Needle Weights as a Measure of Infection by *Uredinopsis mirabilis* and *Chrysomyxa weirii*

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ABSTRACT

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Needle weights were used to determine disease intensity of *Uredinopsis mirabilis* and *Chrysomyxa weirii* on *Abies balsamea* and *Picea pungens*, respectively. Needles were removed from twig samples, infected and healthy needles were separated and counted, and then fresh and oven-dry weights determined. Percentage of needle infection determined by either fresh or oven-dry weight was highly correlated with infection as determined by needle counts. R^2 values correlating weight and count were 0.92 and 0.98 (*U. mirabilis*) and 0.93 and 0.97 (*C. weirii*) for fresh and oven-dry weights, respectively ($P < 0.01$).

Uredinopsis mirabilis (Peck) Magnus (fir-sensitive fern rust) and *Chrysomyxa weirii* Jackson (Weir's spruce cushion rust) are two rusts that annually infect and kill needles of firs (*Abies* spp.) and spruces (*Picea* spp.), respectively. This type of needle mortality can result in growth reduction, and if levels of needle infection are high, trees are unmerchantable for Christmas tree or nursery trades (8,9).

U. mirabilis is a full-cycled heteroecious rust that alternates between *Abies* spp. (especially *A. balsamea* L. (Mill) [balsam fir]) and *Onoclea sensibilis* L. (sensitive fern) (5). In Vermont, pycnia and aecia are produced on the current year's needles during June and July, and by mid-August, all infected needles are dead and cast (6).

C. weirii is an autoecious microcyclic rust that infects emerging spruce needles each spring (10). One year after infection, this rust produces chlorotic needles and erumpent telia from which basidiospores are produced and disseminated during periods of moist weather (1,3). All infected needles die and are cast from the tree after sporulation.

Percentage of needle infection is an important determination when studying yearly infection levels or in fungicide efficacy trials on various needle diseases. Infection levels usually have been

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determined by counting healthy and diseased needles and then calculating percentage of needle infection (2,11). Sinclair and Dwinell (7) reported that the intensity of needle infection of Douglas fir (*Pseudotsuga menziesii* Franco) by *Rhabdocline pseudotsugae* Sydow is accurately determined by using the fresh weight of symptomatic needles expressed as a percentage of total weight of needles for the age class of needles infected. The advantage of this method is that it eliminates the laborious counting of needles. The objective of our research was to compare the needle count method with a weight method using either fresh or oven-dry weights to accurately determine percentage of needle infection by *U. mirabilis* and *C. weirii*.

MATERIALS AND METHODS

Thirty-five balsam fir trees (about 2–3 m tall and 15 yr old) infected with *U. mirabilis* were randomly selected from a plantation in Wolcott, VT. The optimum sampling time for *U. mirabilis* is when symptoms are present and the aecial state is well developed. Twig samples were taken to determine percentage of infection when needles were chlorotic and aecia present on 30 July 1985. Also, 10 Colorado blue spruce (*P. pungens* Engelm.) trees (about 1–2 m tall and 6–8 yr old) infected with *C. weirii* and growing in a commercial nursery in Bakersfield, VT, were sampled to determine percentage of needle infection on 6 June 1985. At this time, symptoms were present and needles supported erumpent telia. The sampling technique used was the same for both rust diseases. Four to 10 cm of terminal growth was removed from each of four twigs equally spaced around the circumferences of the trees at three heights: 0.5 m (bottom), 1 m (middle), 2 m (top). Needles were removed from the twigs and infected needles separated from uninfected needles. Needle weights were determined before and after oven-drying to constant weight (1 hr at 90 C). Weight data were used to determine weight-based percentage of needle infection for each tree. Infected and uninfected needles also were counted to determine count-based percentage of needle infection. Weight-based and count-based percentages were compared using standard regression analysis (4).

RESULTS AND DISCUSSION

Count-based and fresh foliage weight-based percentages of needle infection were highly correlated ($P<0.01$) for *U. mirabilis* and *C. weirii* ($R^2 = 0.92$ [df = 14] and 0.93 [df = 9], respectively) (Fig. 1). Count-based and oven-dried foliage weight-based percentages were also highly correlated ($P<0.01$) for both rusts ($R^2 = 0.98$ [df = 16] and 0.97 [df = 9], respectively). However, oven-drying requires more time and effort and does not provide significantly greater precision.

