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UNIVERSITY OF KENTUCKY — COLLEGE OF AGRICULTURE

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Plant Pathology Fact Sheet

Assessing Foliar Diseases of Corn, Soybeans, and Wheat
—Principles and Practices—

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Introduction

County Extension agents and other agricultural professionals interested in crop production sometimes have a need to answer important applied questions. While written resources from the Extension service, land grant universities, and other sources are valuable, sometimes conducting on-farm field research provides very important information of use to local producers. If these on-farm studies relate in some way to crop diseases, collecting valid data on disease can greatly improve the value of the field trial.

This publication provides basic information on how to conduct disease assessments in on-farm trials. The focus is on foliar diseases, since root diseases are much more difficult to assess properly. The publication begins with fundamentals of proper design of field trials.

Experimental design

Randomization

The experiment should be designed so that treatments are assigned randomly. Randomization is essential as a means of reducing unintended bias in the study. It may be hard for the novice to understand this, but randomization is so fundamental, that failing to randomize treatments in a field trial invalidates the field trial. That's right—it invalidates the field trial.

A fast and practical way to randomize two treatments within a replication is to flip a coin. For tests with more than two treatments, treatments can be randomized by associating each one with a letter in the alphabet. Then take any written document and assign the treatment order based on when the letter comes up in the text. For example, if there are three treatments, associate treatment 1 with the letter "A", treatment 2 with "B", and treatment 3 with "C". If the text reads, "On **a c**lear night, the **b**ayou is most beautiful," then the treatment order in the replication would be 1, 3, 2. For more treatments, simply go further into the alphabet.

Replicating Treatments

Inherent in all field experiments is variation outside the tester's control, such as soil

conditions and weather. Furthermore, it is not possible to know how much environmental variation there is across a field. Consider the World Series: No one expects that the better team will always win the first game. We all understand that a best-of-seven series (=replication) has a better chance of identifying the better team. Replicating (repeating) treatments helps account for natural variability within the test and location.

Typically, the more replications, the better the ability to sort out true treatment effects from natural variation. Three is the minimum number of replicates and is a good target for tests with large plots. For tests with small plots, increase the replication number to four or five. Replicating only a control (or any single treatment), while other treatments are tested without replication is an **invalid** experimental design.

Other Set-up Tips

Treatment strips should be wider than the combine (to avoid border effects like spray drift). Don't include parts of the field with tree lines, heavy weed pressure, soil compaction, or other factors that will affect yield. Do whatever you can to minimize the impact of variations in soil fertility or soil type in the experiment.

Rating Disease in Corn, Soybean, and Wheat

There are various methods for rating leaves or whole plants for disease levels. Examples are shown in the figures and table that follow. It is important to use the same rating scale throughout a particular test. Additionally, be consistent with ratings within a replicate. (A replicate is a block of all treatments included in the test, each represented once.)

The following are some additional tips for conducting disease ratings:

- Record the crop growth stage at the time of disease assessment.
- Take breaks (use the cell phone, etc.) between replicates, but not within a replicate.
- If two people are rating disease, they should work together in each plot or work on separate replicates, but they should not work on separate plots within a replicate.
- Rate each plot "blindly" (i.e., avoid knowing the treatment applied if at all possible).
- Assess disease on 25 to 50 plants per plot, with a higher number being observed as the size of plots increases.
- Rate crops at the following stages:

  Corn—rate diseases on the ear leaf when the crop has reached the dent stage but before black layer. If more than one ear is present, assess the leaf on the uppermost ear.

  Soybean—rate leaves or pods in the upper third of the canopy (one leaf or pod per plant) once the crop has reached the full seed (R6) stage. If rating stems, use the main stem.

  Wheat—rate the flag leaf (F) and the second leaf from the top (F-1 leaf) on the same plant when the crop has reached the early dough stage. Keep separate results for the F and F-1 leaves. Since head diseases are common contributors to yield loss in wheat in Kentucky, also make disease assessments of 10 to 30 wheat heads per treatment. As with leaves, estimate the amount of disease surface area.

