Resistance of corn inbred lines to foliar diseases in two planting dates

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***Abstract*—** *The aim of this study was to attempt to identify elite inbred lines resistant to tropical rust, southern rust, gray leaf spot, northern leaf blight, physoderma brown spot and phaeosphaeria leaf spot. Fifty inbred lines were evaluated, in two seasons, in randomized blocks with 3 replications for AUDPC (Area Under the Disease Progress Curve), obtained by evaluation of the disease at 45, 60, 75 and 90 days after planting. Rating of at 1, 2, 3, 4, 5, 6, 7, 8 and 9 corresponded to 0, 1, 10, 20, 30, 40, 60, 80 and > 80% of leaf symptoms, respectively. The joint analysis of variance had significant differences between inbred lines for tropical rust, southern rust, gray leaf spot and phaeosphaeria leaf spot. There was a significant interaction between inbred lines and seasons for both tropical rust and southern rust. In season 1, tropical rust, southern rust and gray leaf spot differed significantly. In season 2, significant differences occurred for southern rust and phaeosphaeria leaf spot. We found 12 inbred lines with improved levels of resistance to tropical rust, southern rust and gray leaf spot. For phaeosphaeria leaf spot, 38 inbred lines had satisfactory resistance.*

***Keywords*— Gray leaf spot, Northern leaf blight, Phaeosphaeria leaf spot, Physoderma brown spot, Rust.**

I. INTRODUCTION

Big losses in grain yield in corn are associated with the incidence of diseases. Disease monitoring studies have demonstrated that rust, gray leaf spot and Phaeosphaeria leaf spot are among the major diseases that affect the corn crop in Brazil (Carson 2005, Casela et al. 2006).

Due to the characteristics of corn growing in Brazil, such as plant height, the length of the planting season and economic yield and, in some cases, continuous planting of corn years around the most viable measure to control the disease is the use of genetic resistance. For nearly two decades chemical control was practically viable only in seed production fields (Gianasi et al. 1996). Currently, crops grown with the highest level of technology, with higher income potential, can often economically use chemical control for these diseases, although genetic resistance is still preferred. For the farmer, the desired resistance is in the hybrid planted, but breeders have to also worry about resistance in the parental lines that give rise to these hybrids. In addition, resistant inbred lines can be used for adding resistance to other inbred lines and better performance in future hybrids. There is also the possibility of using synthetics from resistant inbreds as commercial varieties for corn producers with lower technological level.

Many reports in the literature indicate that there is genetic variability in cultivars in disease resistance (Nihei and Ferreira 2012, Vieira et al. 2012, Zambrano et al. 2014); however, few papers discuss genetic resistance to diseases in inbred lines. Colombo et al. (2014) reported that the Area Under the Disease Progress Curve (AUDPC) can quantify the progression of disease during a certain period, and it has been frequently used to evaluate the level of resistance in field conditions. The objective of this study was to identify inbred lines resistant to tropical rust (*Physopella zeae* (Mains) Cummins & Ramachar.), southern rust (*Puccinia polysora* Underw), gray leaf spot (*Cercospora zeae-maydis* Tehon & E.Y. Daniels),

northern leaf blight (*Exserohilum turcicum* (Pass.) Leonard & Suggs), physoderma brown spot (*Physoderma maydis*) and phaeosphaeria leaf spot (*Phaeosphaeria maydis* in association with *Pantoeae ananas*).

II. MATERIAL AND METHOD

Fifty inbred lines were used, eighteen derived from the Isanão-VF1 population, nine from the Isanão-VD1 population, ten from the Flintisa population, eight from the Dentado population and five from EMPASC 151- *Condá*. The first two populations are brachytic, the others have normal height. Flintisa and Dentado lines were obtained from the corn breeding program of São Paulo State University – UNESP – Ilha Solteira – SP (Brazil). EMPASC 151- *Condá is an old open pollinated variety from the state of Santa Catarina (Brazil).* These inbred lines have already been selected to yield well in crosses.

The experiments were conducted at the Teaching, Research and Extension Farm of UNESP - Ilha Solteira, located in Selvíria – Mato Grosso do Sul (MS) - Brazil (20° 20'S, 51° 23'W and the altitude of 335 m). The climate of the region, according to Köppen classification, is Aw, defined as tropical humid with a rainy season in summer and dry in winter. The average annual rainfall is 1,330 mm, with the average annual air temperature of about 25°C and average humidity of 66% (Centurion 1982).

