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Reaction of beet genotypes to the Beet Leaf Spot in the upper Valley of Itajaí, Santa Catarina state, Brazil

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ABSTRACT

In the region of the Upper Valley of Itajaí, Santa Catarina state, Brazil, family farmers cultivate beet (*Beta vulgaris*) along with other products such as, onion. However, some diseases, including the Beet Leaf Spot (*Cercospora beticola*), have compromised the success of the beet crop due to severe leaf incidence. The objective of this study was to evaluate the reaction to the Beet Leaf Spot, under local conditions, in the spring-summer season, of the beet cultivars most frequently used by farmers in the region, namely All Green, Stays Green, Early Wonder, Cabernet, Boro, Modana and Itapuã. Two experiments, with a 30-day interval between sowings were carried out in EPAGRI, Experimental Station of Ituporanga. The experimental design was of randomized complete blocks with four replications and 2,25 m² plots. Disease severity was assessed weekly, using a diagrammatic rating scale, in ten plants taken at random and previously labelled. Disease severity data were used to calculate the area under the disease progress curve (AUDPC) for each cultivar. Same plants were used to estimate yield. AUDPC and yield data were submitted to analysis of variance (F-test, 5% probability), and means were studied by the Scott-Knott test (5% probability). There were no significant differences between cultivars, nor for reaction to the disease, neither for yield, in any of the two sowing dates. In both experiments, cultivar All Green scored the highest severity value in the last assessments, 18.46 and 19.84% respectively in the first and second sowing dates, while hybrid Boro (17.79%) in the first experiment, and Stays Green and Cabernet (18.04%) in the second, recorded the lowest values. We concluded that all cultivars were susceptible to the Beet Leaf Spot in spring-summer conditions in the Upper Valley of Itajaí.

Keywords: *Beta vulgaris*, *Cercospora beticola*, cultivars, resistance, disease severity.

RESUMO

Reação de genótipos de beterraba à cercosporiose na região do Alto Vale do Itajaí

Na região do Alto Vale do Itajaí-SC, os agricultores familiares cultivam a beterraba (*Beta vulgaris*) em conjunto com outros produtos como, por exemplo, a cebola. Porém, algumas doenças, entre elas a cercosporiose (*Cercospora beticola*), têm comprometido o sucesso da lavoura de beterraba em decorrência da severa incidência foliar. O objetivo deste trabalho foi avaliar a reação das cultivares de beterraba All Green, Stays Green, Early Wonder, Cabernet, Boro, Modana e Itapuã à cercosporiose nas condições da região, no período de primavera/verão. Dois experimentos, com intervalos de 30 dias entre semeaduras, foram conduzidos na EPAGRI, Estação Experimental de Ituporanga. O delineamento experimental utilizado foi blocos casualizados, com quatro repetições e parcelas de 2,25 m². A severidade da doença foi avaliada semanalmente em dez plantas tomadas ao acaso, previamente demarcadas, utilizando-se uma escala diagramática de notas. As avaliações foram integralizadas em uma área abaixo da curva de progresso da doença (AACPD). Para avaliação da produtividade foram utilizadas as mesmas plantas, convertendo-se os dados para t/ha. Os dados de AACPD e produtividade foram submetidos à análise de variância (teste de F, 5% de probabilidade) e as médias dos tratamentos foram comparadas pelo teste de agrupamento de Scott-Knott (5% de probabilidade). Não houve diferenças significativas entre cultivares para reação à doença e produtividade em nenhuma das duas épocas de semeadura. Em ambos os experimentos, a cultivar All Green apresentou o valor mais alto de severidade na última avaliação, 18,46 e 19,84% respectivamente na primeira e segunda época de semeadura, enquanto o híbrido Boro (17,79%) no primeiro experimento, e os materiais Stays Green e Cabernet (18,04%) no segundo, registraram os valores mais baixos. Concluiu-se que todos os genótipos foram suscetíveis à cercosporiose nas condições de primavera/verão do Alto Vale do Itajaí-SC.

