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MEASURING AND MODELING CROP LOSS OF WHEAT CAUSED BY SEPTORIA LEAF BLOTCH IN SEVEN CULTIVARS AND LINES IN IRAN

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Abstract: Septoria leaf blotch caused by *Septoria tritici*, is one of the most important diseases of wheat worldwide including Iran. To determine yield reduction caused by this disease in Golestan province, field experiments were carried out in randomized complete block design with four replications and five wheat cvs. Tajan, Zagros, Shiroodi, Koohdasht, Shanghai and two lines N-80-6 and N-80-19 at Gorgan Research Station. Artificial inoculation was performed using spore suspension at three growth stages (Zadoks scale) including tillering (GS 37), stem elongation (GS 45) and flag leaf opening (GS 53). Control plots were sprayed with water. In this study, the 1 000 kernel weight (TKW), grain yield and area under disease progress curve (AUDPC) during growth season were measured. Statistical analysis showed that the levels of yield reduction was different in various studied wheat cultivars and lines and was reduced by 30 to 50%. The highest losses were observed for cvs. Zagros and Tajan with 48.86% and 47.41% of grain yield reduction, respectively. There was a positive correlation between grain yield reduction and AUDPC. The results of crop loss modelling using integral and multiple point regression models showed that the integral model (L = 1230.91+1.37AUDPC) in which AUDPC and crop loss percentages were independent and dependent variables, respectively, could explain more than 95% of AUDPC variations in relation to crop loss in all cultivars in two years. In the study of integral model for each cultivar, cv. Shiroodi showed the highest fitness. In multiple point models, disease severity at various dates was considered as independent variables and crop loss percentage as dependent variable. This model with the highest coefficient of determination had the best fitness for crop loss estimation. Besides, the results showed that the disease severity at GS37, GS53 and GS91 stages (Zadok's scale) was more important for crop loss prediction than that in other phenological stages.

Key words: *Septoria tritici*, wheat, septoriosis, crop loss, modelling

INTRODUCTION

Wheat is the most widely grown and consumed food crop in the world (Rajaram 1999). The Septoria blotch diseases of wheat are incited by *Septoria tritici* Roberg in Desmaz. [Teleomorph: *Mycosphaerella graminicola* (Fuckel) J. Schrot in Cohn] cause major foliar disease of wheat, inflicting considerable yield losses in many countries worldwide (Eyal 1999). Disease importance and crop loss were significant when Mexican cultivars with good farm characters like: high yield, tolerance to various environments and resistance to rust were used in many countries. It caused a significant crop loss in many countries including Iran because of their susceptibility to septoriosis (Torabi 1980; Eyal 1981). Septoria leaf blotch (SLB) decreased 31 to 51% of yield yearly (Eyal *et al*. 1987). In addition, disease epidemics decreases quality and made seeds wrinkled and flour unsuitable. Yield reduction due to natural infection reported was 4.625 kg/hl (McKendry *et al*. 1995). Flag leaf plays an essential role for seed filling, and when two or three upper leaves and especially flag leaf were infected, high yield reduction occurred (Shaw and Royle 1989; Thomas *et al*. 1989). The greatest risk to a crop is the occurrence of conditions that favour spore dispersal during and shortly after flag leaf emergence. Spore dispersal and infection at this time favour a second generation of the pathogen (Cordo *et al*. 1999). James (1974) showed that crop loss is related to total leaf area infected, including necrotic lesions and chlorotic flecks. Researchers showed that there was a good correlation between necrosis at GS_{75} and GS_{77} and yield reduction. Also, necrosis showed high correlation with reduction of 1 000 kernel weight (TKW) (Forrer and Zadoks 1983).

The epidemics of SLB occurred in most parts of Iran in 1996 (Dadrezaie *et al.* 2002) and in Golestan province during 2002–2003 (Kia *et al*. 2006b). The disease leads to the decrease of seed formation and filling. Primary infection mostly leads to decrease the number of seeds in the spike while delay in infection reduces TKW (Dadrezaie *et al*. 2003). Kia and coworkers (2006b) reported the yield reduction between 9.17 and 29.95 % depending on cultivars, infection stage and disease severity.

