Zeitschrift für Pflanzenkrankheken und Pílanzenschutz
Journal of Plant Diseases and Protection
104 (4), 336-345, 1997, ISSN 0340-8159

Diagrammatic scales for bean diseases: development and validation

Diagrammatische Boniturskalen fúr Bohnenkrankheiten: Entwicklung und Validation

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Received September 3, 1996; accepted October 16, 1996

Summary

Diagrammatic scales were developed for anthracnose, rust, angular leaf spot, and *Alternaria* leaf spot of beans. Scales were developed according to Weber-Fechner's visual acuity law, considering the lowest and highest limits of severity observed in the field. The maximum severity limits represented in the scales were 22.5 %, 24 %, 30.4 %, and 45 %, for rust, anthracnose, angular leaf spot, and *Alternaria* leaf spot, respectively. Six leveis of severity were represented for rust, nine for anthracnose, nine for angular leaf spot, and seven for *Alternaria* leaf spot. Scales were validated by five experienced raters who utilized 70 to 90 leaflet samples with different leveis of severity for each disease. The scales permitted assessments to be accurate (intercepts of the regression Unes between actual and estimated severity not different from 0 and angular coefficients near 1), and precise (90 % of the assessments with $R^2 > 0.80$) for ali diseases. The absolute error in estimating severity, for any scale and rater, was always lower than 15 %. The reproducibility of the assessments, estimated by the coefficient of determination of regression lines between estimates of severity of the five raters (pairwise in ali combinations for ali the diseases), was high ($R^2 > 0.76$) for rust, anthracnose, and angular leaf spot. The scales proved to be adequate for assessments of severity in the field and have been utilized to develop disease progress curves, and to determine damage functions for bean crops.

Key words: Bean diseases; disease assessment; diagrammatic scales; anthracnose; rust; angular leaf spot; *Alternaria* leaf spot

Zusammenfassung

Diagrammatische Boniturskalen wurden fiir Anthraknose, Rost, die Eckige Blattfleckenkrankheit und *Altemaria-Blaufiecken* an Bohnen entwickelt. Dabei wurde das Weber-Fechnersche Sichtschãrfegesetz zugrunde gelegt unter Beriicksichtigung der niedrigsten und hõchsten Grenzen der im Freiland beobachteten Krankheitsintensitãt. Die maximalen Grenzen der in den Skalen dargestellten Krankheitsintensitáten betragen 22,5 %, 24 %, 30,4 % bzw. 45 % fiir Rost, Anthraknose, die Eckige Blattfleckenkrankheit bzw. *Alternaria-Blattílecken.* Sechs Befallsstufen sind fiir Rost vorgesehen, neun fiir Anthraknose, neun fiir die Eckige Blattfleckenkrankheit und sieben fiir *dieAlternaria-B\attflecken.* Die Giiltigkeit der Skalen wurde durch sechs erfahrene Schátzer iiberprúft, die fiir jede Krankheit 70-90 Blattproben mit unterschiedlichen Krankheitsintensitáten verwendeten. Die Skalen erlaubten akkurate (Schnittpunkte mit der Y-Achse der Regressionsgeraden zwischen tatsáchlichen und geschátzten Krankheitsintensitáten waren nicht verschieden von 0 und der Winkelkoeffizient war nahe 1) und prázise (90 % der

Beurteilungen mit R^2 > 0,80) Bewertungen fiir die genannten Krankheiten. Der absolute Fehler bei der Schàtzung der Krankheitsintensitàt war fiir jede Skala und jeden Schátzer immer niedriger ais 15 %. Die Reproduzierbarkeit der Bewertungen war hoch (R^2 > 0,76) fiir Rost, Anthraknose und die Eckige Blatrfleckenkrankheit wie Berechnungen durch das BestimmtheitsmaE der Regressionsgeraden zwischen den Intensitätsschätzungen der fiinf Schãtzer ergaben (paarweise in allen Kombinationen fiir alie genannten Krankheiten). Die Skalen erwiesen sich ais brauchbar fiir die Schàtzung der Krankheitsintensitáten im Freiland und sind sowohl fiir die Erstellung von Krankheitsverlaufskurven verwendet worden ais auch fiir die Bestimmung von Schadensfunktionen fiir Bohnenkulturen.

