Effect of Planting Date and Fungicide Application on Sugar Beet Leaf Spot Disease Severity in Khuzestan Province, Iran

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ABSTRACT

This study was conducted to evaluate factors affecting severity of the sugar beet leaf spot disease i.e. planting date, sugar beet cultivars and frequencies of fungicide applications at Safi Abad Agricultural Research Center Dezful –Iran during 2004 to 2006. The experimental design was Randomized complete blocks with (split) plot. The Main Plots were planting date on October and November; the sub plots were sugar beet cultivars and applications of fungicide (Mancozeb) frequencies. Two control treatments were used in this experiment. Based on the root yield the results in 2004-2005 showed the significance of planting date (5% level), Mancozeb spraying and cultivar treatments (both at 1% level). The Results obtained indicated that with early planting and with three or four times of fungicide applications sugar beets leaf spot disease would be manageable and higher quality and quantity of sugar beet yield would be expected.

Keywords: *Cecospora beticola*, leaf spot, planting data, sugar beet, spraying.

INTRODUCTION

Sucrose from sugar beet (*Beta vulgaris* L.) is an important dietary supplement worldwide. With production at 35,000,000 tones in 2002, just less than one-third of world sucrose supplies are derived from sugar beet (Anon, 2003). Beet sugar production is distributed across continental regions characterized by temperate climates, complementing cane sugar production in more tropical climate (Weiland and Koch, 2004).

Cercospora leaf spot caused by *Cercospora beticola* Sacc. is considered to be the most destructive foliar pathogen of sugar beet in the world. Warm and humid growing regions are most acutely affected by Cercospora leaf spot and constitute greater than 30% of the area under sugar beet cultivation. Producers in such areas must diligently apply fungicides to varieties possessing moderate to high genetic resistance to the disease in order to harvest and economic crop (Meriggi *et al.* 2000, Windels *et al.* 1998, Wolf and Verreet, 2002). Without such measures, the leaf canopy of sugar beet fields can be destroyed by outbreaks of *C. beticola*, resulting in significant yield loss (Duffus and Ruppel, 1993, Rossi, 2000).

Due to the effects of climate change and warming in Europe especially in the northern regions, sugar beet leaf spot disease appeared as a major disease and has gained importance (Arjomand, 1997). Shane and Teng (1992) showed that as the severity of the disease increases, concentration of impurities increases which reduces sucrose concentration and extractable sucrose.

Rossi et al. (1995) surveyed the severity of sugar beet leaf spot in the Mediterranean have shown that,

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range of disease severity were included from high levels (Po valley, many parts of Greece, Turkey, near the Black Sea) to the low (inner parts of Turkey, southern Spain and parts of Syria, Tunisia, Algeria and Egypt). They also stated that, there is a correlation between the summer drought, planting date, the altitude and irrigation system, with disease development. As well as, they reported that, using resistant cultivars and chemical control had less effect on the severity of the epidemic. Khan and Smith (2004) showed that using fungicides especially Tetraconazole and Pyraklose, caused appropriate control of the disease and increased performance of sugar beet.

MATERIALS AND METHODS:

In a split-split plot designed experiment, the effect of planting date (main plots) on the productivity of two sugar beet cultivars (sub-plots) tread with the fungicide Mancozeb (sub-sub- plots) was studied. The experiment was conducted at the Agricultural Research center of Safi Abad, Dezful –Iran during 2004 to 2006.

Planting dates were October 6th (early planting date) and November 20th (late planting date). The tested cultivars were Line 236 (sensitive) and Posada (semi resistant.) Mancozeb (WP 80%, Iranian Giah Company) at the rate of 2.6 kg/ha was sprayed once, twice, three, four or five times at different time intervals (Table 1). Fungicide application was accompanied with the appearance of new disease symptoms. Unsprayed plots were served as control treatment. The experiment was consisted of four replicates. A plot is 4 lines each 10 meter length.

Assessment of the disease severity was done in the next February, March and April according to Rossi method (Rossi et al. 1995). Evaluation method was based on determination infection rate (from 7 to 10 days after spraying) in 10 plants of the two lines in the center of plots. At harvest, plants in the two central rows of each plot weighed by removing half meters at top and bottom, and the dough samples were analyzed technologically. Sugar beet root yield, sugar percentage and root impurities were measured. Data were statistically analyzed and comparisons of means were done by the LSD test method.

Table 1. Frequency of spraying and spraying time for sub-sub plots.