There is no accurate information on crop loss due to SLB in Iran. It occurs epidemically in many provinces every year due to favourable environment conditions and

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susceptible commercial cultivars (Torabi 1980). Wheat cvs. Darab2 and Flalat showed the highest pycnidial coverage and cv. Cross-Azadi (Marvdasht) showed the lowest pycnidial coverage (Haghdel and Banihashemi 2003). Much research had been done on evaluating relative resistance of wheat cultivars and lines in recent years in Iran (Torabi *et al*. 2002; Mehrabi 2002; Khelghatibana and Dadrezaie 2004; Khekghatibana *et al*. 2004a, b; Pouralibaba *et al*. 2004; Kia *et al*. 2006a).

A lack of sufficient information about crop loss is a major limitation in using Integrated Pest Management (IPM). We need reliable crop loss data to use appropriate control methods (Madden 1983). James (1974) and James and Teng (1979) presented valuable crop loss assessment methods (Madden 1983).

There has long been an interest in determining the impact of plant diseases on crop yield and yield loss and there are many published models for relating disease incidence or severity to crop loss. These models are based on empirical descriptions of the disease- yield relationship from population (field) studies or investigations of crop physiology (Madden *et al*. 2000). Crop loss is a function of disease epidemics and one of the common ways to show this relation to linear regression (Madden 1983). This model has two aspects: monovariate and multivariate. In linear regression models, increasing the crop loss assessment lead to the improvement of fitness of model (Teng 1987). Madden and coworkers (1983) used nonlinear regression model to show the relation between crop loss and disease severity. Weibull distribution is a type of nonlinear methods. It is a flexible model and has a good fitness with various shapes of curves (Teng 1983). Crop loss modelling was studied by many researchers (Madden 1983). The equation (1) shows a common crop loss model.

$$L = Y_0 – Y = b_0 + b_1x_1 + \ldots + c_1z_1 + \ldots + d_1x_1z_1 + \ldots \quad (1)$$

where, L is difference of yield between treatment (Y) and control (Y_0) plots in the field experiments; x shows the disease incidence, disease severity, disease variation at several times or disease density at critical time; z is showing the yield characters or other variables like year, position and b, c and d are the parameters found from data (Zhang *et al*. 2007).

Crop loss assessment and crop loss modeling in Golestan province is significant due to, disease importance and its recent epidemics in this region. In this study the crop loss in different wheat cultivars and lines and their resistance to leaf septoriosis were examined and different crop loss models evaluated.

MATERIALS AND METHODS

To determine crop loss caused by SLB on five cultivars (Tajan, Zagros, Koohdasht, Shanghai and Shiroodi) and two lines (N-80-6 and N-80-19) of wheat which were sown at early December, an experiment was carried out in a Complete Randomize Design with four replications at Gorgan (Araghi mahale) Research Station during 2006–2007 and 2007–2008. In this experiment artificial inoculation was performed in March at three growth stages including; tillering (GS37; Zadoks scale), stem elongation (GS45; Zadoks scale) and flag leaf opening (GS53; Zadoks scale). A replication without artificial inoculation was considered as control of each cultivars and lines. Two single spore isolates of *S. tritici* which were collected from Golestan province were used for inoculation. Potato dextrose broth media was inoculated with a 5-mm plug of each fungal isolate and was shaken for 4–7 days at 25°C. Spore concentration was adjusted to 2×10^6 spores/ml. Inoculation was performed in the calm and rainy weather during March. Disease symptoms were appearance 31 days after first inoculation and disease recording was continued until flag leaf inoculation, every other day. Saari-Prescott (1975) method was used for recording and area under disease progress curve (AUDPC) was calculated according to equation (2) (Campbell and Madden 1990).

$$\text{AUDPC} = \sum_{i}^{n-1}\left(\frac{y_i + y_{i+1}}{2}\right)(t_{i+1} - t_i) \quad (2)$$

TKW and grain yield were calculated for all cultivars and lines and crop losses were calculated based equation (3) (Milus 1994).

$$\text{Crop loss} = \{1-(Y_d / Y_h)\}*100 \quad (3)$$

Y_h was the average of control yield and Y_d was the yield of each treatment. Duncan's multiple range test was performed for comparison of means of yield losses. Statgraphic software ver. 3 was used to calculate the parameters of integral and multivariate crop loss models.