Stichwõrter: Bohnenkrankheiten; Krankheitsbewertung; diagrammatische Boniturskalen; Anthraknose; Rost; Eckige Blattfleckenkrankheit; *Alternaria-Bla.ttílec\íen*

1 Introduction

Epidemiological studies of plant diseases require reliable, precise, and reproducible quantification methods. When incidence (a reliable, precise, and reproductive variable) cannot be used to quantify foliar diseases, then severity is the variable most utilized (GAUNT 1995). There are several modern techniques that may be used to assess disease severity with precision: video imagery, infrared-color photography, infrared thermography, canopy spectral reflectance, and nuclear magnetic resonance imaging (NILSSON 1995). Such techniques require sophisticated equipment, are costly and, with the exception of imaging analyses, assess disease indirectly by measuring the plant's stress. The plant stress may include other factors such as abiotic stress, nutrient deficiencies, etc, in addition to disease. In view of the inconveniences of these techniques, the severity of foliar diseases is generally assessed visually. In visual and, consequently, subjective estimates of severity, diagrammatic scales have become the main tool of raters. Such scales have been developed for a number of diseases of different crops, such as pineapple (ROHRBACH and SCHMITT 1994), lettuce (OBRIEN and VAN BRUGGEN 1992), sugarcane (AMORIM et ai. 1987), cereais (JAMES 1971; DUVEILLER 1994), citrus (AMORIM et ai. 1993), beans (MORA-BRENES 1989; SARTORATO 1989; STONEHOUSE 1994), apple (CROXALCI ai. 1952, 1953), tomato (BOFF et ai. 1991), amongothers, and have been used to estimate severity ofsymptoms on roots (O'BRIEN and VAN BRUGGEN 1992), leaves (JAMES 1971; AMORIM et ai. 1993; SARTORATO 1989; STONEHOUSE 1994), fruit (CROXAL et ai. 1953; ROHRBACH and SCHMITT 1994), panicles (JAMES 1971), and pods (JAMES 1971).

Diagrammatic scales should be easy to use, applicable to a wide range of different conditions with reproducible results, and they should have sufficient intervals to represent ali of the disease development stages, and also allow prompt evaluation (BERGER 1980). Thus, in preparing diagrammatic scales some aspects should be considered: the lowest and highest limits of the scale should correspond, respectively, to the minimum and maximum amounts of disease found in the field, the representation ofsymptoms should be as near as possible to those observed on the plant and the intermediate leveis of disease severity should consider the acuity limitations of the human eye as defined by "Weber-Fechner's stimulus-response law" (actually laws of Weber and of Fechner) (HORSFALL and BARRATT 1945; NUTTER and SCHULTZ 1995).

In addition to the compliance of technical recommendations for their development, the successful utilization of diagrammatic scales also depends on the experience and visual perception of each individual. Precision and accuracy in determining severity vary according to each rater. Specific software may be used to train raters and thus improve their ability in visual assessment of diseases (TOMERLIN and HOWELL 1988; NEWTON and HACKETT 1994; NUTTER and SCHULTZ 1995). Before diagrammatic scales are proposed as Standard assessment methods, they should be tested (validated) by experienced persons and, in case they produce unsatisfactory results, they should be corrected. The poor distribution of intermediate leveis, for instance, may lead to high variability in the estimate of the specific interval of severity. In this latter case, additional leveis should be added to the scale (AMORIM et ai. 1993).