Palavras-chave: *Beta vulgaris*, *Cercospora beticola*, cultivares, resistência, severidade de doença.

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Beet (*Beta vulgaris*), from the Chenopodiaceae family, is original from the temperate zones of Europe and North Africa, which explains why it is easier to grow beet plants in cold climates. Beet is a typical biennial plant, requiring a period of intense cold to trigger the reproductive cycle, from the emission of the floral spike to seed production (Filgueira, 2007). The most suitable temperatures for beet development range from 10 to 20°C

(Puiatti & Finger, 2005).

In several European, North-American and Asian countries, growing beets is highly profitable and plants are used for sugar and forage production (Filgueira, 2007). In Brazil, beets are mainly consumed as vegetable, either *in natura* or cooked, as well as in fresh juices. Lately, processing and baby food industries are also increasing their demand for beets (Tivelli *et al*., 2011).

In 2007, beet seed trade handled nearly 3 million dollars in Brazil for sowing an estimate of more than 20,000 hectares (ABCSEM, 2011). Data from the Wholesale Market Supply Center of the State of Santa Catarina (CEASA-SC) showed that more than 3,000 tons of beets were sold in the state in 2009. Santa Catarina itself produced about 73% of this total. The remainder was imported from other states, especially Rio Grande do Sul, where around 20% of the beet came from (Osorio, 2010). From the second semester of 2011 to the second semester of 2012, 4,583.04 tons of beets were sold at CEASA-SC, with Santa Catarina and Rio Grande do Sul accounting for respectively 65 and 17,4% of the total (Pieva, 2012).

In most of the beet producing regions in Southeast and South Brazil, the main sowing season in low-altitude conditions occurs primarily during autumn-winter. On contrary, in high altitude it is possible to plant throughout the year, including during summer. However, heat is always a limiting factor for most cultivars. When we grow beets under high temperatures and rainfall, fungal diseases prematurely destroy leaves, while light rings are formed in roots, reducing their commercial quality.

The region of the Upper Valley of Itajaí, in the state of Santa Catarina, has a humid subtropical climate (Cfa), according to the Köppen classification. In this region, although growing beets in summer is more difficult than in winter, beet is commonly grown in spring-summer, in succession to onion crops, which are in the field in November and December. However, many pathogens, including *Cercospora beticola*, etiological agent of the Beet Leaf Spot, hamper beet production in this season.

The Beet Leaf Spot is the most relevant beet disease, since it leads to the full leaf blade destruction and, consequently, significant yield drop (Puiatti & Finger, 2005). The characteristic symptoms are leaf circular spots, with purple borders and clear center (Filgueira, 2007). As the disease progresses, spots increase in size, become grayish and eventually necrotic; the dead tissue falls and leaves become multi-hole (Hermann, 1998). The increase in both spot number and area, along with phytotoxin accumulation, induce leaf senescence and, consequently, significant reduction in leaf area. Old leaves are more susceptible to the disease (Weiland & Koch, 2004).

This is the most limiting disease for growing beets in spring-summer, especially when temperatures and relative humidity rise (Agrofit, 2013). Despite the availability of effective chemical control, the disease usually prevents beets from being commercialized in bunches (Tivelli *et al*., 2011) due to the leaf damages and senescence.

Genetic resistance would be the most adequate control method, considering that it does not significantly impact production costs and production systems (Camargo, 2011). However, there is little information on the resistance to leaf spot in the beet cultivars used in Brazil. To contribute to build up knowledge on the subject, our objective was to evaluate the reaction of beet cultivars to the Beet Leaf Spot under natural inoculum conditions during the spring-summer cropping at the Upper Valley of Itajaí.

MATERIAL AND METHODS

We carried out the study from November 2012 to February 2013 in the Agricultural Research and Rural Extension Corporation of the state of Santa Catarina (EPAGRI), at the Experimental Station of Ituporanga, county of Ituporanga, in the region of Upper Valley of Itajaí (27°38'S, 49°60'W, 475 meters altitude). According to the Köppen classification, the local climate is Cfa and the soil is classified as an Inceptisol (Embrapa, 1999).