RESULTS AND DISCUSSION

There were significant differences ($p \le 0.05$) between different wheat genotypes for yield loss (Fig. 1), AUDPC (Fig. 2) and reduction of TKW (Fig. 3) data. There was no significant difference between cultivars and lines for reduction of TKW in 2007–2008. The crop loss ranged from 30% to 50% in 2006–2007 and 5% to 20% in 2007–2008 (Fig. 1). It was in the same range as reported by Eyal and coworkers (1987) in 2006–2007. Crop loss was reported between 9.17% and 25.95% depend on cultivar, growth stage and disease severity by Kia and coworkers (2006). Also, Dadrezaie and coworkers (2003) reported it between 6.99% and 38.20%. Our results were corresponding with their results in 2007–2008. Our results differed from theirs due to different environmental factors (precipitation, relative humidity and temperature) and disease severity in different years as it was reported by other researchers (Madden *et al.* 2000). The maximum and minimum yield reductions were observed in cvs. Tajan and N-80-19 line, respectively (Fig. 1). The TKW was reduced between 17 and 30% in various cultivars and lines. The maximum and minimum reductions of TKW were observed in cvs. Zagros and Shanghai, respectively (Fig. 3).

Based on disease progress observations, disease severity on flag leaf was more than 50% in all cultivars and lines except for Shanghai. Cultivars Tajan and Zagros showed high flag leaf infection. Flag leaf is the most important factor for seed filling (Shaw and Royle 1989; Thomas *et al*.

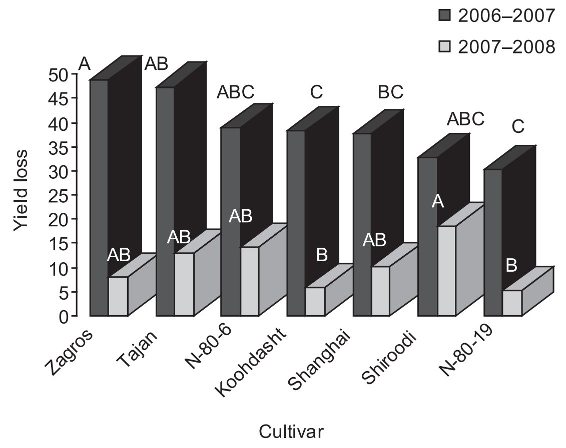

Fig. 1. Crop loss due to *S. tritici* in five wheat cvs. Tajan, Zagros, Koohdasht, Shiroodi and Shanghai and two lines (N-80-6, N-80-19) in 2006–2007 and 2007–2008

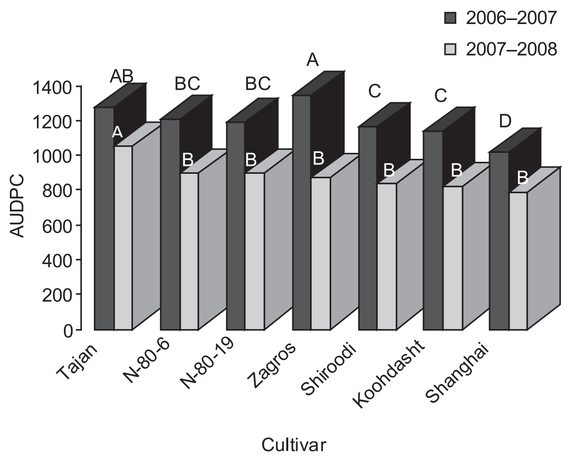

Fig. 2. Area Under Disease Progress Curve in five wheat cvs. Tajan, Zagros, Koohdasht, Shiroodi and Shanghai and two lines (N-80-6, N-80-19) in 2006–2007 and 2007–2008

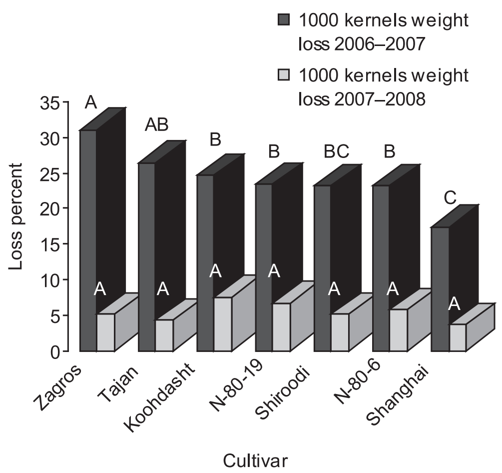

Fig. 3. 1000 kernels weight reduction due to *S. tritici* in five wheat cvs. Tajan, Zagros, Koohdasht, Shiroodi and Shanghai and two lines (N-80-6, N-80-19) in 2006–2007 and 2007–2008