The fifty experimental inbred lines were evaluated in a randomized block design with three replications in two seasons (planting on 02.20.2014 and 04.17.2014). Each plot was a single row with 8 m in length and spacing of 0.45 m between plots and an average of 0.4 m between plants. Planting was with normal tillage, irrigated by a center pivot, with twice the number of seeds needed and thinned at six fully developed leaves. Fertilization was done according to soil analysis with 300 kg ha^{-1} of 8-28-16 applied followed by 250 kg ha^{-1} of urea at the 6 leaf stage.

The inbred lines were evaluated for tropical rust (TR), southern rust (SR), gray leaf spot (GLS), northern leaf blight (NLB), physoderma brown spot (PBS) and phaeosphaeria leaf spot (PLS). Evaluations were carried out at 45, 60, 75 and 90 days after planting, determining the severity of disease based on the percentage of symptoms of the plot, according to the diagrammatic scale suggested in Agroceres Guide to Sanity (Agroceres 1996). The ratings were assigned values of 1, 2, 3, 4, 5, 6, 7, 8 and 9, corresponding to 0, 1, 10, 20, 30, 40, 60, 80 and > 80% of leaf symptoms, respectively.

The Area Under the Disease Progress Curve (AUDPC) for each disease was calculated as suggested by Campbell and Maddenn (1990):

$$AUDPC = \sum_{i=1}^{n-1}(Y_{i+1} + Y_i)(T_{i+1} - T_i) \quad (1)$$

Where:

Y_i: severity of the disease at the stage of evaluation i (i = 1,...n).
Y_{i+1}: severity of the disease at the stage of evaluation i+1.
T_i: evaluation stage i, is the number of days after planting.
T_{i+1}: evaluation stage i+1.
n: the total number of evaluations

For statistical analysis, the scores were transformed by $\sqrt{x + 0.5}$, using the Genes software (Cruz 2013) for the individual analyses and the combined analyses of variance, Microsoft Excel 2010® was used for calculating the AUDPC.

Temperature and humidity were collected from the weather station located near the experiment (latitude: 20º 25' 24.4" and longitude: 51º 21' 13.1") for the period from February until July 2014 (Figure 1).

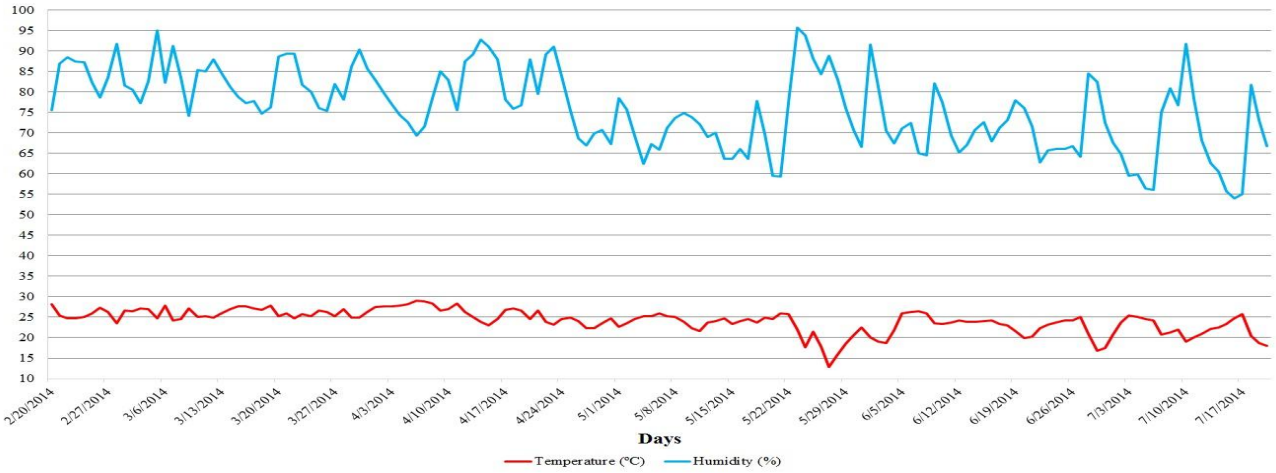

FIGURE 1 – TEMPERATURE AND RELATIVE HUMIDITY IN ILHA SOLTEIRA – SP, BRAZIL FROM FEBRUARY TO JULY 2014.

