Determination of Losses in Soybeans Caused by Rhizoctonia solani

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ABSTRACT

A method for visually scoring disease severity was evaluated to determine losses in soybeans caused by *Rhizoctonia solani*. In different fields infected with the fungus, two cultivars, Amsoy and Hawkeye 63, were evaluated to determine whether the method was valid. Plots 3.1 m long were selected and scored for disease severities of 0, 1, 2, 3, 4, and 5 (ca. 0, 5, 15, 30, 60, and 75 to 100% plants killed, respectively). Data were obtained on total cm killed, total cm barren, plants killed early, mid-, and late season, stand, and yield. The validity of the scoring method was indicated by absence of interaction between the cultivars or fields and the score when the data were analyzed statistically. The relationships with score were linear for five of seven characters, and midseason kill generally had the closest relationship. Total cm killed was closely related to score, but total cm barren was not. Total plants, like cm barren, did not affect scoring; thus, both are considered inaccurate guides in visual scoring methods to determine losses from *R. solani* in soybeans. Indications were that the fungus is able to reduce yield as much as 48% in Amsoy and 42% in Hawkeye 63 in small plots. Phytopathology 61:1444-1446.

Additional key words: rating method, effect upon yield.

Plant disease losses are estimated to be several billion dollars each year. Three recent reports (2, 5, 9) indicate that accurate information on plant disease losses is not available. Usually estimates are based on the subjective judgment of specialists in the field. LeClerg (5) specified that study of losses in economic crops due to disease consists of two phases: (i) determination of intensity; and (ii) establishment of the relationship between intensity and loss per unit of production. Analyses of these determined values calculated through modern computation equipment provides objectively evaluated data. More precise data on losses due to disease in the field are needed, and such information can be obtained by specifically designed and executed studies.

Information is not available for determining losses caused by root rots in soybean (*Glycine max* [L] Merr.) fields, particularly when the disease occurs at different stages of plant development. Neither have specific methods been reported for obtaining the information.

In 1967, an outbreak of root rot caused by *Rhizoctonia solani* Kuehn occurred in soybeans in central Iowa (8). The purpose of this study was to (i) investigate the disease losses; (ii) relate the losses to the number of dead plants, taking into account the stage of growth at which the plants were killed; and (iii) investigate the validity and utility of a scoring technique for determining loss due to the root rot in soybeans.

MATERIALS AND METHODS.—Two commercial soybean fields (near Ames, Iowa) planted to Amsoy and Hawkeye 63 cultivars were used. Amsoy is susceptible, and Hawkeye 63 is resistant to *Phytophthora megasperma* Drechs. var. *sojae* A. A. Hildeb. Henceforth, cultivars will be used to refer to the fields. Both cultivars were severely infected with *R. solani*. Dying plants of both Amsoy and Hawkeye 63 showed typical lesions caused by *R. solani*, sharply delineated, reddish-brown localized lesions in the hypocotyl (1, 4, 8). Rhizoctonia rot occurred throughout the 1967 growing season (8), but the wilt symptoms associated with the disease occurred periodically, coincident with the dry periods of wet-cool and warm-dry weather. The duration of each period of wilting and dying plants was ca. 1 week. As a result, three distinct periods of root rot damage were observed during the season. Early kill occurred at or before flowering; midseason kill was observed after flowering to pod formation; and late kill occurred as the lower leaves began to yellow and as upper pods were filling. In addition, barren sections, presumed due to pre-emergence damping-off, were also seen in the rows.

Within each field, 42 plots were selected after maturity and prior to harvesting in an area 45.8 m^2. Each plot consisted of a 3.1-m length of row; the rows were 0.82 m apart for Amsoy, and 1 m, for Hawkeye 63. The plots were randomly selected by observations made from 10-ft distances, and scored to represent a range of disease development from no readily visible signs of disease to extensive killing; otherwise, plots were scattered at random throughout the area selected in the fields. A zero score indicated no readily visible evidence of dead or dying plants, and 1, 2, 3, 4, and 5 had ca. 5, 15, 30, 60, and 75-100% plants killed, respectively. In each field, 12 plots with zero score and 6 plots for each of the other scores were selected. Data recorded for each plot were visual score, number of plants killed in early, mid-, and late season, total cm of row killed, total cm of row barren (based on gaps in row of at least 15 cm in length), stand or total plants (including killed plants), and yield. Dates of scoring and obtaining all data, except yield, were 11 September for Hawkeye 63 and 13 September for Amsoy.

