Chapter 3

Measuring Plant Disease

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1 Introduction

The measurement of disease intensity plays the same key role for plant pathology as does diagnosis. Without quantification of disease no studies in epidemiology, no assessment of crop losses and no plant disease surveys and their applications would be possible. Disease assessment is also needed for many other applications in plant pathology, such as screening for resistance and fungicides. It expresses the effects of various treatments or factors on disease in experiments, and disease control.

Under measurement we also include assessment methods used to estimate disease intensities. Except for precise laboratory or field studies, disease intensities must be estimated, unless some equipment (see pp. 45–46) can ensure precise measurements. These methods have varying degrees of sophistication, accuracy and precision. For field studies they should be easy and quick in use for a wide range of conditions but also adequately reliable and reproducible, accurate and precise. This is not always achieved and for more refined studies the presently available methods of measurement are often unsatisfactory. Reasons for this are discussed in a number of publications to which we refer in this chapter (Horsfall and Barratt 1945; Large 1966; Kranz 1970; Amanat 1977; Berger 1981; Sherwood et al. 1983; Seem 1984; Forbes and Jeger 1987).

In disease assessment we distinguish two distinct components: (1) disease assessment proper, and (2) sampling techniques. Both components imply different aspects. In the context of this chapter we shall deal first with assessment, then with a description of techniques employed and, finally with some specific applications of them. We cannot, however, give here an answer to every problem which may arise.

2 About Terms

Disease intensity can be expressed either as incidence (or frequency) or severity. *Incidence* is the percentage of diseased plants or plant parts in the sample (or population), irrespective of their individual severity. Disease *severity* is the percentage of the relevant host tissue or organ covered by symptoms (or lesions) of the disease. Severity results from the number and size of lesions. These two components of severity may change independently during disease progress. When intensity values are divided by 100 they become the y ($0 < y \leqq 1$) values as used in infection rates.

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The choice between evaluation of disease according to its *severity* or incidence depends largely on the type of disease and on the objective of disease assessment. Disease severity appears to be more appropriate for rusts, downy and powdery mildews, leaf spots and similar diseases. If not stated otherwise, each severity value comprises both the number of lesions and the total of their area. In some cases it may be essential to differentiate between the symptom area proper and the chlorosis, necrosis or leaf shedding caused by the pathogen indirectly. In specific cases there is a difference between disease severity and destruction which may result from disease – accelerated senescence of the host (Seem 1984). For crop loss assessment such a distinction may be irrelevant but it may be important for purely epidemiological purposes. Hence, when measuring disease it should be made clear whether disease and/or destruction is referred to.

Evaluation of disease itensity according to its *incidence* is suitable for most diseases in the early stages of their epidemics. But it applies mainly to disease which affects entire plants, e. g. systemic virus diseases, wilts, smuts or spots on fruits, if one lesion makes the latter unfit for sale. Disease incidence can be assessed by simple counting of diseased vs healthy sampling units (see p. 45) and thus is less cumbersome and error prone than assessment of disease severity. Sampling units may, however, be defined diseased only if disease severity is beyond a certain level (e. g. physiological damage threshold) and then assessed as disease incidence. Figures for disease intensity should be unconfounded, or, as Large (1966) stated "... results must be easily communicable to others...". Disease

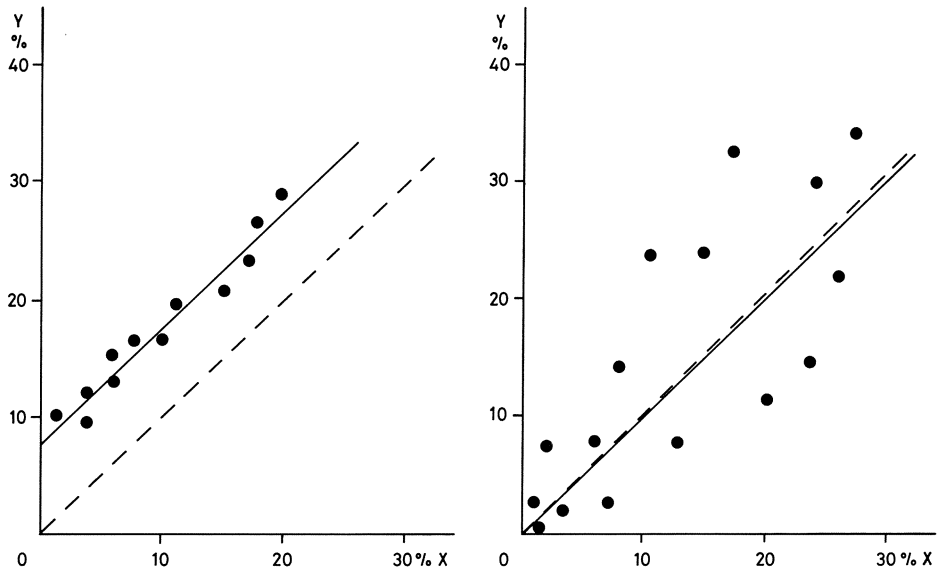

Fig. 3.1 Examples for accuracy and precision in disease assessment. The *abscissa* gives the true, the *ordinate* the estimated severities in percent; the correct estimates for both assessors should have been on the *broken line*. The person on the *left* made inaccurate but (within his concept) very precise estimates, whereas mean estimates of the one on the *right* were highly accurate but imprecise (Amanat 1977)