Time of sprayed	Frequency of sprayed
after the first symptoms appearance	application
15-10 days after the first spraying	app 2
10 to 15 days after second spraying	app 3
2 to 3 weeks after the third spraying	app 4
2 to 3 weeks after fourth spraying	app 5

RESULTS

Based on the results of variance analysis (Table 2), treatments of planting date at 5% and cultivars and spraying with Mancozeb at 1% levels, had an impact on root yield. Average root yield was 68.42 tons per hectare, whereas the maximum was 70.95 tons. The early planting date showed 11.03 % increasing in yield compared with late planting (Table 3). Delay planting from mid-October to Late November (despite reduced severity of leaf spot in later crops) decreased root yield, which approves the positive effects of early planting on the yield of sugar beet in the region. In terms of root yield, statistical differences were

observed among cultivars at 1% level (Table 2). Pasoda cultivar with 73.44 tons/ha yielded 15.84% more than line 263 (Table 3).

Results of variance analysis (Table 2) show that the control of sugar beet leaf spot disease has significantly positive effect on yield of root. The lowest root yield (54 ton/ha) was for positive control treatment while the highest yield (74.9 ton/ha) was related to the five times sprayed treatment followed by the treatment with three times spraying with 74.6 ton/ha (Table 3). As it is clear from the mean comparison table, treatments with spraying and control without spraying show significant differences. Treatments with three, four, and five times spraying compared to the other treatments have significant difference at the 1% level and they were in the statistical group (A). In contrast, the positive control placed alone in D group and other treatments were between the two groups (Table 3). Figure 1 shows the presence of negative and significant regression between sugar beet leaf spot disease severity and the root yield (root weight). Conclusively there are a direct relation between the severity of the disease and root weight decreasing. Therefore, it can be concluded with high confidence coefficient of up 77% that for every one unit of increase in the disease severity, there would be an approximately 3738 kg/h reduction in sugar beet root performance. This shows the critical importance of the sugar beet leaf spot disease in losing weight of sugar beet roots. Interactions of planting date and cultivars, planting date in sprayed treatments and cultivars with Mancozeb spraying and also the interaction of the three investigated factors for decreasing root weight was not significant. Absence of significant interaction among treatments indicates that all factors have independent impact on yield.

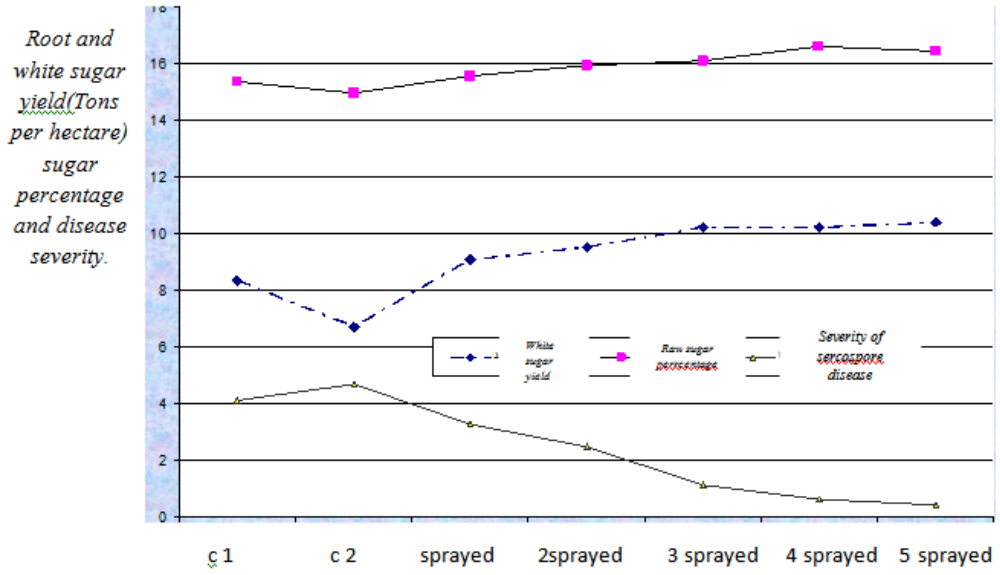

Figure 1. The impact of fungicide on white sugar yield, sugar percentage, and severity of sugar Beet disease of Khuzestan.

