

Practical considerations for estimating foliage late blight severity in the field

Estimation of severity is crucial to study epidemics of potato late blight (LB) (see [Estimation of Disease Severity](#)). Severity is used to graph disease progress curves and to calculate epidemic descriptors, such as the area under the disease progress curve (AUDPC) and the apparent infection rate (r) (see [Summarizing the Epidemic](#)). Several questions may be raised when estimating foliage LB severity in the field.

What method to use? The International Potato Center (CIP) recommends simply estimating the percentage of foliage affected by LB. Illustrated keys for whole plants (Figure 1, 4) or leaves (Figure 2, 8) can be used as reference. The modified blight rating system (see [Estimation of Disease Severity](#)) can be used if greater precision is required. Readings across the season in a certain experiment should be done by the same person to avoid inter-assessor variability.

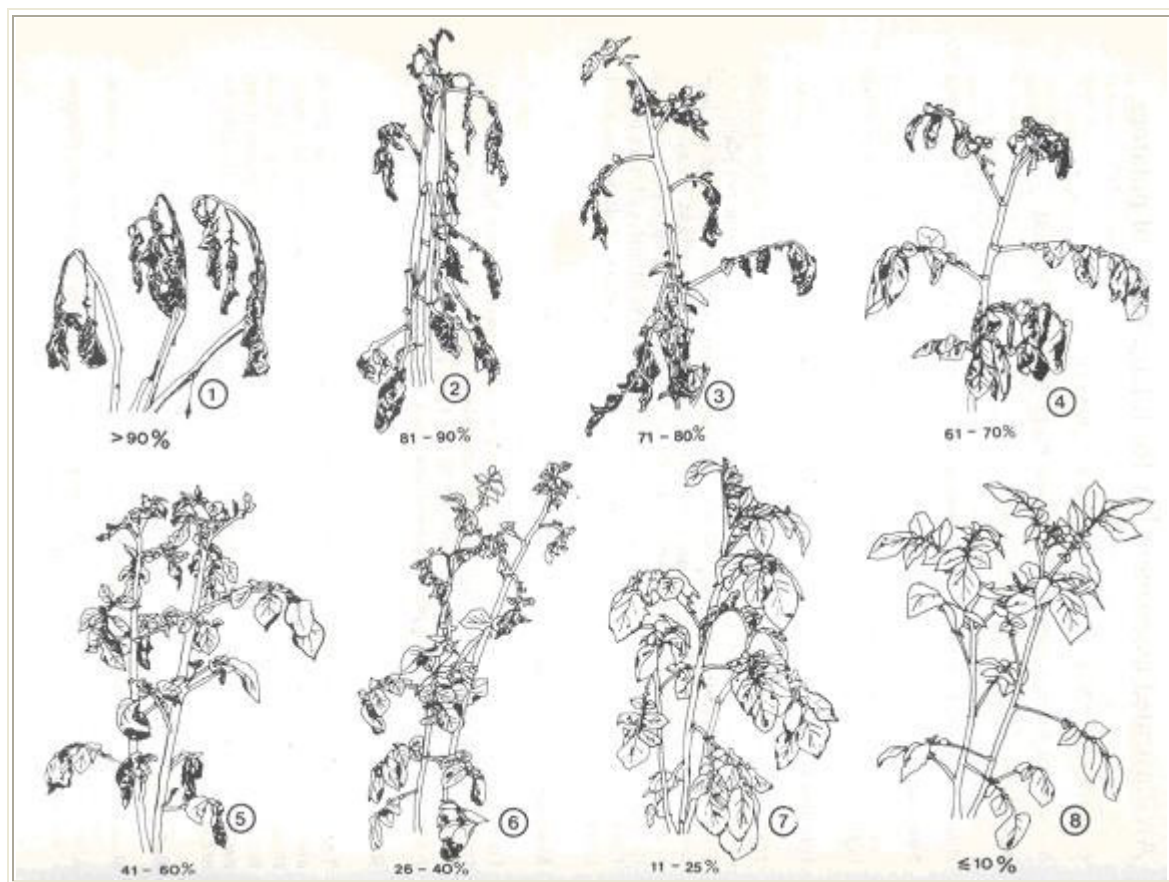


Figure 1. Key to evaluate percent infection of late blight in potato plants. Reproduced from Cruickshank et al. (4).