III. RESULTS AND DISCUSSION

In the joint analyses of variance for AUDPC (Table 1), the F test for inbred line variation is significant for TR, SR, GLS and PLS, showing that the inbred lines had different responses to the natural infection of these diseases. However, the discrimination among inbred lines observed in the joint analysis occurred for both planting seasons only for SR. The analyses of individual seasons (Table 2) indicated that the significance of the F test for inbred lines for TR and GLS occurred only for the first season, while for the PLS significance differences occurred only for the second season. Therefore, early planting can be used to select more resistant inbred lines for TR, SR and GLS while a later planting is more appropriate for PLS.

TABLE 1
JOINT ANALYSIS (MEAN SQUARES) OF AREA UNDER THE DISEASE PROGRESS CURVE (AUDPC) FOR TROPICAL RUST (TR), SOUTHERN RUST (SR), GRAY LEAF SPOT (GLS), NORTHERN LEAF BLIGHT (NLB), PHYSODERMA BROWN SPOT (PBS) AND PHAEOSPHAERIA LEAF SPOT (PLS). SELVÍRIA - MATO GROSSO DO SUL (MS), BRAZIL, 2014.

Source of variation	DF	TR	SR	GLS	NLB	PBS	PLS
Inbred lines (L)	49	0.4665**	1.8852**	1.0177**	0.3414	0.0590	0.3511**
Seasons (S)	1	0.1611	22.2522*	0.3628	0.0758	8.2220**	2.0415*
Lx S	49	0.5005*	1.7671**	0.7771	0.2426	0.0545	0.2598
Error	196	0.2450	0.7678	0.5911	0.2618	0.0800	0.1999
Average		103.0	134.4	108.1	95.3	93.5	94.4
CV%		4.87	7.58	7.4	5.24	2.92	4.6

*****. * Significant at 1% and 5% probability level for the F test.***

For NLB and PBS, there was no discrimination among inbred lines in either season (Tables 1, 2, 3 and 4), with AUDPC average of 95.3 and 94.4, respectively, showing moderate resistance, inadequate conditions for the development of diseases or insufficient natural inoculum pressure. The possibility exists that the tested inbred lines are similar in levels of resistance to these two diseases. White (1999) suggests that northern leaf blight epidemics are related to temperatures around 20°C and relative humidity above 90%. These conditions of humidity were not observed in the two evaluation periods of this study. For the development of PBS, the optimum temperature is between 23°C and 30°C with constant water accumulation on the leaves and is favored by the presence of free water on the surface of leaves as described by Robertson et al. (2013), which was often observed in this study, showing weather conditions sufficient for the development of the pathogen in the tested inbred lines. As there were no differences between inbred lines, it can be considered that they have equal levels of resistance, although further assessment covering other planting dates are recommended for a more accurate conclusion on the subject. The use of a known susceptible check may be useful for this purpose, but in this work, there was no prior information available to select a susceptible check, as this is the first report on inbred lines from São Paulo for resistance to these diseases.

TABLE 2

INDIVIDUAL ANALYSIS OF VARIANCE FOR AREA UNDER THE DISEASE PROGRESS CURVE (AUDPC) FOR BOTH PLANTING DATES (SEASON 1: 02.20.2014 AND SEASON 2: 04.17.2014) TO TROPICAL RUST, SOUTHERN RUST, GRAY LEAF SPOT, NORTHERN LEAF BLIGHT, PHYSODERMA BROWN SPOT AND PHAEOSPHAERIA LEAF SPOT SELVÍRIA - MATO GROSSO DO SUL (MS), BRAZIL, 2014.

Source of variation	DF	Season 1	Season 2
Tropical rust			
Blocks	2	1.1953	1.0820
Inbred lines	49	0.7426**	0.2243
Error	98	0.2610	0.2290
Average	-	102.65	103.4
CV%	-	5.04	4.70
Southern rust			
Blocks	2	5.3528	0.1828
Inbred lines	49	2.2758**	1.3764*
Error	98	0.6445	0.8912
Average	-	140.85	128.05
CV%	-	6.78	8.36
Gray leaf spot			
Blocks	2	0.7130	0.0427
Inbred lines	49	1.2002*	0.5946
Error	98	0.7427	0.4396
Average	-	109.05	107.2
CV%	-	8.27	6.40
Northern leaf blight			
Blocks	2	1.5406	0.9401
Inbred lines	49	0.4039	0.1801
Error	98	0.3689	0.1547
Average	-	95.05	95.45
CV%	-	6.22	4.01
Physoderma brown spot			
Blocks	2	0.0234	0.2258
Inbred lines	49	0.0119	0.1015
Error	98	0.0119	0.0893
Average	-	90.25	96.75
CV%	-	1.14	3.03
Phaeosphaeria leaf spot			
Blocks	2	0.1257	0.2984
Inbred lines	49	0.2053	0.4056*
Error	98	0.1445	0.2552
Average	-	92.7	96.06
CV%	-	3.94	5.15