The quantification of severity of bean leaf diseases has been done in different manners; e.g., descriptive scales as for anthracnose (LATUNDE-DADA 1990) and for rust (DAVISON and VAUGHAN

1963); counting number of pustules as for rust (BACCHI 1993); and diagrammatic scales used for angular leaf spot (MORA-BRENES 1989; SARTORATO 1989) and other fungai and bacterial diseases (VAN SCHOONHOVEN and PASTOR-CORRALES 1987; STONEHOUSE 1994). Ali of these scales published in the literature for bean diseases present some type of deficiency. The scale used by SARTORATO (1989) for angular leaf spot, for example, shows incorrectness in the disease amounts represented in the diagrams. The scale used by MORA-BRENES (1989), also for angular leaf spot, was not validated and presents an excessive number of intermediate leveis, with arithmetic increments, seemingly inadequate for field assessment. The scales used at the International Centre of Tropical Agriculture (VAN SCHOONHOVEN and PASTOR-CORRALES 1987) are a combination of descriptive and diagrammatic keys designed specifically to characterize bean germplasm. Finally, the scales proposed by STONEHOUSE (1994) for foliar bean diseases are too complex, with representations of 11 leaflets for eight leveis of severity. Each severity levei is described by a numeric interval that must be applied to a quadratic equation to determine the proportion of the área covered by the symptoms. In addition, such scales present very high values in their maximum leveis (99.6 % for anthracnose and 79.4 % for angular leaf spot).

The research reported here describes the development and validation of diagrammatic scales for bean rust *(Uromyces appendiculatus),* anthracnose *(Colletotrichum lindemuthianum),* angular leaf spot *(Phaeoisariopsis griseola),* and *Alternaria* leafspot *(Alternarias.^))* on common beans.

2 Materials and methods

In ali of the scales developed in this study, the different leveis of severity were represented in diagrams of one bean leaflet. For the representation of the leveis of severity and for determination of its minimum limit (lowest amount of disease observed visually) and maximum limit (amount of disease from which leaf senescence occurs), leaves with the widest possible range of severity of each disease were collected from different bean cultivars. To quantify the minimum and maximum leveis of severity, the leaves showing the lowest and highest disease intensity collected in the field were reproduced in transparent plastic. The foliar área was quantified by planimeter and the injured áreas measured and integrated by a LICOR leaf área meter (LI-3000). The intermediary leveis of severity of each scale were mathematically determined according to Weber-Fechner's visual acuity law (HORSFALL and BARRATT 1945).

Once the disease percentages to be represented in the scales were established, a Standard leaflet of known área was represented eight times with increasing injured áreas, starting from the minimum levei, following a logistic increment. The distribution of the lesions (with predetermined áreas) in each leaflet was made in such a manner as to reproduce exactly the symptoms of the leaves collected in the field. In the scales developed for rust and *Alternaria* leaf spot, circles and ellipses were drawn, respectively, of variable diameters, that represent the lesion área added to the adjacent chlorotic halo. For anthracnose, the disease symptoms were represented by lines that simulate the necrosis of veins. For angular leaf spot, polygons of several forms were utilized in the representation of symptoms.

After preliminary assessments conducted by two experienced raters with the four scales, it was decided to remove two leveis of severity from the scale for rust and one levei from the scale for *Alternaria* leaf spot. In view of the high variability observed in the intermediate leveis of assessments for angular leaf spot and anthracnose, an additional levei was inserted in each one. Thus, six leveis of severity were represented for rust, nine for anthracnose, nine for angular leaf spot, and seven for *Alternaria* leaf spot.

For the validation of the definitive scales, 70 to 90 figures of leaflets (reproduced from the field) were obtained with a range of disease severity (0 to 10 % for rust and 0 to 35 % for other diseases). The área of each leaf and of diseased tissue were determined with the leaf área meter and the levei of severity was assessed by five raters. The scales were used as guides to estimate severity, and, in practice, the raters interpolate severity. Ali raters were experienced in estimating disease severity in the field and were designated as rater 1, 2, 3, 4, and 5. The accuracy of the estimates of each rater was determined by the t-test applied to the angular coefficients to test if they were significantly different from 1.0. The t-test was also applied to intercepts to test if they were significantly different from 0. The equations of linear regression were calculated where actual severity was the independem variable and estimated severity the dependent variable of each disease, according to methodology described by DRAPER and SMITH (1981) and TENG (1981). The precision of the assessments was estimated by the coefficient of determination of the same regression lines and by the variance of the absolute errors (estimated severity minus actual severity) for each assessment (KRANZ 1988; NuTTERand SCHULTZ 1995). The reliability (reproducibility of assessments) of the scales was evaluated by coefficients of determination of the regression lines obtained between the estimates of different raters for ali diseases, as proposed by NUTTER et ai. (1993) and by NUTTER and SCHULTZ (1995). Minitab for Windows and Plot-It for Windows were used in the regression analysis.