1989) and severe infection leads to high crop loss and high reduction in TKW. Significant differences between yield, TKW and AUDPC of various cultivars and lines were due to genetic differences. Humidity plays an essential role in all stages of the infection cycle of this pathogen (Chungu *et al*. 2000). Pycnidiospores have the most importance as secondary inoculums and disseminated mainly by rain splashing (Scharen 1999). The greatest risk to a crop is the occurrence of conditions that favour spore dispersal during and shortly after flag leaf emergence (Cordo *et al*. 1999). Previous investigators recognized the close association between humidity and infection and subsequent pathogen development in the host plant (Magboul *et al*. 1992). Meteorological data suggested that low temperature, high precipitation and relative humidity during February, March and April (data are not shown) provide favourable conditions for penetration, establishing of pathogen and disease progression. As a result, pathogen will be infectious during flag leaf opening and extending and lead to severe infection and high crop loss. This can explain the higher cop loss in our study than those were reported by Kia and coworkers (2005). Cultivars Zagros and Tajan have been showed the maximum AUDPC, crop loss and TKW reduction, respectively. Cultivars Shanghai showed the minimum AUDPC and TKW reductions and N-80-19 showed the lowest crop loss (Fig. 1 and 3). In the studied cultivars and lines, Shanghai showed the lowest susceptibility.

These results showed the positive correlation between AUDPC and crop loss. But there were no correlation between AUDPC and TKW reduction, as well as between crop loss and TKW reduction.

To develop a crop loss assessment model, AUDPC was considered as independent variable and crop loss (L) as dependent one in an integral model. The equation (4) shows the resulting model using data of all cultivars and lines except Shanghai.

$$L = 1230.91+1.37AUDPC \qquad (4)$$

Coefficient of determination (R^2) of this model was 96%. This model explained more than 95% of AUDPC variation against crop loss.

Crop loss integral models and R^2 for cultivars and lines were calculated (Table 4). Cvs. Zagros and Tajan had the highest and Shanghai had the lowest R^2. In cv. Zagros, R^2 for integral model was 99%, which was the highest R^2 among the developed crop loss assessment models. Integral model were revealed to be an efficient model for crop loss assessment in all cultivars except Shanghai.

Table 1. Crop loss model of wheat leaf septoriosis caused by *S. tritici* in five wheat cvs. Tajan, Zagros, Koohdasht, Shiroodi and Shanghai and two lines (N-80-6, N-80-19)

Coefficient of determination [%]	Model	Cultivar/Line
95.03	L = –145.35+0.15AUDPC	Tajan
99.31	L = –66.94+0.09 AUDPC	Zagros
89.09	L = –70.02+0.09 AUDPC	Koohdasht
87.76	L = –16.99+0.04 AUDPC	Shiroodi
51.81	L = –53.57–0.09 AUDPC	Shanghai
79.74	L = –48.68–0.07 AUDPC	N-80-6
81.46	L = –68.25+0.08 AUDPC	N-80-19

When all disease severity records were considered in multivariate analysis, the best multiple point model was obtained (5).

$$L = 20.73 - 0.015X_1 - 0.21X_2 + 0.33X_3 - 0.55X_4 + 0.65X_5 - 0.37X_6 + 0.75X_7 - 0.67X_8 + 0.32X_9 + 0.085X_{10} \quad (5)$$

Where X was the disease severity at different times of recording disease and including, x_1 and x_2, six leaf stage (GS37; Zadoks' scale), x_3 flag leaf opening (GS39), x_4 and x_5 flag leaf extension (GS45), x_6, x_7 and x_8 earring (GS53) and flowering (GS61), x_9 and x_{10} flag leaf infection (GS91). The R^2 was 81%, which was indicating more than 80% of variability could be explained by this model.

To determine the most important phenological stages in crop loss assessment, the multivariate analysis was done for disease severity at different growth stages. The results showed that x_1 (beginning of disease appearance), x_4 and x_5 (earring), x_{10} (flowering) were more efficient stages in crop loss assessment. R^2 of the model based on these three stages was more than 50%.

