11.1 INTRODUCTION

Knowledge of plant disease epidemiology has had increasing impact in the production-based industry of both the developed and developing world. In the last 50 years European agriculture has been associated with a move towards the simplification of systems, as farms have tended to specialize in arable or livestock production, largely determined by their soil or climatic conditions. Although cereal monoculture is no longer such a common practice as during the 1970s and 80s, the production of autumn-sown combinable crops still dominates large areas. The adverse effect of this on the biodiversity of the countryside has been accentuated by advances in the control of weeds and pests – with consequent direct and indirect effects on non-target species and thus on the food chains dependent on them. Fungicides have had far less deleterious environmental impact, though the vermicidal effects of benomyl and the insecticidal properties of pyrazophos gave cause for concern when these were widely used.

In recent years there has also been an increasing awareness that modern arable agriculture is dependent on non-renewable resources. While the same criticism could be levelled at most other industries, agriculture is one of the few which, since it is by its very nature producing renewable resources, could use this ability to reduce its reliance on external inputs.

Sustainability means different things to different people. In this chapter, we have adopted the definition used by the UK Government (Anon., 1994), the agricultural elements of which are:

- To provide an adequate supply of good quality food and other products in an efficient manner.
- To minimize consumption of non-renewable and other resources including by recycling.
- To safeguard the quality of soil, water and air.
- To preserve and where feasible enhance biodiversity and the appearance of the landscape including the UK’s archaeological heritage.
- To encourage environmentally sensitive agriculture.

The aim must be to maintain the economic viability of individual farms while avoiding the unnecessary use of resources and deleterious effects on the agro-ecosystem. Sustainability does not necessarily imply low inputs; it does depend on their optimal use. Disease control, for example, will rely heavily on husbandry practices that reduce...
disease. The definition of sustainability used here would embrace the integrated crop management (ICM) systems, which have become the key elements of recent attempts in western Europe to produce a more environmentally benign agriculture, and would also include ‘organic’ systems of production. In this chapter we use the term ‘organic’ to describe crops grown “without artificial chemicals or genetic modification” (HRH Prince of Wales, Soil Association literature).

Disease control in both ICM and organic systems involves the sound application of epidemiological principles and may be seen as the practical application of the concepts expressed by Van der Plank (1960) as:

\[ \Delta t = \frac{(230/r) \log(I_0/I'_0)}{11.1} \]

where the expected delay (\(\Delta t\)) in the development of an epidemic is dependent upon the reduction of the initial inoculum from \(I_0\) to \(I'_0\) and the rate of disease increase (\(r\)). This chapter considers how such epidemiological information can be used in conjunction with cultural and crop management to reduce the initial inoculum (\(I'_0\)) and the rate of disease development (\(r\)).

11.2 INOCULUM

The first phase of a disease epidemic depends on the level of inoculum present when the crop is first exposed to infection and on the ability of the pathogen to take advantage of this initial vulnerability of the host to become established in the crop. This ability is usually dependent upon climatic (or micro-climatic) conditions at the time. The importance of these factors relative to those influencing the later stages of epidemic development varies widely from disease to disease, as does the feasibility of reducing inoculum potential as a method of disease control in a sustainable arable system. This may be illustrated by reference to some of the more common diseases of arable crops.

11.2.1 Seedborne inoculum

There are many examples of seedborne inoculum initiating epidemics and this is the primary infection source for a number of major crop diseases (see Chapter 13). Bunt of wheat (caused by *Tilletia tritici*), may be considered as an example. The control of bunt has long depended primarily on the control of inoculum. The disease is usually introduced into a crop on the seed sown, although infection from soilborne inoculum may occur. A low level of infection in a crop may go unnoticed but, if seed is saved from such a crop, a much higher level of disease is likely to occur in the following year. The millions of spores released from bunted ears during threshing become dusted onto the surrounding healthy seeds and thus act as a potent source of inoculum for the following season’s epidemic. Dillon Weston and Engledow (1933) calculated the potential rate of increase in infection levels that could occur in a stock of wheat from which seed was saved, but not treated, over a three-year period. If one ear in 8500 is affected by bunt in year 1, one in 450 could be infected in year 2 and one in four in year 3. The proportion of ears developing the