We carried out two successive experiments with a 30-day difference between sowing dates (October, 31 and November, 30) due to the difference in the harvesting dates of the previous onion crops, planted using distinct cultivars. Our treatments corresponded to the seven most commonly used beet cultivars (seed company) in the region, namely All Green (Hortec), Stays Green (Agrocinco), Early Wonder (Horticeres Sementes), Cabernet (hybrid, Horticeres Sementes), Boro (hybrid, Bejo), Modana (monogermic, Tecnoseed) and Itapuã (Isla). We used a randomized block design with four replications and plots of 2.25 m² (1.5x1.5 m), with five lines each, resulting in 75-plant plots.

Seeds were manually sown with 30x10 cm spaces between rows and plants, respectively. Planting, in the sowing furrow, and top fertilization dressing, broadcasted, were calculated as recommended by the Fertilization and Liming Manual for the States of Rio Grande do Sul and Santa Catarina (2004). Weeds and pests were managed manually and, when necessary, with the aid of herbicides and insecticides registered for beet, using a 20-L back sprayer Jacto PJH. Average temperatures were 21.9 and 22.5°C in the first and second experiments, respectively, while total monthly rainfalls were 79.7 mm in November, 162.4 mm in December, 167.7 mm in January, and 92.8 mm in February.

To assess both disease severity under natural inoculum pressure and yield, we took and identified ten plants at random in each replication. We evaluated disease severity on a week basis in each expanded leaf of the identified plants using the diagrammatic scale (0.41; 0.97; 2.26; 5.21; 11.53 and, 23 61% of affected leaf area) proposed by May de Mio *et al*. (2008). We used the disease severity data to calculate the Area Under the Disease Progress Curve (AUDPC) using the formula: $AACPD = \Sigma [(y1 + y2)/2] * (t2-t1)$, where y1 and y2 refer to two successive disease severity assessments carried out at times 1 and 2, respectively (Jesus Junior *et al*., 2004). We harvested the identified plants 84

to 82 days after sowing in the first and second experiments, respectively. At harvest, we weighted plants and then converted the data to yield, in tons per hectare (t/ha).

Data for AUDPC and yield (t/ha) were analyzed (F test, 5% probability), and when significant differences were found, we studied means using the Scott-Knott cluster test, also at 5% probability. The statistical software SASM-Agri (Canteriet *et al*., 2001) was used to perform the analyses.

RESULTS AND DISCUSSION

None of the genotypes showed resistance to the Beet Leaf Spot when planted after onion in spring-summer conditions, independent of the sowing period. There were no significant differences among cultivars for the area under the disease progress curve (AUDPC) in the experiment sowed in October 31 (Table 1), while in the second experiment, the Scott-Knott test grouped all cultivar averages for AUDPC in a single class (Table 2).

In the first experiment, hybrid Cabernet AUDPC was 10.62% lower than hybrid All Green's, the highest value (Table 1), stressing that the difference between them was not significant. In the experiment sowed in November 30, hybrid Boro AUDPC was 11.45% higher than that observed for cultivar Stays Green, the lowest value for AUDPC in this experiment, and both cultivars were clustered in the same class. It is worth mentioning that cultivar Stays Green is the most used beet cultivar in the region. Although Khan *et al*. (2009) observed that the amount of spores in the air is directly related to disease severity in the Beet Leaf Spot; in the current study disease severity did not increase from the first to the second experiment. Actually, disease severity scores in the last assessment did not differ between experiments within cultivars. We believe that disease severity was not influenced by the inoculum produced during crop development in any of the evaluations, since all inoculum was very likely produced within the plant itself. Bălău (2011), working with sugar beet, did not find significant differences in disease severity among cultivars either.