*****. * Significant at 1% and 5% probability level for the F test.***

TABLE 3

AVERAGES OF INBRED LINES IN SEASON 1 (PLANTING DATE 02.20.2014) FOR AREA UNDER THE DISEASE PROGRESS CURVE (AUDPC, NON-TRANSFORMED). SELVÍRIA - MATO GROSSO DO SUL (MS), BRAZIL. 2014.

Inbred line	Tropical rust		Southern rust		Gray leaf spot		Northern leaf blight		Physoderma brown spot		Phaeosphaeria leaf spot	
IVF1-2-1	102.5	a	147.5	b	97.5	a	90	a	90	a	90	a
IVF1-3	97.5	a	132.5	a	135	b	112.5	a	90	a	90	a
IVF1-4	112.5	b	125	a	127.5	b	92.5	a	90	a	90	a
IVF1-5	105	a	125	a	112.5	b	90	a	90	a	90	a
IVF1-6-1	100	a	157.5	b	92.5	a	102.5	a	90	a	90	a
IVF1-6-2	102.5	a	157.5	b	117.5	b	90	a	90	a	90	a
IVF1-6-3	97.5	a	140	b	110	a	102.5	a	90	a	90	a
IVF1-7	92.5	a	100	a	150	b	90	a	90	a	90	a
IVF1-8	102.5	a	145	b	90	a	102.5	a	90	a	90	a
IVF1-9	92.5	a	122.5	a	90	a	90	a	90	a	90	a
IVF1-10	92.5	a	120	a	105	a	115	a	90	a	95	a
IVF1-11	97.5	a	122.5	a	97.5	a	90	a	90	a	90	a
IVF1-12	127.5	c	147.5	b	122.5	b	90	a	90	a	90	a
IVF1-12-1	102.5	a	160	b	97.5	a	90	a	90	a	92.5	a
IVD1-2	117.5	b	167.5	c	95	a	97.5	a	90	a	90	a
IVD1-3	90	a	112.5	a	120	b	90	a	90	a	90	a
IVD1-5	90	a	175	c	127.5	b	90	a	90	a	90	a
IVD1-8	127.5	c	147.5	b	125	b	90	a	90	a	95	a
IVD1-9	100	a	120	a	127.5	b	90	a	90	a	90	a
IVD1-10	105	a	197.5	c	115	b	90	a	90	a	90	a
IVD1-11	120	b	150	b	102.5	a	90	a	90	a	90	a
IVD1-2-1	100	a	132.5	a	102.5	a	107.5	a	90	a	90	a
IVD1-12	105	a	137.5	a	97.5	a	90	a	90	a	92.5	a
1D	110	b	147.5	b	90	a	90	a	90	a	90	a
2D	105	a	127.5	a	115	b	110	a	90	a	95	a
3D	92.5	a	152.5	b	110	a	90	a	90	a	92.5	a
6D	110	b	150	b	97.5	a	97.5	a	90	a	90	a
7D	115	b	145	b	92.5	a	90	a	95	b	112.5	b
8D	95	a	132.5	a	127.5	b	92.5	a	97.5	b	110	b
9D	92.5	a	127.5	a	125	b	90	a	90	a	90	a
10D	105	a	115	a	105	a	90	a	90	a	100	b
1F	140	c	147.5	b	117.5	b	90	a	90	a	90	a
2F	90	a	107.5	a	107.5	a	90	a	90	a	90	a
3F	97.5	a	125	a	100	a	95	a	90	a	90	a
4F	100	a	142.5	b	115	b	92.5	a	90	a	102.5	b
5F	97.5	a	187.5	c	110	a	90	a	90	a	90	a
6F	105	a	135	a	92.5	a	90	a	90	a	90	a
7F	90	a	115	a	125	b	97.5	a	90	a	92.5	a
8F	102.5	a	147.5	b	105	a	90	a	90	a	90	a
9F	97.5	a	142.5	b	97.5	a	105	a	90	a	100	b
10F	107.5	a	175	c	122.5	b	90	a	90	a	90	a
IVF1-5-2	95	a	152.5	b	112.5	a	102.5	a	90	a	110	b
IVF1-247	110	b	130	a	110	a	112.5	a	90	a	95	a
IVF1-25	105	a	122.5	a	105	a	90	a	90	a	92.5	a
IVF1-230	92.5	a	120	a	90	a	90	a	90	a	90	a
1C	107.5	a	165	c	117.5	b	90	a	90	a	90	a
2C	92.5	a	147.5	b	102.5	a	90	a	90	a	90	a
3C	95	a	142.5	b	105	a	102.5	a	90	a	90	a
4C	100	a	117.5	a	100	a	115	a	90	a	92.5	a
5C	102.5	a	180	c	97.5	a	97.5	a	90	a	95	a
Average	102.65		140.85		109.05		95.05		90.25		92.7	