Table 2. Summary of ANOVA test

Sources of Variation	Degrees of Freedom	Disease Severity	Yield t / ha	Sugar percentage	Performance of white sugar
Replication	3	0.65 ^{ns}	169.34**	0.24 ^{ns}	3.25 ^{ns}
Plantning date	1	4.03 ^{ns}	718.74*	86.94**	146.63**
Error (a)	3	0.57	48.49	0.41	1.69
Cultivars	1	0.76*	2819.47**	0.096 ^{ns}	73.65**
Planting date X Cultivars	1	0/85*	43.05 ^{ns}	6.23**	0.18 ^{ns}
Error (b)	6	0.13	96.16	0.33	0.94
Fungicide	6	46.74**	842.53**	5.49**	28.25**
Planting date X Fungicide	6	0.3**	25.8 ^{ns}	0.43 ^{ns}	0.82 ^{ns}
Cultivars X Fungicide	6	0.21 ^{ns}	56.07 ^{ns}	0.23 ^{ns}	1.29 ^{ns}
Planting date X Cultivars X Fungicide	6	0.08 ^{ns}	42.57 ^{ns}	0.24 ^{ns}	0.75 ^{ns}
Error ©	72	0.1	36.83	0.27	0.76

*: Significant at the five percent level.

**: Significant at the one percent level. ns: not significant

Table 3. Effect of Planting date and Fungicidal Treatment on the Control of Cercospra Leaf spot and the Quantitative and Qualitative Characters of Two Sugar Beet Cultivars.

The Tested Factor	Disease Severity	Root yield(T / ha)	Sugar Percentage	Performance of White Sugar
PLANTING DATE				
6. 10.2004	2.59a	70.95a	16.72a	10.36a
20. 11.2004	2.21**a**	65.89b	14.96b	8.07b
CULTIVARS				
Posada	2.31a	73.44a	15.81a	10.03a
Line 236	2.50b	63.40b	15.87a	8.40b
FUNGICIDAL TREATMENTS				
Control 1	4.11 B	64.67C	15.34 D	8.33 C
Control 2	4.7 A	54.03 D	14.96 E	6.71 D
application	3.28 C	68.98 B	15.55 D	9.09 B
2 app.	2.48 D	69.99 B	15.92 C	9.52 B
3 app.	1.14 E	74.64 A	16.09 BC	10.21 A
4 app.	0.63 E	71.79 B	16.58 A	10.23 A
5 app.	0.44 F	74.91 A	16.42 AB	10.4 A

Means followed by the same letter in each column within each factor are not significantly different.

According to ANOVA table, planting date and sprayed treatments with Mancozeb had a significant effect on the percentage of sugar at 1% level. It indicates the importance factors in storage and increasing local sugar beet sugar purity. The average of sugar percentage in test was 15.84%, the maximum amount was 16.72% from the first planting date and the lowest value was 14.96 % from the late planting date. Sugar content Comparisons of tested varieties (Line 236 with 15.87 % and Pasoda with 15.81%) placed both of them in a same statistical level. Mean comparisons of sprayed treatments with Mancozeb, indicates the significant effect of disease control on the percentage of raw sugar. The results approved the significant difference between control and sprayed treatments at 1% level. The highest percentage of sugar with 16.58 % was related to four times sprayed treatment and minimum amount with 14.96 % to the positive control treatment (Table 3). Therefore, the maximum damage of this disease on sugar content in a severe epidemic situation accounts for 1.62 units equals to 10.83 % in Khuzestan province environmental condition. As diagram 2 depicts there is a significant negative regression in 0.01 levels between leaf spot disease severity and root sugar content (with explanation coefficient of 96%). It can be concluded that for every one unit increase in severity of leaves spots disease, 0.34 % of sugar purity content is reduced and this indicates the largest impact of disease on the sugar purity. Except interaction of planting date in cultivars that was significant at 0.01 level, other interaction effects of treatments were not significant for sugar content.

