Egypt. J. Phytopathol., Vol. 35. No. 2. pp. 1-10 (2007)

Management of Cercospora Leaf Spot Disease of Sugar Beet Plants by some Fungicides and Plant Extracts

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Cercospora leaf spot of sugar beet caused by *Cercospora beticola* is a devastated foliar disease affecting plant growth and hence sugar production. Since, there are no available varieties resist such disease, therefore, there is an attempt to control it under field conditions at El-Abbasa village, El-Read, Kafr El-Sheikh governorate by two commercial plant extracts (Sincocin and Agrispon) and by three triazole derivative fungicides (Score, Eminent and Opus) in two successive growing seasons, (2004-2005 and 2005-2006).

All compounds were applied at the recommended dose and plants were left for natural infection. Plants were sprayed when disease severity reached 0.1%. Each compound was tested either as one, two or three sprays.

Mixture of Sincocin and Agrispon (1:1 v/v) treatment was the most efficient in reducing disease severity followed by Sincocin then Agrispon. Comparing all treatments, Score was the superior treatment followed by Eminent, Opus, mixture of Agrispon and Sincocin, Sincocin then Agrispon in a descending order.

Concerning productivity, Agrispon was the best compound followed by the mixture of Sincocin and Agrispon then Sincocin in a descending order. Agrispon increased significantly root weigh, sugar percentage and decreased potassium, sodium and alpha amino acid contents compared to control, therefore increased sugar quality to very great extent. Score was found to be the best fungicide in this respect.

Low differences were found between the effect of the two or the three sprays by all the tested compounds, in controlling Cercospora leaf spot disease.

Keywords: *Cercospora beticola*, Cercospora leaf spot, plant extracts, sugar beet and triazole.

Sugar beet (*Beta vulgaris* L.) is one of the most important sugar crops. *Cercospora beticola* Sacc., severely infect sugar beet plants world wide (Georgopoulos and Dovas, 1973 and Smith and Ruppel, 1974) and causes great reduction in sugar yield up to 43% (Shane and Teng, 1992). Loss of sugar in beet roots occurs as new leaves are grown to replace those heavily damaged by Cercospora leaf spot. (Steinkamp *et al.*, 1979 and Vereijssen *et al.*, 2003). Losses are manifested as reduction in root weight, lower sugar content, and increased impurities leading to a loss of sugar to molasses (Smith and Martin, 1978).

Smith and Ruppel (1971) indicated that Cercospora leaf spot led to increased rots during storage as well as of cercosporin and beticolin toxins.

Cercospora leaf spot is managed by fungicide applications, reducing inoculum by crop rotation and tillage and by planting disease tolerant varieties (Miller *et al.*, 1994).

The benzimidazole derivatives were the first systemic fungicides that became available for *C. beticola* control (Georgopoulos and Dovas, 1973).

Tetraconazole resulted in significant Cercospora leaf spot control, root yield, and recoverable sucrose compared to fenbuconazole with an adjuvant (Khan and Smith, 2005).

Most growers experienced inconsistent leaf spot control, probably because of ineffective fungicides as a result of high population of benzimidazole resistant and fentin hydroxide tolerant strains of *C. beticola* (Bugbee, 1982; Dexter and Luecke, 1999; Weiland and Smith, 1999 and Weiland and Halloin, 2001).

In our previous studies, we found that Sincocin, Agrispon and other plant extracts led to an increased resistance of tomato plants against root-knot nematode *Meloidogyne* spp. (Mostafa *et al.*, 2006) and potato against late blight caused by *Phytophthora infestans* (Mostafa and Gado, 2007).

In the current study, enhancement of plant growth by commercial plant extracts (Bioactivator) are being investigated as an alternative disease control option in comparison to application of fungicides, *i.e.* Score, Opus and eminent for disease management. Plant yield and sugar content was taken into consideration.

Materials and Methods

Field experiments:

Experiments were carried out at El-Abbasa village, El-Read, Kafr El-Sheikh governorate, Egypt, during two successive growing seasons, *i.e.* 2004/2005 and 2005/2006. This location was chosen because it has a long history of heavy infection by Cercospora leaf spot disease (CLS) (El-Sayed, 2000). Field was divided into plots (8 x 10 m), and plot was specified for one tested compound and three plots were left for control. Rows (12 rows/plot) were sown by sugar beet seeds 30cm apart (Raspoly cv.). Large area around the plots was left without treatment to avoid any contamination by any treated chemicals from nearly fields. Field was fertilized and irrigated as usual.

Tested compounds:

The following plant water extract and fungicide solutions were sprayed on plants as shown in Table (1). Plants were sprayed one, two or three times at three week-intervals started when the first sign of disease has appeared.