**** - Average with the same letter do not differ by the Scott-Knott test at 5% probability.***

TABLE 4

AVERAGE OF INBRED LINE IN SEASON 2 (PLANTING DATE 04.17.2014) FOR AREA UNDER THE DISEASE PROGRESS CURVE (AUDPC NON-TRANSFORMED). SELVÍRIA - MATO GROSSO DO SUL (MS), BRAZIL. 2014.

Inbred line	Tropical rust		Southern rust		Gray leaf spot		Northern leaf blight		Physoderma brown spot		Phaeosphaeria leaf spot	
IVF1-2-1	115	a	127.5	a	97.5	a	107.5	a	95	a	90	a
IVF1-3	102.5	a	130	a	132.5	a	95	a	92.5	a	97.5	a
IVF1-4	107.5	a	142.5	a	102.5	a	97.5	a	95	a	92.5	a
IVF1-5	95	a	117.5	a	112.5	a	92.5	a	97.5	a	92.5	a
IVF1-6-1	97.5	a	105	a	122.5	a	95	a	97.5	a	90	a
IVF1-6-2	105	a	120	a	110	a	95	a	102.5	a	92.5	a
IVF1-6-3	115	a	155	a	102.5	a	90	a	102.5	a	102.5	b
IVF1-7	102.5	a	110	a	105	a	95	a	102.5	a	95	a
IVF1-8	105	a	130	a	97.5	a	97.5	a	95	a	90	a
IVF1-9	102.5	a	127.5	a	107.5	a	92.5	a	95	a	97.5	a
IVF1-10	102.5	a	147.5	a	95	a	90	a	92.5	a	90	a
IVF1-11	95	a	152.5	a	97.5	a	92.5	a	97.5	a	115	b
IVF1-12	97.5	a	112.5	a	105	a	95	a	97.5	a	92.5	a
IVF1-12-1	97.5	a	142.5	a	115	a	90	a	95	a	115	b
IVD1-2	100	a	132.5	a	120	a	92.5	a	102.5	a	105	b
IVD1-3	112.5	a	145	a	140	a	95	a	95	a	105	b
IVD1-5	100	a	107.5	a	115	a	97.5	a	100	a	97.5	a
IVD1-8	110	a	110	a	102.5	a	100	a	97.5	a	92.5	a
IVD1-9	102.5	a	127.5	a	115	a	92.5	a	97.5	a	90	a
IVD1-10	115	a	132.5	a	100	a	92.5	a	92.5	a	107.5	b
IVD1-11	97.5	a	122.5	a	107.5	a	92.5	a	95	a	92.5	a
IVD1-2-1	100	a	132.5	a	125	a	90	a	95	a	90	a
IVD1-12	112.5	a	142.5	a	100	a	97.5	a	95	a	92.5	a
1D	95	a	145	a	107.5	a	97.5	a	95	a	90	a
2D	102.5	a	107.5	a	102.5	a	112.5	a	92.5	a	102.5	b
3D	102.5	a	130	a	97.5	a	90	a	97.5	a	90	a
6D	107.5	a	120	a	102.5	a	90	a	105	a	90	a
7D	102.5	a	120	a	97.5	a	97.5	a	95	a	95	a
8D	97.5	a	147.5	a	100	a	92.5	a	100	a	115	b
9D	107.5	a	112.5	a	97.5	a	90	a	97.5	a	95	a
10D	100	a	107.5	a	105	a	95	a	90	a	92.5	a
1F	102.5	a	145	a	115	a	92.5	a	105	a	90	a
2F	110	a	130	a	100	a	95	a	92.5	a	90	a
3F	95	a	150	a	107.5	a	92.5	a	97.5	a	90	a
4F	107.5	a	112.5	a	125	a	92.5	a	97.5	a	105	b
5F	107.5	a	130	a	100	a	92.5	a	95	a	92.5	a
6F	107.5	a	152.5	a	105	a	107.5	a	95	a	115	b
7F	102.5	a	107.5	a	100	a	90	a	95	a	90	a
8F	102.5	a	120	a	102.5	a	92.5	a	95	a	90	a
9F	110	a	102.5	a	102.5	a	95	a	92.5	a	92.5	a
10F	112.5	a	122.5	a	97.5	a	95	a	97.5	a	102.5	b
IVF1-5-2	105	a	142.5	a	110	a	97.5	a	90	a	92.5	a
IVF1-247	107.5	a	115	a	107.5	a	107.5	a	95	a	97.5	a
IVF1-25	97.5	a	127.5	a	102.5	a	100	a	92.5	a	90	a
IVF1-230	97.5	a	130	a	112.5	a	92.5	a	102.5	a	95	a
1C	102.5	a	125	a	115	a	100	a	97.5	a	90	a
2C	105	a	165	a	102.5	a	97.5	a	100	a	90	a
3C	97.5	a	120	a	112.5	a	92.5	a	100	a	92.5	a
4C	97.5	a	105	a	105	a	102.5	a	95	a	107.5	b
5C	97.5	a	137.5	a	100	a	97.5	a	102.5	a	95	a
Average	103.4		128.05		107.2		95.45		96.75		96.05	