The results show the main effect of planting date, cultivars and fungicide sprayed treatments on white sugar yield was significant. However, it was not significant interaction effect on sugar yield. Thus, it can be concluded that disease control as an independent agent affects performance of white sugar. The largest amount of white sugar with 10.43 ton/ha obtained from treatment with five times sprayed, followed with treatments of four and three times spraying (10.23 and 10.21 ton/ha respectively). The local conventional control treatment yielded 8.33 ton/ha and the lowest amount of white sugar obtained from positive control treatment with 6.71 ton/ha. According to statistical grouping, treatments with five, four and three times spraying placed in the first group (A) and those with once and twice application of fungicide and local conventional control, set in the group B, AB and C and the positive control treatment alone placed in the last group (D) (Table 3). Diagram 3 indicates a significant negative regression equation between severity of leaf spot disease and performance of white sugar, as the consequence of every one unit increase in sugar beet leaf spot severity was reduction of 727 kg of white sugar/ha. The correlation coefficient in the linear regression equation equals(R2=. 871) which shows after the sugar content the second indicator which affected by the disease is the extracted sugar. The results also showed that planting date, cultivars treatments, spraying with Mancozeb gained significant influence on characteristics of white sugar percentage, the purity degree and sugar molasses. Sucrose was extracted using the formula Reinefeld with Increasing the elements such as K, N, Na on the extraction steps, quality of extracted sugar and molasses levels are reduced (Reinefeld et al. 1974). The highest percentage of white sugar, the purity degree and sugar molasses respectively were estimated 14.57, 87.09 and 2.15 % in the first planting date. Delay in planting date caused reduction of qualitative characteristics of the plant and increased root impurities. This issue could rise from short growth period and lack of technological maturity of sugar beet at the later planting dates. In term of qualitative characteristics and root impurities, tolerant cultivar to leaf spot disease performed better than susceptible lines. Effect of sprayed treatments with Mancozeb fungicide and control without spraying at 1% level had significant effects on white sugar percentage characters, degree of raw juice purity, sodium impurities

and harmful nitrogen in sugar beet roots. However, no significant effect was observed on the characteristics of K and molasses sugar. According to the results, spraying with Mancozeb fungicide was effective on intensity of disease and control of disease, Positive control with average of 4.7 showed the most disease severity and control without sprayed with average of 4.11 placed in the second rank. So many of leaves in these treatments were burned out due to the severity of infection and dried up prematurely. In these treatments separated spots after a while were combined and caused sudden large blighted area on the leaves. Once sprayed treatment although had the average of 3.28 degree of infection, compared with two controls showed less disease severity. However the amount of damage and disease epidemic was still high. It seems that spraying with Mancozeb fungicides maximum from three weeks to one month can help to prevent pathogen activity, depending on weather conditions especially rainfall, after this period the contamination trend in this treatment was in the level of control treatments. Similarly, the Sprayed twice treatment with average of 2.5 degree after the once sprayed and three times sprayed treatments with the average infection of 1.14 degree, significantly controlled the disease and increased in sugar beet productivity. There was no significant difference between four and five times sprayed treatments. Therefore, the epidemic of sugar beet leaf spot disease could be prevented by three four times spraying by Mancozeb , resulting **s** in increment of the quantity and quality of sugar beet yield especially on early planting dates.

Table 4. Regression relationships between sugar beet leaf spot disease severity and root weight, sugar percentage and sugar yield weight.

Sources Changes	r^2	CV	a ± SE	b ± SE
Disease severity and root weight	0.771	5.55	2.61± 0.774**	-3.71 ± 0.91**
Disease severity and the sugar percentage	0.957	0.843	16.64 ± 0.092**	-0.34 ± 0.03**
Disease severity and weight of sugar	0.87	5.65	10.96 ± 0.36**	-0.73 ± 0.12**

** : Statistically significant at the level of one percent

DISCUSSION

According to the obtained results, sugar beet leaf spot disease of sugar beet significantly reduces sugar beet qualitative and quantitative indicators in Khuzestan, and causes economic damages on this product. The results of this study are different from results of the conducted research in temperate regions, particularly in USA and Europe. For example Rosso and Bimbatti (1994) researches showed that maximum reduction in root yield and white sugar due to this disease is 10 %. Khan and Smith (2004) reported that the control of sugar beet leaf spot disease has caused to increase the sugar yield but other factors did not change significantly. In most regions of the world sugar beet plants grow in spring and harvested in falls, although autumn and spring are the growing and harvesting seasons in Khuzestan province. Therefore in Khuzestan condition, sugar beet has a little growth during the spring. The pathogen infects to the mature leaves and causes leaf blight which exerts a significant effect on assimilation. Therefore, the intensity of photosynthetic level winter and stay in the state of the rosette and assimilation rate of leaves spend to rise percentage of root sugar. Root weight in this period of time have had no significant