3 Results and discussion

The diagrammatic scales for bean diseases (Fig. 1 to 4) show representations of the disease symptoms and not only the sporulating área of lesion. This difference is fundamental for rust, where the pustules are very small (3.5 mm diameter) but the área occupied by the chlorotic halo may be four times larger. The large circles represented in the highest leveis of severity (Fig. 2) correspond to this situation. The highest leveis of severity in the scale of anthracnose (Fig. 1) and for *the Alternaria leaf* spot (Fig. 4) also iiaclude necrosed tissues resulting from the action of the pathogen on the veins and borders. The dilemma of choosing between the representation of the áreas occupied exclusively by the pathogen (sporulating áreas) or by the disease (symptoms) has been discussed by NEWTON and HACKETT (1994). They defended disease quantification, stating that there was a higher correlation of this variable with damage and with the effectiveness of control measures. The same choice was made in this study.

The maximum disease levei represented in the scales was 22.5 % for rust, 24 % for anthracnose, 30.4 % for angular leaf spot, and 45 % for *Alternaria* leaf spot. Severity values above these limits are rarely found in the field since they cause rapid leaf senescence (anthracnose and *Alternaria* leaf spot) or even shedding of leaves (angular leaf spot). Raters should be warned of the maximum severity expected in the field, since the expectation of finding 100 % of diseased área as maximum severity often leads to error (KRANZ 1977).

The logistic increment of severity leveis is one of the characteristics of the scales responsible for the ease in interpolating severity estimates. Logistic increments are often utilized as synonyms of "Horsfall & Barratt's scale". When they rediscovered Weber-Fechner's law (HORSFALL and BARRATT 1945), these authors proposed a diagrammatic scale with the following leveis of severity: 1 (0), 2 (0-3 %), 3 (3-6 %), 4 (6-12 %), 5 (12-25 %), 6 (25-50 %), 7 (50-75 %), 8 (75-88 %), 9 (88-94 %), 10 (94-97 %), 11 (97-100 %) and 12 (100 %). Scales with representation of such leveis of severity are presently designated as "Horsfall & Barratt's scales". Several plant pathologists (FORBES and KORVA 1994; NUTTER and SCHULTZ 1995) have hesitated in using such scales due, mainly, to the wide interval represented in the mean severities, with only two leveis between 25 and 75 % of disease severity (CAMPBELL and MADDEN 1990). However, these mean leveis may be sub-divided into smaller intervals, as proposed by BERGER (1980) and AMORIM et ai. (1993). This was done in this paper for the scales of angular leaf spot and anthracnose. It is importam to note that the diagrammatic scales may follow Weber-Fechner's law (logarithmic increments) without necessarily utilizing the intervals chosen by HORSFALL and BARRATT (1945).

Accuracy, represented by the degree of proximity of a mean estimate and reality (NUTTER et ai. 1991), may be measured by the angular coefficients and intercepts of the regression lines between actual and estimated severity. Truly accurate assessments are those in which for each x percent in actual severity, an x percent increase is also credited to the estimated severity. That is, the slope of the regression line between actual and estimated values is equal to 1 without systematic deviations, and the intercept of the regression line is equal to 0 (NUTTER et ai. 1993).

Figure 5 depicts the severity estimates of the best and worst raters (lowest and highest absolute errors, respectively) for each disease. The worst assessments were always made by rater 2, showing a low accuracy in ali situations, regardless of the disease assessed. Ali of the other raters behave in a manner similar to that of the best, shown in Figure 5. As a general rule, the accuracy of the assessments was high, as the regression lines between actual and estimated severity presented in 67 % of the cases intercepts equal to 0 (Table 1).