**** - Average with the same letter do not differ by the Scott-Knott test at 5% probability***

For seasons, significant differences were observed for SR, PBS and PLS (Table 1), with the highest incidence of the first two with planting in February and the highest incidence of PLS with planting in April (Tables 3 and 4). According to the analysis of temperature and humidity (Figure 1), it is possible to verify that in the period from February until May, which includes all the evaluations of the first season, temperature and humidity were higher, while during the second season peaks of higher temperature and humidity occurred on some evaluation dates. These conditions benefited the development of SR and PBS, hindered the development of PLS and were not sufficient to alter the symptoms of other diseases. For selection, only seasons when there is discrimination of genotypes are consequential. Favorable environmental conditions can be sufficient for the development of disease epidemics, provided that sufficient inoculum exists (Fernandes and Oliveira 2000, Rolim 2007).

Although it is possible to select resistant genotypes when there is statistical discrimination, an issue to be discussed is what is the AUDPC limiting value to consider a genotype resistant to foliar diseases. By the Agroceres Guide to Sanity (Agroceres 1996), a genotype is considered resistant with score lowers than or equal to three at 30 days after silking. Projecting this for our evaluation dates, it would correspond to a score of one for 45 and 60 days, a score of two to 75 days and a score of three for 90 days. These values correspond to an AUDPC of 120, which can be regarded as a limit for a genotype to be considered resistant. Genotypes do not exhibit these scores exactly, but those with AUDPC less than 120 can be considered resistant. Taking as an example gray leaf spot, the IVF1-8 inbred line (Figure 2) is considered to be highly resistant, with AUDPC equal to 90, which indicates the absence of disease symptoms. The IVD1-3 inbred line is at the resistance threshold, with AUDPC equal to 120, while the IVD1-7 inbred line is considered susceptible (Figure 2). In commercial hybrids, thinking of the farmer's situation, this threshold could even be increased slightly, but in the selection of inbred lines for the production of breeding proposes, it is understood that accuracy should be stricter.

