11 Disease Management by Chemicals

'It was, finally, a matter of trying a large number of remedies, assuring myself of their merits, making them easy of execution, of taking into special account their economy of application, and of winning the confidence of the farmer.' [M. Tillet, 1714–1791]

In an age of increasing environmental awareness, the use of chemicals to control pests, pathogens and weeds is now questioned. This is part of the wider debate about intensive agriculture and its effects on the environment, but the issue of chemicals has become particularly emotive. There is nowadays no shortage of critics eager to discredit the manufacturers and users of pesticides. But this state of affairs is a recent development, and should not obscure the relief and excitement which greeted the discovery of the first effective pesticides, which provided growers with a quick, economic means to control previously destructive infestations and diseases. The stability and security of food supplies in the developed world is due in part to the success of this strategy. While assessing the current status of the chemical control of plant diseases it is important to maintain this historical perspective, and to consider the achievements as well as the problems posed by the use of chemicals in crop management.

The following account will focus on fungicides, as these are the chemicals most frequently used to control plant diseases. Many of the basic principles discussed, however, apply equally well to other important types of crop protection chemicals, such as insecticides and herbicides.

Fungicides

The evolution of fungicides

The fungicidal properties of certain chemicals have been known for many years. The first fungicides, based on sulphur and copper, were discovered in 1846 and 1882, respectively. The discovery of Bordeaux mixture, based on copper sulphate and lime, by Pierre Millardet in France, is one of the most familiar stories in plant pathology, starting with the chance observation that copper salts applied to grapevines to deter thieves also controlled infection by the downy mildew pathogen, *Plasmopara viticola*. Millardet's achievement was to translate this observation into practical use by developing formulations of copper for effective commercial application on crops. During the century since this discovery, fungicides have diversified and changed dramatically (Fig. 11.1; Tables 11.1 & 11.2). The early inorganic compounds have now been superseded by organic chemicals which are active at very low doses, are effective against a wide range of fungal pathogens, and can be applied with precision by machinery appropriate to a small plot or a 1000-ha plantation. However, if pioneers such as Millardet were still alive today, two features of the current fungicide market (Fig. 11.2) would surprise them. Firstly, many of the old, original compounds are still widely used. Secondly, almost all the modern generation of fungicides were discovered by a process not dissimilar to Millardet's initial observation, with the most effective compounds being selected by random screening for activity against a few fungi chosen to represent the most important target pathogens. Only in the past few years, with advances in molecular biology, structural chemistry, and computer technology, has the prospect of designing molecules to perform specific tasks become a reality.

The perfect fungicide

It is relatively easy to compile a list of the desirable properties one would like any new fungicide to