As for the other characteristics evaluated in this study, cultivars did not differ significantly from each other in yield (Tables 1 and 2). In Lithuania, sugar beet cultivars resistant and susceptible to the Beet Leaf Spot did not show significant differences in yield either (Gaurilčikienė *et al*., 2006). Bălău (2001) in Romania, found no difference in yield among cultivars in different assessment years, even when the disease was present. In our study, despite the lack of significant differences in yield among cultivars, we observed interesting figures. Cultivar Itapuã recorded the highest yield in the first experiment (Table 1), while, in the second, its yield was reduced by 2/3 (Table 2). Instead, hybrid Boro, which had the lower yield in the first experiment, experienced not more than a 20% drop in yield in the second trial (Table 1 and 2).

Although marketing flyers of cultivars Itapuã and Stays Green and

Table 1. Area Under the Disease Progress Curve (AUDPC), disease severity at the last assessment and yield of beet cultivars under natural pressure of the Beet Leaf Spot, sowing of October, 31 {Área Abaixo da Curva do Progresso da Doença (AUDPD), severidade de doença na última avaliação e produtividade de cultivares de beterraba em condições de pressão natural de cercosporiose, plantio de 31 de outubro}. Ituporanga, Epagri-EEItu, 2013.

Cultivars	Sowing date: October, 31		
	AUDPC	Disease severity (%)	Yield (t/ha)
Boro	585.64 ns*	17.79 ns*	15.76ns*
Stays Green	572.85	18.44	27.43
Modana	589.50	18.25	23.83
All Green	604.02	18.46	19.45
Early Wonder	564.31	17.99	20.25
Cabernet	546.22	18.18	24.38
Itapuã	573.66	18.16	32.62
CV (%)	5.39	2.90	39.38

*ns= non significant, F test, p<0.05 (não significativo, teste F, p<0,05).

Table 2. Area Under the Disease Progress Curve (AUDPC), disease severity at the last assessment and yield of beet cultivars under natural pressure of the Beet Leaf Spot, sowing of November, 30 {(Área Abaixo da Curva do Progresso da Doença (AUDPD), severidade de doença na última avaliação e produtividade de cultivares de beterraba em condições de pressão natural de cercosporiose, plantio de 30 de novembro}. Ituporanga, Epagri-EEItu, 2013.

Cultivars	Sowing date: November, 30		
	AUDPC	Final severity (%)	Yield (t/ha)
Boro	489.81 a*	19.73 a	12.65 ns**
Stays Green	433.55 a	18.04 a	17.01
Modana	464.21 a	19.23 a	16.19
All Green	466.05 a	19.84 a	16.56
Early Wonder	471.73 a	19.42 a	15.05
Cabernet	465.43 a	18.04 a	12.47
Itapuã	452.75 a	18.42 a	10.89
CV (%)	4.32	4.42	34.05

*Means followed by the same letter in the column did not differ significantly from each other, Scott-Knott test, p<0,05 (médias seguidas pela mesma letra na coluna não diferem significativamente entre si, teste de Scott-Knott, p<0,05); ** ns= non significant, F test, p<0.05 (não significativo, teste F, p<0,05).

hybrid Carbenet describe these materials as tolerant to the Beet Leaf Spot, in fact, none of them showed such gain when compared to the other cultivars. Cultivar Itapuã, considered resistant to the Beet Leaf Spot (Isla, 2014), did not differ from other genotypes when planted after the harvesting of onion in the spring-summer season at the Upper Valley of Itajaí. Filgueira (2007) indicated that most of beet cultivars did not have a high resistance level to the Beet Leaf Spot, which explains why the disease is usually controlled by spraying specific fungicides, with systemic action. Although it has been commercially said that there are new beet cultivars and hybrids with resistance to the Beet Leaf Spot, so far there is no scientific evidence to support this information. This study confirms the lack of resistance to the Beet Leaf Spot in this group of cultivars, under these growing conditions.

Therefore, based on our results, we conclude that for the spring-summer season, in the region of the Upper Valley of Itajaí, none of the challenged cultivars showed resistance to the Beet Leaf Spot.

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