There are many models to show the relation between disease incidence or disease severity and yield. A key result of these models is that, the time of plant infection has a major effect on the resulting yield (Madden *et al*. 2000). Crop loss is the function of disease epidemics and a common way to show this relation is linear regression (Madden 1983). Single point model is a common type of linear regression method. In this model, x considered as disease variable for predicting crop loss (y). Disease variable could be assumed as disease severity at special time (critical point), disease free days and Area Under Disease Progress Curve (AUDPC) or integral value (Teng 1987).

Single point models have been used for several diseases including, corn leaf southern blight (*Bipolaris maydis*) (Gregory *et al*. 1978), potato late blight (*Phytophthora infestans*) (Olofson 1968). Integral model was used for wheat stem rust (*Puccinia graminis*) crop loss assessment for the first time (Teng 1987). Single point models have been developed for short time disease which affect seed yield. In these models, crop loss assessment has been performed by using disease severity in one growth stage (Teng 1987). Since SLB affects grain yield, using single point model is suitable for it. Our Results showed that, this model (equation 4) can explain 95% of AUDPC variation against crop loss.

Multiple point model is another type of crop loss assessment models. In this model, two or more disease recordings are use for crop loss assessment (Teng 1987). Berleigh and coworkers (1972) presented the crop loss model caused by wheat stem rust (*Puccinia graminis*). They used rust severity at three growth stages (Teng 1987). In Multiple point model, increase of disease assessment leads to improve models fitness. For example in barley brown rust (*Puccinia hordei*), when two growth stages were considered separately the model was justified 72% of crop loss but when they considered together, 82% of crop loss was justified (Teng 1987). Robert and coworkers (2004) presented prediction model for crop loss caused by *S. tritici* and wheat brown rust (*P. recondita*). Zhang and coworkers (2007) studied cultivar resistance and its effect on four diseases (leaf septoriosis, yellow rust (*P. striformis*), brown rust (*P. recondita*) and powdery mildew (*Blumeria graminis*)) crop loss. They used different method to determine cultivar resistance to Septoria blotch. They calculated the difference between each cultivar and resistant cultivar. In this model cultivar was considered as constant effective factor and other factors like year, trial effects and year-cultivar interaction were considered as variable factors. Dadrezaie and coworkers (2003) studied the linear regression between crop loss and time of infection in cvs. Tajan, Atrak and Darab 2. They found a linear function with negative slope. In these three cultivars, coefficient of correlation was –0.99. It showed that delay in disease appearance lead to decrease the crop loss.

The developed models in this study need to be further evaluated using more data on crop loss of SLB and may lead to a validate model for accurate crop loss prediction of this important disease.

REFERENCES

Burleigh J.R., Roelfs A.P., Eversmeyer M.G. 1972. Estimating damage to wheat caused by *Puccinia recondita tritici*. Phytopathology 62: 944–946.

Campbell C.L., Madden L.V. 1990. Introduction to Plant Disease Epidemiology. John Wiley and Sons, 532 pp.

Chungu C., Gilbert J., Townley-Smith F. 2001. *Septoria tritici* blotch development as affected by temperature, duration of leaf wetness, inoculum concentration, and host. Plant Dis. 85: 430–435.

Cordo C.A., Simon M.R., Perello A. E. Alippi A.E. 1999. Spore dispresal of leaf blotch pathogens of wheat (*Mycosphaerella graminicola* and *Septoria tritci*). p: 98–101. In: "Septoria and Stagonospora Disease of Cereal: A Compilation of Global Research". Mexico, D.F.: CIMMYT: 98–101.

Dad rezaie S.T., Minassian V., Torabi M., Lotfali ayene Gh.A. 2003. Effect of *Septoria tritici* infections at different growth stages on yield and yield components of three wheat cultivars. Seed and Seedling J. 19: 101–106.

Eyal Z. 1981. Integrated control of Septoria diseases of wheat. Plant Dis. 65: 763–768.

Eyal Z., Scharen A.L., Prescott M.J., Van Ginkel M. 1987. The Septoria diseases of wheat: concepts and methods of disease management. Mexico, D. F.: CIMMYT, 46 pp.

Eyal Z. 1999. The Septoria/ Stagonospora blotch diseases of wheat: past, peresent, and future. p. 177–182. In: "Septoria and Stagonospora Disease of Cereal: A Compilation of Global Research". Mexico, D.F.: CIMMYT: 177–182.

Forrer H.R., Zadoks J.C. 1983. Yield reduction in wheat in relation to leaf necrosis caused by *Septoria tritici*. Neth. J. Plant Pathol. 89: 87–98.