- Regardless of the crop, plants should be arbitrarily selected from the central portion of each plot. A good way to select plants is to shut your eyes when reaching for a plant. Avoid plants near plot borders or in the immediate vicinity of sprayer tire tracks.

- Practice first before recording data.

- Rating in a comfortable environment can be helpful for enhancing concentration and therefore accuracy. If you wish, you can collect leaves into labeled bags and bring them to a more comfortable environment to rate. However, leaves will begin to turn yellow within a few days, which can make disease assessment much more difficult for some diseases.

- Verify the predominant cause of the symptoms observed by submitting representative leaves to a UK Plant Disease Diagnostic Clinic. If you are uncertain about the cause of symptoms at the time of rating or if more than one disease is present at the same time, it still is possible to take useful ratings. Simply rate "percent of leaf with necrosis", without attempting to determine how much is caused by Disease A and how much is caused by Disease B.

- If you have gone to the trouble of putting plots in, don't give in to time pressures during the season and neglect to take disease ratings if, in fact, treatments are targeting diseases. Drawing conclusions about yield effects of a treatment without making actual disease ratings is improper since diseases may not have impacted yields and differences between treatments may be related to some other cause. Without disease assessment data, you will have no way of knowing if your conclusions are accurate or not.

Analysis of Test Data

Average the results for each treatment, and compare averages. It is also a good idea to take note of the range of results (low and high) as means of gauging variation within each treatment. Be aware that a statistical analysis of your results is necessary to have higher confidence in your conclusions, but even a simple comparison of means is useful and is a good starting point.

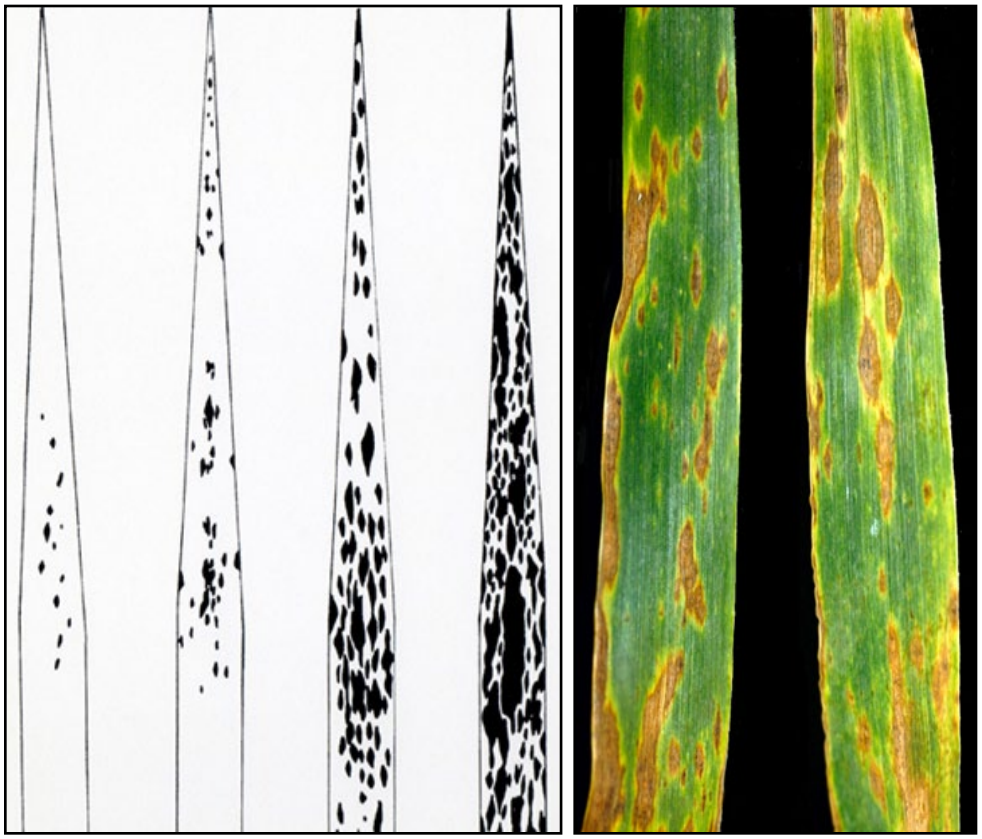

Figure 1. A diagrammatic representation (left) of the percentage of leaf area covered by lesions of wheat caused by leaf blotch complex compared to actual symptoms (right). Rating common fungal diseases of corn, such as gray leaf spot or northern corn leaf blight, will be similar, but at a larger scale. This rating scale can help in assessing other leaf diseases, as well. (Diagram from Clive James, 1971, *A Manual of Assessment Keys for Plant Diseases*, APS Press (Key 1.6.10). Photo by Robert Mulrooney, University of Delaware. Used with permission).