Even though most of the angular coefficients of the lines were different from 1, at $p = 0.01$, they presented values close to 1, with mean errors lower than 15 % (Fig. 6). Less accurate assessments were

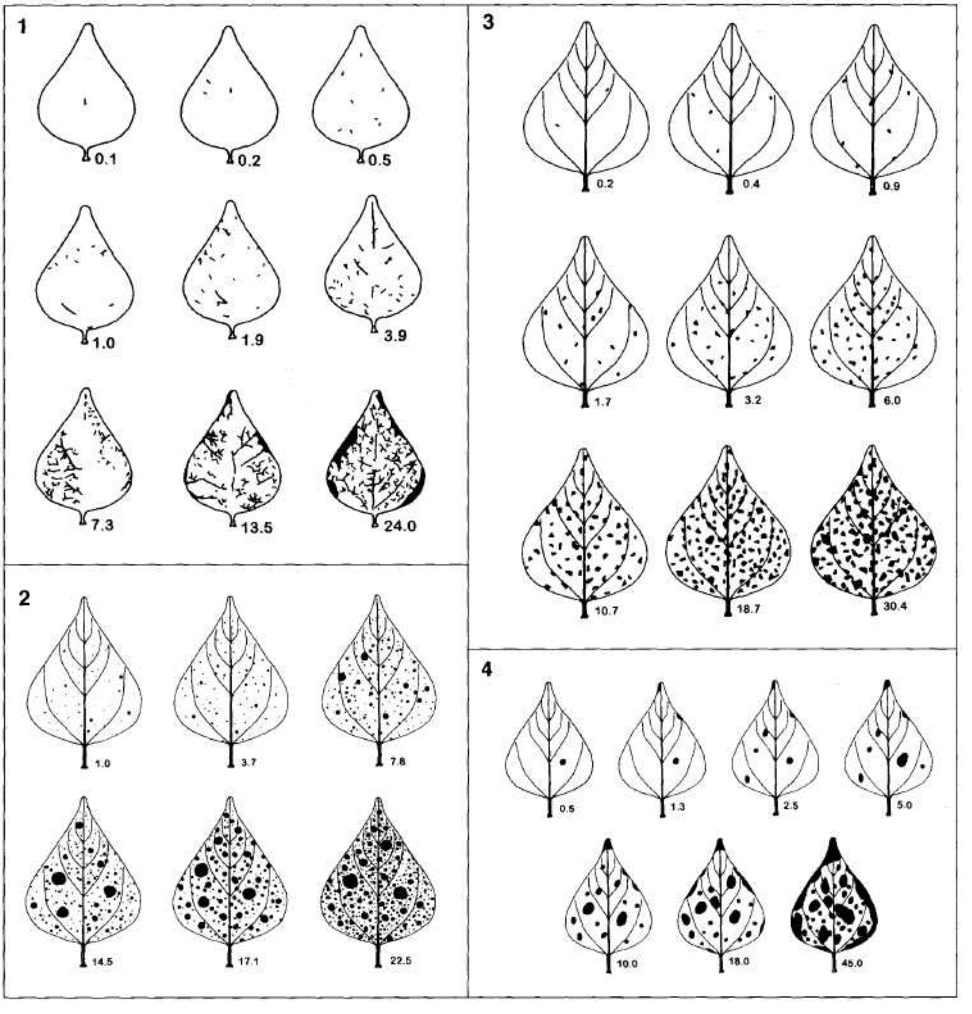

Fig. 1. Diagrammatic scale of severity (percentage of leaf área diseased) of anthracnose *(Colletotrichum lindemuthianum).*
Abb. 1. Diagrammatische Boniturskala fúr die Befallsstárke (Prozent erkrankter Blattfláche) bei Anthraknose *(C. lindemuthianum).*
Fig. 2. Diagrammatic scale of severity (percentage of leaf área diseased) of rust *(Uromyces appendiculatus).* Abb. 2. Diagrammatische Boniturskala fiir die Befallsstárke (Prozent befallener Blattfláche) Rir Rost *(U. appendiculatus).*
Fig. 3. Diagrammatic scale of severity (percentage of leaf área diseased) of angular leaf spot *(Phaeoisariopsis griseola).* Abb. 3. Diagrammatische Boniturskala fiir die Befallsstárke (Prozent erkrankter Blattfláche) bei der Eckigen Blattfleckenkrankheit *(P. griseola).*
Fig. 4. Diagrammatic scale of severity (percentage of leaf área diseased) *oí Alternaria* leaf spot *{Alternaria* sp.).
Abb. 4. Diagrammatische Boniturskala fiir die Befallsstárke (Prozent befallener Blattfláche) bei *Alternaria-Blztt-*flecken *{Alternaria* sp.).