Gregory L.V., Ayers J.E., Nelson R.R. 1978. Predicting yield losses in corn from southern corn leaf blight. Phytopathology 68: 517–521.

Hghdael M., Banihashemi Z. 2003. Reaction of wheat cultivars to isolates of *Septoria tritici* under greenhouse and controlled chamber conditions. Iranian J. Plant Pathol. 39: 65–67.

Khelghatibana F., Dadrezaie S.T. 2006. Evaluation of synthetic hexaploid wheat lines for resistance to *Septoria tritici* in field. 16th Iranian Plant Protection Congress, p. 12.

Khelghatibana F., Dadrezaie S.T., Dehghan M.A., Nazari A., Torabi M. 2004a. Evaluation of the wheat genotypes from north elite regional wheat yield trials (ERWYT-2003) for resistance to *Septoria tritici* in field. 16th Iranian Plant Protection Congress, p. 14.

Khelghatibana F., Zade-Dabbagh G., Dehghan M.A. 2004b. Evaluation of wheat lines and genotypes from advanced regional wheat yield trials (ARWYT) for resistance to *Septoria tritici* in field. 16th Iranian Plant Protection Congress, p. 13.

Kia Sh., Torabi M., Nazari A. 2006a. Evaluation of resisitance to Septoria leaf blotch in wheat lines and cultivars. 17th Iranian Plant Protection Congress, p. 3.

Kia Sh., Torabi M., Nazari A. 2006b. Study on the effects of Septoria leaf blotch (*Septoria tritici*) infection on yield reduction of wheat cultivars in Golestan province. 17th Iranian Plant Protection Congress, p. 4.

Madden L.V. 1983. Measuring and modeling crop losses at the field level. Phytopathology 73: 1591–1596.

Madden L.V., Hughes G., Irwin M.E. 2000. Coupling disease – progress – curve and time – of – infection for predicting yield loss of crop. Phytopathology 90: 788–800.

Madden L.V., Pennypacker S.P., Kingsolver C.H. 1981. A comparison of Crop loss models. Phytopathology 101: 196–201.

Magboul A.M., Geng S., Gilchrist D.G., Jackson L.F. 1992. Environmental influence on the infection of wheat by *Mycosphaerella graminicola*. Phytopathology 82: 1407–1413.

McKendry A.L., Henke G.E., Finney P.L. 1995. Effect of Septoria leaf blotch on soft red winter wheat milling and baking quality. Cereal Chemistry 72: 142–146.

Mehrabi M. 2002. Evaluation of tetraploid wheat accessions of *Triticum turgidum* to *Septoria* leaf blotch (*Mycosphaerella graminicola*) disease. 15th Iranian Plant Protection Congress, p. 26.

Milus E.A. 1994. Effect of leaf rust and Septoria leaf blotch on yield and test weight of wheat in Arkansas. Plant Dis. 78: 55–56.

Nazari A., Dehghan M.A., Khelghatibana F. 2002. Resistance sources against Septoria leaf blotch in advanced lines of wheat. The First International Wheat Congress. Tehran, 7–10 Dec 2002, p. 170 (in farsi).

Pouralibaba H.R., Torabi M., Dehghan M.A., Dadrezaie S.T. 2004. Evaluation of some advanced dry land wheat genotypes for resistance to *Septoria* leaf blotch disease caused by *Septoria tritici* (per. *Mycosphaerella graminicola*). 16th Iranian Plant Protection Congress, p. 47.

Rajaram S. 1999. Historical aspects and future challenges of an international wheat program. p. 1–17. In: Septoria and Stagonospora Disease of Cereal: A Compilation of Global Research. Mexico, D.F.: CIMMYT: 1–17.

Robert C., Bancal M.O., Nicolas P., Lannou Ch., Ney B. 2004. Analysis and Modeling of effects of leaf rust and *Septoria tritici* blotch on wheat growth. J. Exp. Bot. 55: 1079–1094.

Saari E.E., Prescott J.M. 1975. A scale for appraising the foliar intensity of wheat diseases. Plant Dis. Report. 59: 377–380.

Scharen A.L. 1999. Biology of the Septoria/ Stagonospora pathogens: An overview. p: 19–22. In: Septoria and Stagonospora Disease of Cereal: A Compilation of Global Research. Mexico, D.F.: CIMMYT: 19–22.