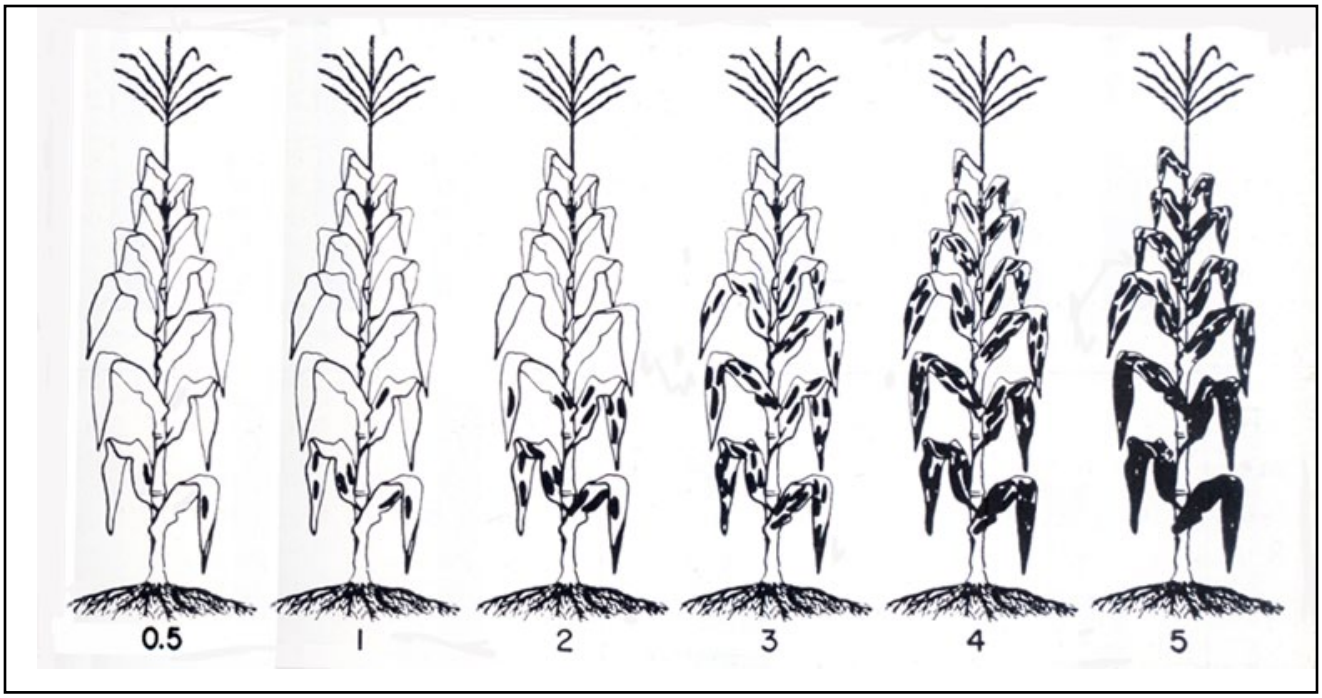

FIGURE 2. THIS SYSTEM FOR RATING CORN LEAF BLIGHTS ON WHOLE PLANTS IS BASED ON THE FOLLOWING SCALE: 0 = NO SYMPTOMS, 0.5 = VERY LIMITED SYMPTOMS WITH ONE OR TWO RESTRICTED LESIONS ON THE LOWER LEAVES; 1 = SLIGHT SYMPTOMS WITH A FEW SCATTERED LESIONS ON THE LOWER LEAVES; 2 = LIGHT SYMPTOMS WITH MODERATE NUMBER OF LESIONS ON THE LOWER LEAVES; 3 = MODERATE SYMPTOMS WITH ABUNDANT LESIONS ON LOWER LEAVES AND A FEW ON MIDDLE LEAVES; 4 = HEAVY SYMPTOMS WITH LESIONS ABUNDANT ON LOWER AND MIDDLE LEAVES, AND EXTENDING TO UPPER LEAVES; 