made for rust, and are, probably, due to the high number of small pustules on the leaves caused by the pathogen. Leaves where similar severities are represented by a different number and, consequently, size of lesions often generate different estimates, and the tendency is to overestimate severity when the

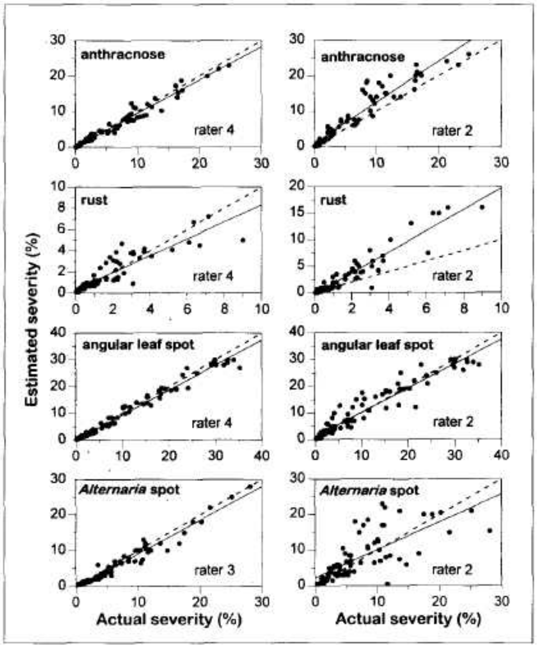

Fig. 5. Estimated severity (•) with the aid of diagrammatic scales and regression lines obtained between actual and estimated disease severity (solid line). Dotted lines represem ideal situation, with estimates identical to reality. On the left, the best raters, on the right, the worst.
Abb. 5. Befallsstârke (•) geschãtzt mit Hilfe der diagrammatischen Boniturskalen und Regressionsgeraden zwischen tatsáchlichen und geschätzten Befallsstárken (durchgezogene Linie). Die unterbrochenen Linien stellen die ideale Situation dar, wobei die Schãtzungen mit der Realitàt identisch sind. Auf der linken Seite die besten Schätzer, auf der rechten die schlechte-

Table 1. Intercepts (a) and angular coefficients (b) of the regression line for actual (independent variable) versus estimated severity (dependent variable), of the various diseases, for five raters, separately (rater 1, 2, 3, 4, 5) and jointly Tab. 1. Schnittpunkte (a) und Winkelkoeffizienten (b) der Regressionsgeraden fiir tatsàchliche (unabhàngige Variable) gegenúber der geschãtzten Befallsstãrke (abhãngige Variable) der verschiedenen Krankheiten getrennt fiir fúnf Schátzer (Schãtzer 1, 2, 3, 4 und 5) und kombiniert

Diseases/ Rater	a						b					
	1	2	3	4	5	all	1	2	3	4	5	all
Anthracnose	0.36	0.90	0.50	0.06	0.30	0.44	0.82*	1.16*	1.07	0.94*	0.96	0.99
Rust	0.17	0.31	0.20	0.37*	0.57*	0.20	1.27*	1.99*	1.29*	0.79*	0.96	1.26*
Angular leaf spot	–0.50	1.06*	0.57	0.02	–0.27	0.17	0.94*	0.91*	0.93*	0.93*	0.92*	0.93*
Alternaria leaf spot	–0.66*	2.29*	–0.47	–0.69	0.28	0.15	0.80*	0.78*	0.95	1.05	1.0	0.92*

* asterisks represent situations in which the null hypothesis (a = 0 or b = 1) was rejected by t-test, $p < 0.01$

numberoflesions is higher and their size smaller (SHERWOOD et ai. 1983; HAU et ai. 1989). Three raters overestimated rust severity in this study, with estimates that generated regression lines of angular coefficients significantly higher than 1 (Table 1).