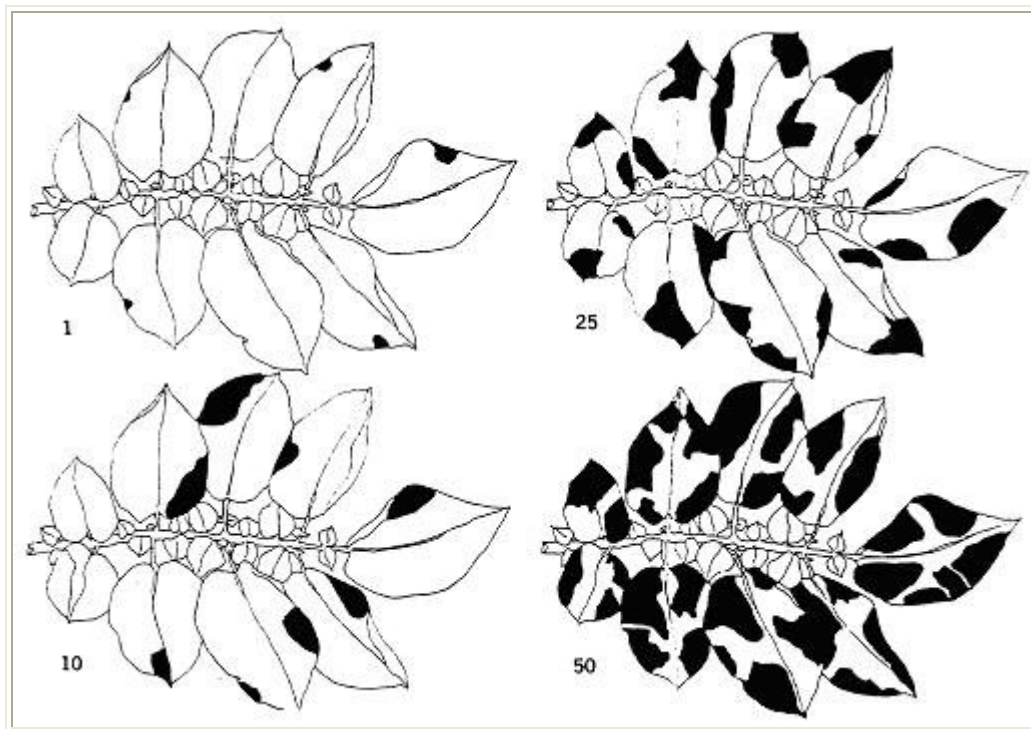


Figure 2. Key to evaluate percent infection of late blight in potato leaves. Reproduced from James (8).

Severity is estimated in each experimental unit several times across the growing season. The results are written in a datasheet (Table 1) preferably printed in dark tone paper to avoid reflection of sunlight. If possible, the evaluations should be made early in the morning or in overcast days, because excessive sunlight may difficult the readings (7). Depending on the size of the experimental unit and the variability within it, it may be possible to take more than one reading per unit and use the average for the calculation of descriptors. In that case, the experimental unit could be divided into quadrants (Table 2) as described by Fry (5) (see [Estimation of Disease Severity](#)). Also, it is best to record readings independently (i.e., without knowing the value given at the previous reading) at each date, such as having someone else write in the field book or by using a cassette recorder (7).

Table 1. Datasheet for evaluation of potato late blight severity (%) in an experiment with 2 treatments, 3 repetitions, and 3 evaluation dates.

Treatment	Repetition	15-aug	30-aug	15-jul
A	1	0	1	5
A	2	0	3	5
A	3	0	1	5
B	1	0	0	1
B	2	0	0	3
B	3	0	0	1

Table 2. Datasheet for evaluation of potato late blight severity (%) in an experiment with 2 treatments, 3 repetitions, 4 quadrants per repetition, and 3 evaluation dates.