Means of data were graphed and statistically analyzed. Analyses of variance were computed to evaluate differences within and among score groups, both within each field and across both fields for seven disease-related characters measured. The linear relationship of disease score and yield with the other characters was also computed, plus additional computations for partial regression and correlation coefficients.

RESULTS.—Similar linear relationships were observed in five of seven disease characters measured for both Amsoy and Hawkeye 63 (Fig. 1). Yield alone decreased with increasing disease score; whereas, of total cm killed, plants killed early, mid-, and late season progressively increased with disease score (Fig. 1-A, B, C, D). Total plant and cm barren remained constant regardless of disease score. The progressive nature of disease severity appeared effectively scored by visual ratings into categories that reflect increasing disease severity.

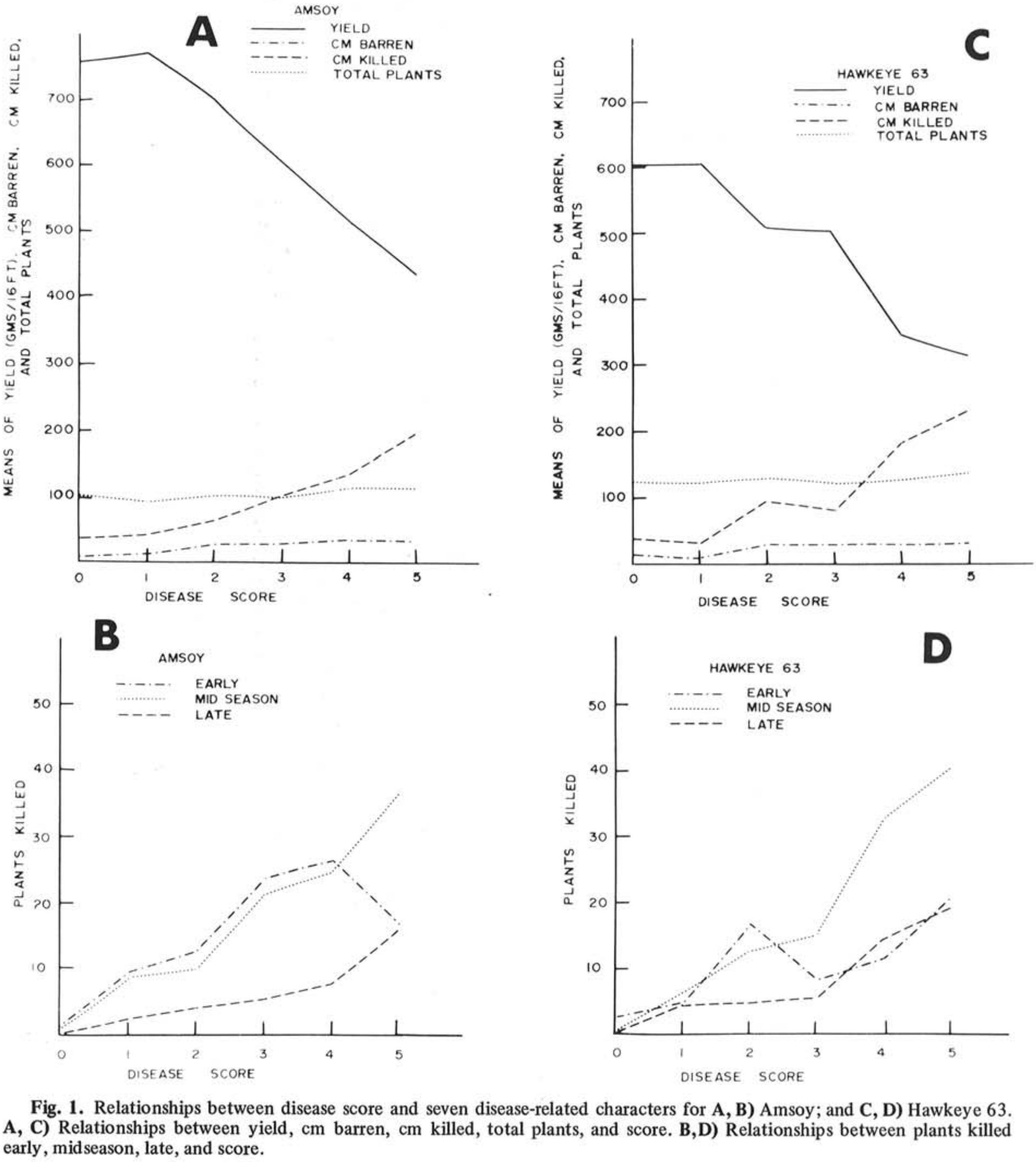

Fig. 1. Relationships between disease score and seven disease-related characters for **A, B)** Amsoy; and **C, D)** Hawkeye 63. **A, C)** Relationships between yield, cm barren, cm killed, total plants, and score. **B,D)** Relationships between plants killed early, midseason, late, and score.

F values from analyses of variance of disease score and linearity for yield, cm killed, early, mid-, and late season kill, were all significant at the 1% level of significance for both Amsoy and Hawkeye 63. The residual *F* values were significant in a few cases, but these values were small in relation to *F* values of score and linearity. Percentages of total variation due to differences among disease scores (R^2) were 21.0, 23.2, 64.8, 78.1, 78.6, 86.4, and 90.3 for cm barren, total plants, early and late season kill, yield, mid-season kill, and cm killed, respectively, of Amsoy. Respective R^2 values of Hawkeye 63 were 3.6, 13.2, 44.2, 82.2, 68.2, 93.7, and 92.2.

Summarized analysis of variance for scores between Amsoy and Hawkeye 63 showed little evidence of interaction between the cultivars and scores. There were differences between cultivars, such as total plants, but these differences did not affect scoring. Large *F* values were obtained for score, and this indicates that a change of one unit of score produced a proportionate change for both Amsoy and Hawkeye 63 in respective disease-related characters.

Regression coefficients (*b*) for each disease characters to score were also similar in both Amsoy and Hawkeye 63. The *b* values for all characters, except total plants and cm barren, were highly significant at the 1% level. The regression values of yield for score in Amsoy and Hawkeye 63 were −64.9 and −60.6, respectively.