In spite of the significance, the lines that overestimated rust did not produce importam absolute errors, since the highest severity value assessed during scale validation was 9 %. The maximum error in estimates for rust was 10 % for rater 2 (angular coefficient of regression line equal to 1.99). Much higher angular coefficients (between 4.91 and 13.6) were obtained for barley rust (BERESFORD and ROYLE 1991). In this latter case, the overestimation of disease severity was attributed to the very small size of the uredinia of *Puccinia bordei.* The same problem was reported for barley mildew (NEWTON and HACKETT 1994), for a corn leaf spot complex (HOCK et ai. 1992), and for simulated diseased plants

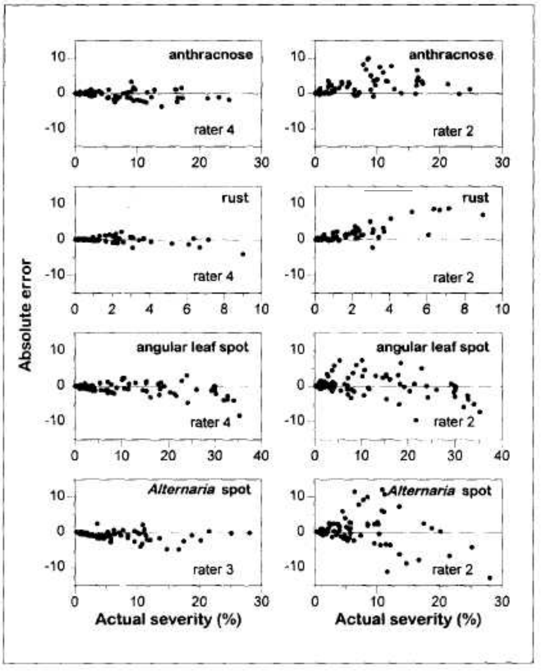

Fig. 6. Absolute errors (actual severity - estimated severity) of the best (left) and worst (right) raters.
Abb. 6. Absolute Fehler (tatsáchliche Befallsstãrke - geschãtzte Befallsstârke) der besten (links) und des schlechtesten (rechts) Schàtzers.

Table 2. Coefficients of determination (R^2) obtained in the regressions between actual (independem variable) versus estimated severity (dependent variable) of different diseases, for five raters
Tab. 2. Bestimmtheitsmafie (R) in den R.egressionen zwischen tatsáchlichen (unabhàngige Variable) gegeniiber geschátzten Befallsstárken (abhàngige Variable) der verschiedenen Krankheiten fiir fiinf Schàtzer

Diseases	Rater				
	1	2	3	4	5
Anthracnose	0.94	0.91	0.95	0.97	0.95
Rust	0.87	0.90	0.90	0.76	0.83
Angular leaf spot	0.97	0.93	0.94	0.98	0.97
Alternaria leaf spot	0.94	0.54	0.96	0.90	0.90

structures (FORBES and JEGER 1987). The solution proposed to correct overestimation of disease severity varies according to the error magnitude. Suggestions included the elaboration of more adequate scales (HOCK et ai. 1992), training of raters (NEWTON and HACKETT 1994), or the change to a more objective assessment method (BERESFORD and ROYLE 1991). Specific training to estimate bean rust seems to be sufficient to attain a higher accuracy in the assessments of this disease.

The utilization of scales conferred high precision (repeatability or variation associated with an estimate, regardless of the mean value) to the estimates of severity for ali of the diseases. Sixteen out of the twenty regressions had $R^2 > 0.9$, and two cases $R^2 = 0.8\text{-}0.9$ (Table 2). In addition to the coefficient of determination, precision was measured by absolute errors (estimated minus actual disease severity) of the estimates of raters and by repeatability of such estimates. The absolute errors for the best and worst raters of each disease are given in Figure 6. The highest absolute errors were observed above 10 % severity for anthracnose, angular leaf spot, and *Alternaria* leaf spot, and between 4 % and 8 % for bean rust. In ali assessments, the absolute error was below 15 % (Fig. 6).