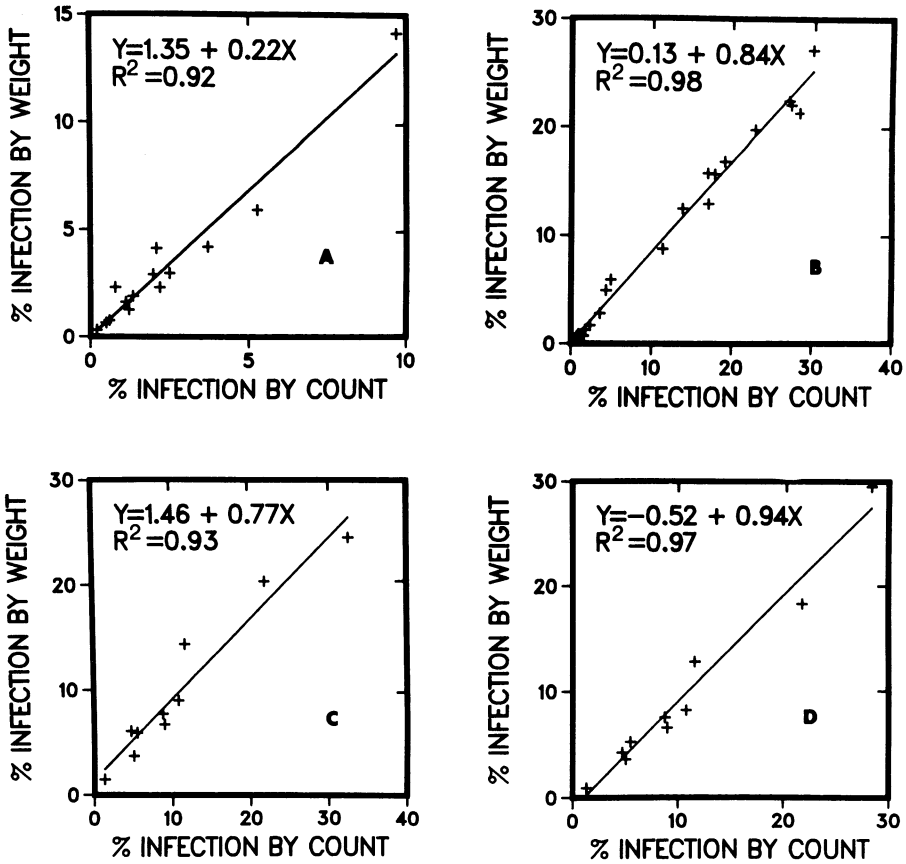

Fig. 1. Relation of weight-based to count-based determination of percentage of needle infection by **(A and B)** *Uredinopsis mirabilis* on *Abies balsamea* and **(C and D)** *Chrysomyxa weirii* on *Picea pungens*. A and C are for fresh weight, and B and D are for oven-dry weight. Each data point represents a tree. For all regressions, $P<0.01$.

Determining percentage of needle infection for both rust diseases using fresh foliage weights was about twice as fast as the count-based method, because needles were treated in groups and not counted individually. Integrating a compatible computer program with an electronic balance could expedite the weight-based technique.

We believe these weight methods would be appropriate for determining percentage of needle infection in studies of other conifer needle diseases. These methods were not used to assess inoculum potential and production but, as used by Sinclair and Dwinell (7), to rapidly estimate the percentage of needles that will be lost from trees because of these rust diseases. We are using the fresh-weight method to determine percentage of needle infection in fungicide efficacy studies on fir-sensitive fern rust on balsam fir.

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LITERATURE CITED

1. Bergdahl, D. R. 1985. Periods of sporulation and infection for *Chrysomyxa weirii* on *Picea pungens* in Vermont. (Abstr.) Phytopathology 75:1294.
2. Bergdahl, D. R., and Mazzola, M. 1986. Efficacy of Bayleton and benodanil in the management of *Uredinopsis mirabilis* on *Abies balsamea*. (Abstr.) Phytopathology 76:650.
3. Bergdahl, D. R., and Smeltzer, D. L. K. 1983. *Chrysomyxa weirii* on *Picea pungens* in Vermont. Plant Dis. 67:918.
4. Draper, N. R., and Smith, H. 1981. Applied Regression Analysis. 2nd ed. John Wiley & Sons, New York.
5. Faull, J. H. 1938. Biology of the genus *Uredinopsis*. J. Arnold Arbor. Harvard Univ. 19:402-436.
6. Mazzola, M. 1985. The phenology of *Uredinopsis mirabilis* and its associated hosts. M.S. thesis. University of Vermont, Burlington.
7. Sinclair, W. A., and Dwinell, L. D. 1966. A method for estimating intensity of Rhabdocline needle cast of Douglas-fir. Plant Dis. Rep. 50:406-408.
8. Van Sickle, G. A. 1972. Epidemiology and impact of a needle rust (*Pucciniastrum goeppertianum*) on *Abies balsamea*. Ph.D. thesis. Pennsylvania State University, University Park.
9. Van Sickle, G. A. 1974. Growth loss caused by a needle rust (*Pucciniastrum goeppertianum*) of balsam fir. Can. J. For. Res. 4:138-140.
10. Weir, J. R. 1923. The genus *Chrysomyxa*. Mycologia 15:183-187.
11. Weir, L. C. 1963. Control of needle cast of Douglas-fir by antibiotics. For. Chron. 39:205-211.