only specific disease problems, whereas agricultural producers must manage the whole pest and disease complex within their production system.

Current concerns with climate change led to many researches on how climate change may affect plant diseases and these have concentrated on the effects of a single atmospheric constituent or meteorological variable on the host, pathogen, or the interaction of the two under controlled condition. However, interactions are more complex in the real situation, where multiple climatological and biological factors are varying simultaneously in a dynamic environment. Climate change has the potential to modify host physiology and resistance and to alter the stages and rates of development of the pathogen. The most likely impacts would be shift in the geographical distribution of the host and pathogen, change in the physiology of host-pathogen interactions and change in crop losses. New disease complexes may arise and some diseases may cease to be economically important if warming causes a poleward shift of agroclimatic zones and host plants migrate into new regions. The pathogens would be following the migrating hosts and may infect vegetation of natural plant communities not previously exposed to the often more aggressive strains from agricultural crops. Facultative parasites with broad host range may infect plants in their proximity. The mechanism of pathogen dispersal, suitability of the environment for dispersal, survival between seasons, and any change in host-physiology and ecology in the new environment will largely determine how quickly pathogens become established in a region.

Plants growing in marginal climate could experience chronic stress that would predispose them to insect and disease out breaks. Warming and other changes could also make plants more vulnerable to damage from pathogens that are currently not important because of unfavourable climate. Under climate change plants may potentially be unable to migrate or adapt as readily as environmental conditions change. But most pathogens have advantage over plants because of their shorter generation time and in many cases the ability to move readily through wind dispersal. Because of these characteristics, rate of evolution will be highest among pathogens to reduce sensitivity to climate change phenomenon.

Solutions to disease problems must be location, crop and disease specific. Meteorological observations, forecasts and outlooks, coupled with plant and disease observations, can help to predict the development of key diseases and can be used to schedule control actions for preventing disease development or protecting an infested crop. Where feasible, farmers can modify the microclimate e.g., through pruning to reduce humidity within the plant canopy and reduce the likelihood of infection from plant pathogens.

I am pleased to see that this special number of Scientia Agricola about Agrometeorology and Plant Disease contains a number of interesting agrometeorological applications for the monitoring and forecasting of important diseases such as grape downy mildew, potato leaf blight, black sigatoka of banana, soybean rust etc., A number of papers are addressing the important aspect of leaf wetness duration and how it can be estimated effectively for disease forecasting purposes. Two papers have dealt with climate change impacts on plant diseases and on the need to help the farmers cope with climate risks.

Given the current concerns with the food prices and the need to enhance the efficiency of the farming sector to meet the growing need for food, especially in the developing countries, it is vital that losses due to diseases during the crop growing season as well as during post-harvest storage be reduced. Uncoordinated or uncontrolled application of pesticides and fungicides often results in excessive use of chemicals that may harm human health and the environment. An approach involving simple field scouting for diseases, weather monitoring, and use of disease forecasting models in an integrated framework could help develop whole farming systems which are ecologically sound and economic.

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