increase, during the autumn and winter months, growth of sugar beet root only is about 30 % of all root weight. In late winter and during the spring with warm weather plants growth increase rapidly and due to temperature raise, photosynthesis of aerial organs to increase root weight. Growth curve of sugar Beet leaf spot disease in Khuzestan conditions is such that the disease appears in mid-February as the scattered spots and its severity gradually rises with increasing temperature and rainfall, the exponential burst of disease severity occurs in the plants is reduced and plants for compensation the defect produce new leaves. The leaves are as a new destination for consumption of photosynthetic products competes with the roots. The consequence of these events are lack of root growth and reduction of root weight by 25%, in other words, It can be noted that growth curves of sugar beet leaf spot disease is consistent with Root growth curve. For this reason in Khuzestan condition with increasing severity of leaf spot disease, the most important performance indicator that is affected, is the tubers weight. On the other hand, regression curves showed that there is high negative correlation between disease severity of sugar beet leaf spot with all of the three yield indicators i.e. sugar yield, purity (root sugar content) and root performance and charts show sugar beet leaf spot disease effects all performance indicators of this product., annual loss of sugar yield due to the disease could be about 20% and the potential damage of the disease is 35%. This is the first report of damages caused by sugar beet leaf spot disease in Iran which is critically differs researchers from other world regions.

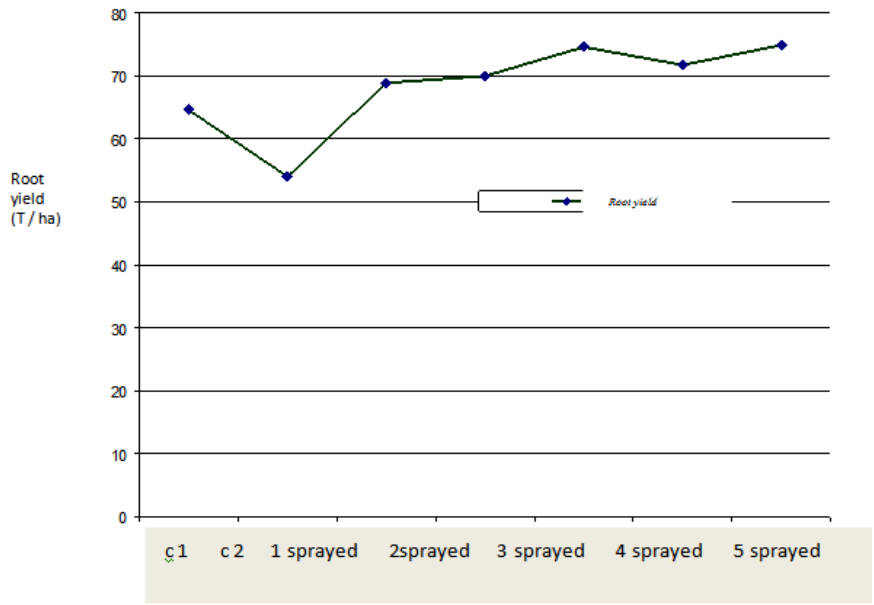

Figure 2. The relationship between volume spraying sugar beet against Cercospora disease white root yield

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تأثير موعد الزرعة ورش المبيدات الفطرية على شدة مرض تبقع أوراق الشمندر السكري في إقليم كوزستان / إيران

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ملخص

تم القيام بهذه الدراسة لتقييم عوامل تؤثر على شدة مرض تبقع أوراق الشمندر السكري، مثل موعد الزراعة، الأصناف وتكرار رش المبيد الفطري في مركز سافي أباد للبحوث الزراعية في ديزفل / إيران، خلال الفترة 2004 – 2006. كان تعميم التجربة القطاعات العشوائية الكاملة المنقسمة. القطاعات الرئيسة كانت موعد الزراعة في أشهر تشرين الأول وتشرين الثاني. تحت القطاعات كانت أصناف الشمندر السكري (بوسودا، خط سلالة 226، وعدد مرات رش المبيد الفطري مانكوزب. في هذه التجربة تم استعمال معاملتي شاهد. بناء على الإنتاج الجذري لعام 2004 – 2005 بين التحليل الإحصائي أن موعد الزراعة ذو معنوية عالية (بمستوى 95%) وأن المبيد الفطري مانكوزب ومعاملة الأصناف ذو معنوية عالية (كلاهما عند مستوى 99%). أوضحت النتائج المتحصل عليها أنه في الزراعة المبكرة، ومع 3 أو 4 رشات من المبيد، كان مرض تبقع الأوراق تحت السيطرة، ويتوقع الحصول على محصول أكبر كمّاً ونوعاً.

الكلمات الدالة: Cerrospora beticola ، تبقُّع ورقي، مواعيد الزراعة، شمندر سكري، رش.

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