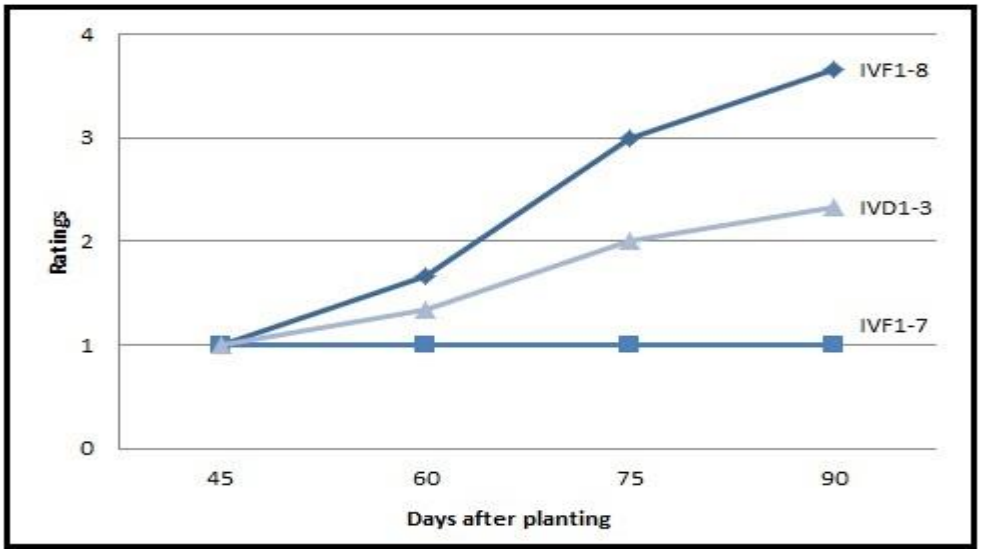

FIGURE 2 – EVOLUTION OF THE SCORING OF THE IVD1-3, IVF1-7 AND IVF1-8 INBRED LINES FOR GRAY LEAF SPOT IN THE FIRST PLANTING SEASON, SELVÍRIA - MATO GROSSO DO SUL (MS), BRAZIL, 2014.

For NLB, PBS and PLS there was either not much diseases or almost complete resistance. Later planting had slightly increased disease scores, but artificial inoculation may be necessary to discriminate among lines. GLS and both rests had a good range of disease scores, but only the early planting had a fully susceptible line (IVF1-7) for gray leaf spot. Both rests have a wide range of scores, but these was a general lock of resistance for SR and for more infection with the earlier planting (mean of 141 vs 128). While the mean scores for TR differed little between planting dates, only one line, 1F, was highly susceptible and that was only for the early planting. Overall, where discrimination among lines was possible, the earlier planting was most useful.

Analysis of the average cluster, the Scott-Knott test (Table 3), showed that there are inbred lines with different resistance levels for various diseases during the first season. In this context the inbred lines that showed higher levels of resistance to tropical rust, southern rust, gray leaf spot, physoderma brown spot and phaeosphaeria leaf spot were: IVF1-3, IVF1-9, IVF1-10, IVF1-11, IVF1-25 and IVF1-230 from the Isanão-VF1 population; IVD1-2-1 and IVD1-12 from the Isanão-VD1 population; 2F, 3F and 6F from Flintisa population and the inbred line 4C from the Condá population. The inbred lines coming from the Isanão-VF1 had a higher frequency of inbred lines resistant to these diseases. The 1F, 5C and 9D inbred lines were the most susceptible to tropical rust, southern rust and gray leaf spot, respectively, and can be used as checks in

future experiments of genotypes for evaluations of resistance to these diseases.

The analysis of the average cluster, the Scott-Knott test for the second season (Table 4) was significant only for phaeosphaeria leaf spot. The inbred lines with higher values of AUDPC for phaeosphaeria were 4C, 10F, 6F, 4F, 8D, 2D, IVD1-10, IVD1-3, IVD1-2, IVF1-12-1, IVF1-11 and IVF1-6-3. Only the inbred lines IVF1-11, 6F and 4C showed favorable AUDPC for the first season, while in the second season they had higher AUDPC. The analysis of the effect of seasons on phaeosphaeria leaf spot (Table 1) revealed that there were differences between the seasons, which is related to the fact that weather conditions were different in the two seasons. However, in this case, the effect of the seasons was essentially the same for all the inbred lines, as evidenced by no significant interaction of season x inbred lines.

IV. CONCLUSION

The resistant inbred lines based on Area Under Disease Progress Curve (AUDPC) for southern rust, tropical rust, gray leaf spot, northern leaf blight, phaeosphaeria leaf spot and physoderma brown spot were IVF1-3, IVF1-9, IVF1-10, IVF1-11, IVF1-25, IVF1-230, IVD1-2-1, IVD1-12, 2F, 3F, 6F and 4C. The results of this study suggest the need for further assessment, in other months of planting, for the correct evaluation of symptoms of northern leaf blight and physoderma brown spot.

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