5 = VERY HEAVY SYMPTOMS WITH LESIONS ABUNDANT ON ALL LEAVES, PLANTS MAY BE PREMATURELY KILLED. ALTHOUGH WE AT UK ALMOST ALWAYS RATE DISEASE ON THE EAR LEAF, THIS RATING SCALE IS ALSO VALID AND MAY BE USEFUL FOR SOME CIRCUMSTANCES. (REPRODUCED FROM C. ELLIOT AND M.T. JENKINS, 1946, *HELIMINTHOSPORIUM TURCICUM* LEAF BLIGHT OF CORN. PHYTOPATHOLOGY 36:660-666)

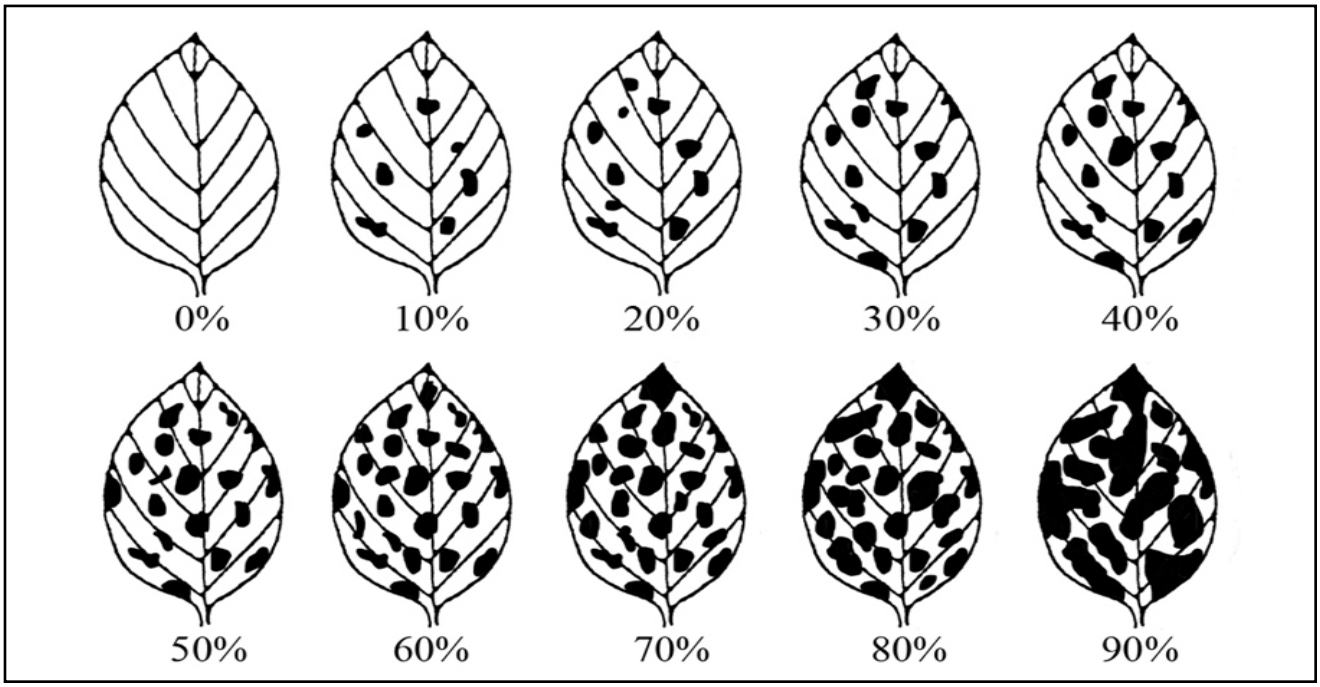

FIGURE 3. THIS FIGURE ILLUSTRATES A SYSTEM OF RATING FOLIAR DISEASES OF SOYBEAN. (BASED ON A FIGURE IN *KENTUCKY INTEGRATED CROP MANUAL FOR SOYBEANS, IPM-3*. 2009. PG.3)