Calculations of partial regression coefficients (7) of yield on early, mid-season, and late kill indicated that midseason value alone was highly significant. The partial regression coefficients for midseason kill were −10.2 and −7.4 for Amsoy and Hawkeye 63, respectively.

Correlation coefficients of early, midseason, and late kill for both cultivars were all significant at the 1% level, except for the correlation coefficient for early kill for Amsoy, which is significant at the 5% level. The latter coefficient was the lowest at 0.32. Greatest correlation was between midseason and late kill for both cultivars, 0.86 and 0.89 for Amsoy and Hawkeye 63, respectively.

DISCUSSION.–To expect a subjective scoring method to produce identical results in two rather different circumstances was unreasonable, particularly when two cultivars and two fields were involved. Nonetheless, a change in one unit of score must result in a proportionate change in the disease-related characters over a wide range of circumstances for the method to be practical. The applicability and validity of the scoring method for practical purposes depended upon observations of proportionate changes or the absence of interaction between scores from different cultivars or fields. Interaction was not detected in analyses of data obtained from Amsoy and Hawkeye 63, indicating the validity of the method.

The poor relationship between yield and cm barren also suggested that yield reduction was due to the death of older plants. Compensation usually occurs by increased growth of plants adjacent to barren sections (3, 6). Because yield loss was most closely related to midseason kill, plants killed early are thought to be compensated by additional growth of adjacent plants. Late-killed plants had completed most of their seed development before death and did not drastically reduce yield. Plants killed in midseason did not realize any appreciable seed development and could not contribute to seed yield, and adjacent plants had lost their ability to branch and could not compensate for the midseason kill.

The effect of root rot on yield caused by *R. solani* in soybeans is reported for the first time. The fungus has been described as a potential threat to soybeans (1), but amount of potential loss due to the pathogen was not known until this study. Potential losses as high as 48% are indicated by Hawkeye 63 and 42% by Amsoy in plots of five scores in the method presently described (Fig. 1-A, C).

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