Reproducibility of assessments among raters may also be used as an indication of precision of an assessment method (NUTTER and SCHULTZ 1995). Linear regressions applied to the different raters produced high coefficients of determination (Table 3) and angular coefficients close to 1 (Fig. 7). For angular leaf spot, e.g., the severity estimate of rater 4 explained 96 % of the variation of rater 1, 94 % of rater 2, and 95 % of raters 3 and 5 (Fig. 7). Thus, the data collected by ali raters were in high consonance and the reproducibility of assessments was guaranteed. Rater 2 proved to be less precise in his assessments *oíAlternaria* leaf spot. The low coefficients of determination (Table 3) observed for that disease are the result of an isolated problem in the precision of that rater, thus he should be trained to improve his visual ability to estimate that disease.

The proposal of a Standard system to assess bean leaf diseases carries great responsibility because, if the system is deficient, then the cost of using it may be higher than the benefits attained (NUTTER and SCHULTZ 1995). Imprecise visual estimates made for barley oidium, for example, led to errors that altered the conclusions of experiments intended to control that disease (PARKER et ai. 1995). The scales proposed in this study proved to be adequate to assess severity in the field. The raters produced precise and relatively accurate estimates with these scales and the margin of errors was reduced in the interpretation of results of epidemiological experiments. These scales have been used with satisfactory results in the construction of disease progress curves (AMORIM et ai. 1995; BERGER et ai. 1995) and in the determination of damage functions for bean crops (NUNES 1994; GODOY 1995; IAMAUTI 1995; CARNEIRO 1995).

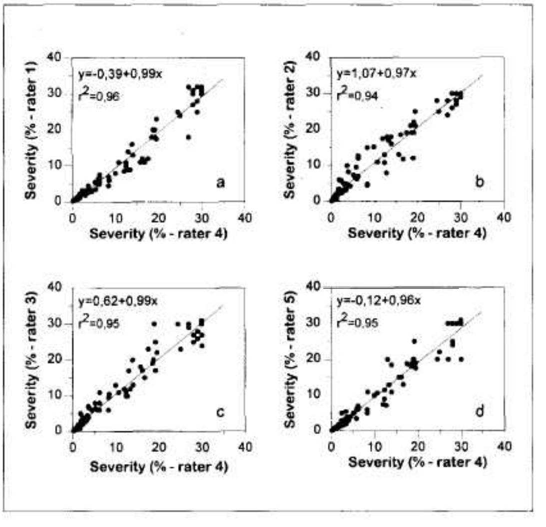

Fig. 7. Severity estimates of angular leaf spot *(Phaeoisariopsisgriseola)* made by rater 4 as compared with the other raters, l(a), 2(b), 3(c) and 5(d), and regression lines obtained between the estimates.
Abb. 7. Schàtzungen der Stàrke des Befalls mit der Eckigen Blattfleckenkrankheit *(P. griseola)* durch den Schãtzer 4 im Vergleich zu den anderen Schátzern 1 (a), 2 (b), 3 (c) und 5 (d) sowie Regressionsgeraden zwischen den Schãtzungen.

Table 3. Coefficients of determination (R^2) obtained in the regressions between the severity estimates of different raters for different diseases Tab. 3. Bestimmtheitsmafte (R) in den Regressionen zwischen den Befallsstárkenschâtzungen der verschiedenen Schãtzer Rir die genannten Krankheiten

Diseases	Raters									
	1*2	1*3	1*4	1*5	2*3	2*4	2*5	3*4	3*5	4*5
Anthracnose	0.91	0.95	0.97	0.95	0.90	0.87	0.86	0.93	0.92	0.92
Rust	0.76	0.93	0.76	0.82	0.79	0.76	0.76	0.82	0.86	0.81
Angular leaf spot	0.92	0.92	0.96	0.94	0.92	0.94	0.92	0.95	0.94	0.95
Alternaria spot	0.51	0.93	0.89	0.89	0.58	0.53	0.43	0.92	0.95	0.86

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