Treatment	Repetition	Quadrant	15-aug	30-aug	15-jul
A	1	1	0	3	10
A	1	2	0	1	5
A	1	3	0	0	5
A	1	4	0	0	0
A	2	1	0	5	10
A	2	2	0	1	3
A	2	3	0	1	3
A	2	4	0	5	5
...
B	3	1	0	1	1
B	3	2	0	0	1
B	3	3	0	0	1
B	3	4	0	0	1

It is recommended to confirm that what it is being evaluated is indeed LB. Other diseases (e.g., early blight), frost, and herbicides cause necrosis that may be misinterpreted as LB (7). Inexperienced evaluators may use field microscopes to verify the presence of sporangia and sporangiophores. In closed canopies, it is advisable to take a closer look within them, because there is usually more disease in the lower than in the upper leaves.

When to start? The time to start the severity readings depends on the objective of the experiment and on weather conduciveness for LB. Depending on the objective of the experiment, severity readings should start before the initiation of disease or as soon as the symptoms appear. In experiments for validation of LATEBLIGHT, a LB simulator (1), it is critical to have an accurate estimation of the time when disease starts and initial severity (2). Therefore, severity readings should start before the initiation of disease. In experiments for evaluation of treatments to control LB (e.g., potato genotypes, fungicides, etc.), severity readings should start as soon as the symptoms appear. Otherwise, part of the disease progress curve of the less effective treatments would not be considered and epidemic descriptors, such as AUDPC, would be biased.

Weather conduciveness for LB also determines the time to start the severity readings. In locations/seasons with very conducive weather (and inoculum available), LB can appear a few days after plant emergence (2). Thus, it is advisable to start the readings as soon as the plants emerge. In locations/seasons with less favorable weather, there is no a defined moment to start the severity readings and frequent scouting is required.

How many readings? The number of severity readings depends on the objective of the experiment and on the expected speed of the epidemic. If the objective of the experiment is to evaluate resistance of many potato genotypes against *P. infestans* and AUDPC is used as epidemic descriptor, then the number of readings could be as low as 2 (6,9). The first severity reading must be made shortly after the epidemic has started, and the second when the

epidemic has reached its peak (100% severity) in the most susceptible genotypes (6). Using 2 severity readings is recommended when time and economic resources are tight, but there are two conditions that must be met: (i) the period of time that disease is present must be the same for all the genotypes, and (ii) the disease must progress as a sigmoid curve (6).

In experiments in which non-sigmoid progress curves are expected (e.g., in experiments to test fungicides), or in those in which an accurate estimation of disease progress curves is needed (e.g., in the validation of a disease model), the number of severity readings depends on the expected speed of the epidemic. In locations/seasons with very conducive weather for LB and susceptible potato genotypes, a high level of disease (e.g. 50% blight severity) may be reached in a few days (3) and, therefore, severity should be evaluated frequently (5 to 7 days). In locations/seasons with less favorable weather and/or resistant genotypes, 50% blight severity may be reached in a longer period (3), and the interval between evaluations can be longer (10 to 14 days).

The intervals between evaluations are flexible, especially if AUDPC is being used as epidemic descriptor. If an accurate estimation of disease progress curves is needed, then the intervals are still flexible, though it is advisable to try to keep them constant.

When to finish? It depends on the objective of the experiment and the variables to evaluate the treatments. In experiments to evaluate the resistance of potato genotypes against *P. infestans* by using AUDPC and/or *r*, the severity readings should be finished when the most susceptible genotypes reach 100% severity. If readings are taken too long after susceptible genotypes reach 100%, the differences in AUDPC between resistant and susceptible genotypes may be underestimated. In the case of *r*, the logistic transformation is undefined at severity values of 100%.

In experiments in which the efficacy of a certain treatment (e.g., potato genotype, fungicide, etc.) is evaluated by measuring yield, or in those to validate a disease model, it is advisable to continue the severity readings until plants in LB-free treatments start to senesce. These treatments are obtained usually with continuous applications of fungicides against *P. infestans*.

References

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