Shaw M.W., Royle D. J. 1989. Airborne inoculum as a major source of *Septoria tritici* (*Mycosphaerella graminicola*) infections in winter wheat crops in the UK. Plant Pathol. 38: 35–43.

Teng P.S. 1987. Quantifying the relationship between disease intensity and yield loss. p. 105–113. In: "Crop Loss Assessment and Pest Management" (P.S.Teng, ed.). APS PRESS.

Thomas M.R., Cook R.J., King J.E. 1989. Factors affecting development of *Septoria tritici* in winter wheat and its effect on yield. Plant Pathol. 38: 246–257.

Torabi M. 1980. Wheat septorios and its importance in Iran. Iranian J. Plant Pathol. 16: 7–14.

Torabi M., Pouralibaba H.R., Dehghan M.A., Dadrezaie S.T. 2002. Evaluation of resistance of advanced dry land wheat lines at seedling and adult stages against Septoria leaf blotch in different part of Iran. 15th Iranian Plant Protection Congress, p. 6.

Zhang X.Y., Loyce C., Meynard J.M., Monod H. 2007. Modeling the effect of cultivar resistance on yield losses of winter wheat in natural multiple disease conditions. Eur. J. Agron. 26: 384–393.

POLISH SUMMARY

OKREŚLANIE I PRZEWIDYWANIE STRAT PLONU POWODOWANYCH PRZEZ SEPTORIOZĘ PASKOWANĄ LIŚCI PSZENICY U SIEDMIU ODMIAN I RODÓW HODOWLANYCH W IRANIE

Septorioza paskowana liści pszenicy wywoływana przez grzyb *Septoria tritici* jest jedną z najważniejszych chorób występujących w uprawie pszenicy na świecie, a także w Iranie. W celu określenia straty plonu powodowanej występowaniem tej choroby przeprowadzono doświadczenia polowe w prowincji Golestan. Doświadczenia założono metodą bloków losowanych w czterech powtórzeniach z udziałem pięciu odmian pszenicy: Tajan, Zagros, Shiroodi, Koohdast, Shanghai oraz dwóch rodów hodowlanych N-80-6 i N-80-19 w Stacji Doświadczalnej Gorgan. Rośliny pszenicy zakażano sztucznie przy użyciu zawiesiny zarodników. Inokulację roślin przeprowadzono w trzech stadiach rozwojowych (wg skali Zadoks'a): krzewienie (GS 37), wydłużanie źdźbła (GS 45), otwieranie się pochwy liścia flagowego (GS 53). Poletka kontrolne spryskiwano wodą. Wzięto pod uwagę masę tysiąca ziaren, plon ziarna oraz powierzchnię pod krzywą postępu choroby (AUDPC) w czasie sezonu wegetacyjnego. Wyniki analizy statystycznej wykazały, że wielkości strat plonu różniły się dla badanych odmian i rodów pszenicy i wahały się w granicach od 30 do 50%. Najwyższe straty plonu wystąpiły u odmian Zagros i Tajan i wynosiły odpowiednio 48,86% i 47,41%. Stwierdzono dodatnią korelację pomiędzy stratą plonu ziarna a powierzchnią pod krzywą postępu choroby. Wyniki analizy dotyczącej przewidywania strat plonu ziarna przy zastosowaniu modelu integralnej wielopunktowej regresji wykazały, że integralny model (L = 1230.91+1.37 AUDPC), gdzie wielkości powierzchni pod krzywą postępu choroby i procentowe straty plonu stanowiły odpowiednio niezależne i zależne zmienne, proponowany model był przydatny do interpretacji powyżej 95% zmienności AUDPC w odniesieniu do strat plonu u wszystkich odmian. Spośród wszystkich

odmian, odmiana Shiroodi okazała się najbardziej przydatna do badań nad integralnym modelem. Prowadząc analizy przy użyciu modelu integralnej wielopunktowej regresji brano pod uwagę nasilenie choroby w różnych okresach jako niezależną zmienną oraz procentowe straty plonu jako zależną zmienną. Proponowany model o najwyższym współczynniku determinacji okazał się najbardziej przydatny do oszacowania strat plonu ziarna. Ponadto, wyniki prezentowanych badań wykazały, że oceny nasilenia choroby prowadzone w stadiach wzrostu GS 37, GS 53 i G S91 (wg Zadoks'a) były najbardziej przydatne przy przewidywaniu strat plonu ziarna pszenicy.