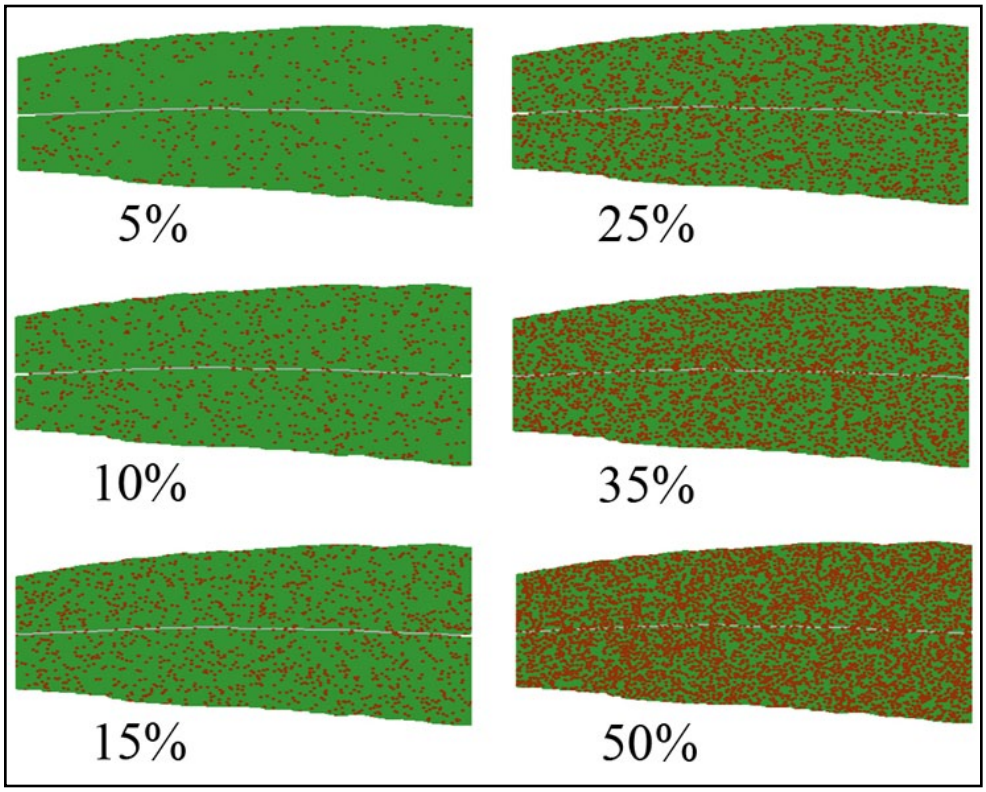

Figure 4. Illustration is for common rust of corn, but it is also helpful for "tuning" one's eye to rate southern corn rust, wheat leaf rust, soybean rust, or any disease that produces small lesions. (Image created using CornPro v3.3 Disease Assessment Training computer program by Forrest W. Nutter, Jr., Iowa State University)

Scale designation	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10	Level 11	Level 12	Level 13
A	0	5	10	25	50	75	90	95	100				
B	0	2	10	20	35	50	65	80	90	98	100		
C	0	2	5	10	20	35	50	65	80	90	95	98	100
D	0	2	5	10	20	30	40	50	60	70	80	90	100

Table 1. Several different scales for rating leaf necrosis. The values in boxes represent percent necrotic leaf tissue. Use the scale that you feel best represents your ability to visually distinguish different categories of damage in the field.

Additional Resources

- *A Manual of Assessment Keys for Plant Diseases* by Clive James, 1971. APS Press.
- Guide to Field Experimentation (Government of Alberta Agriculture and Rural Development, 2010) http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag3022
- On-Farm Field Trials—How to Lay Them Out (Ohio State University, 2011) http://corn.osu.edu/newsletters/2011/2011-08-1/on-farm-field-trials-2013-how-to-lay-them-out

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