Disease assessment:

By the end of the growing season, disease severity was determined on 50 plants for each particular treatment by removing one leaf from the inner leaves and

Table 1. Tested compounds for Cercospora leaf spot management

Tested compound	Concentration	Active ingredient	Company
Agrispon®	1 ml/l	Plants and mineral extracts	Agric. Sci. Dallas
Sincocin®	1 ml/ l	Plants extract	Agric. Sci. Dallas
Agrispon and Sincocin	(1:1 v/v)	Plants and mineral ex.	Agric. Sci. Dallas
Score® 25% EC	0.5 ml/ l	Difenconazole	Syngenta®
Eminent® 16%	1 ml/ l	Tetraconazole	Sipcam®
Opus® 12.5%	1 ml/ l	Epoxyconazole	BASF

Cercospora spots were counted. Disease severity was determined according the scale of Shane and Teng (1983). Scale ranged from 0-10 categories where: O; no visual infection; (1) 1-5 spots/leaf (0.1% severity), (2) 6-12 spots (0.35 % severity): (3) 13-25 spots/leaf (0.75% severity): (4) 26-50 spots/leaf (1.5% severity): (5) 51-75 spots/leaf (2.5 % severity); (6) At higher disease incidences, the average affected area per leaf was estimated from standard area diagrams, and categories 6 through 10 represented 3, 6, 12, 25, and 50% disease severity, respectively .

At harvest, three replicate samples, each of twenty roots for three sprays were randomly collected for determination of crop yield and sugar analysis.

Juice analysis was done at the sugar factory laboratory (El-Hamol, Kafr El-Sheikh), where sucrose % (using standard polarimetric method) was estimated (Schneider *et al.*, 2002). Alpha amino acids, potassium and sodium were estimated by flourimetric methods as sugar purity (Hoffman, 2005).

Results

Effect of plant extracts and fungicides on disease severity:

Spraying of plant extracts Agrispon, Sincocin and their mixture as well as the fungicides Eminent, Opus and Score significantly reduced Cercospora leaf spot disease in all treatments during the growing seasons of 2004-2005 and 2005-2006 (Table 2)

Data in Table (2) illustrate that there were considerable differences among the values of the three sprays. On the other hand, no difference was found between the values of two and three sprays in both seasons.

Final determination of disease severity clearly indicated that three sprays by either plant extracts or fungicides gave the best results in management of the disease (Table 2).

Mixture of Sincocin and Agrispon was the best treatment followed by Sincocin then Agrispon in a descending order, and all treatments led to great reduction in the disease comparing with non treated plants.

Table 2. Effect of different treatments by plant extracts and fungicides on management Cercospora leaf spot disease of sugar beet under field condition during two successive growing seasons, *i.e.* 2004/ 2005 and 2005/2006

Treatment	Leaf spot severity (%?)								
	2004/2005			2005/2006			Average of the 2 years		
	One spray	Two sprays	Three sprays	One spray	Two sprays	Three sprays	One spray	Two sprays	Three sprays
Agrispon	5.54^{b}	3.40^{b}	2.97^{b}	6.10^{b}	3.76^{b}	3.11^{b}	5.82	3.58	3.04
Sincocin	5.14^{c}	3.15^{c}	2.87^{c}	4.32^{d}	3.62^{c}	2.98^{c}	4.73	3.38	2.92
Agrispon +Sincocin	4.44^{d}	3.09^{d}	2.75^{d}	5.80b^{c}	3.55^{d}	2.85^{d}	5.12	3.32	2.80
Eminent	4.10^{f}	1.76^{f}	1.25^{f}	4.88^{cd}	1.96^{e}	1.88^{f}	4.49	1.86	1.56
Opus	4.24^{e}	1.84^{e}	1.43^{e}	4.90^{cd}	1.95^{e}	1.01^{e}	4.57	1.89	1.22
Score	3.64^{g}	0.92^{g}	0.31^{g}	4.13^{d}	0.92^{f}	0.85^{e}	3.88	0.92	0.58
Control	15.03^{a}	15.03^{a}	15.03^{a}	16.96^{a}	16.96^{a}	16.96^{a}	15.99	15.99	15.99
M.S.D.	0.03	0.02	0.04	0.11	0.24	0.04	-	-	-

Means in the same column followed by the same letter are not significantly different at $P \leq 0.05$ according to Duncan's multiple range tests (Duncan, 1955).

The averages of disease severity were reduced from 15.99% in non sprayed plants to 2.80% in case of spraying plants by mixture of Agrispon and Sincocin three times and to 2.92% in case of spraying Sincocin and to 3.04% in case of spraying of Agrispon three times.

By calculating the efficiency of tested natural extracts, data obtained indicated that the mixture of Agrispon and Sincocin gave 82.49%, Sincocin gave 81.71% and Agrispon gave 80.99% efficiency after three times of spraying (Table 3).

Table 3. Efficiency of different treatments with different plant extracts and fungicides on Cercospora leaf spot severity on sugar beet plants under field condition during two successive growing seasons, *i.e.* 2004/ 2005 and 2005/2006

Treatment	Efficiency (%) of the tested compounds		
	One spray	Two sprays	Three sprays
Agrispon	63.61	77.61	80.99
Sincocin	70.42	78.83	81.71
Agrispon + Sincocin	67.99	79.24	82.49
Eminent	71.92	88.37	90.21
Opus	71.42	88.15	92.37
Score	75.71	94.24	96.37
Control	0	0	0

$$\text{Efficiency (\%)} = \frac{\text{Disease severity in control} - \text{disease severity in treatment}}{\text{Disease severity in control}} \times 100$$

Concerning fungicides, Score caused the highest effect in reducing disease severity of Cercospora leaf spot disease; being 0.58% in the average followed by Opus after three times of sprayings.

In general, fungicides were more efficient in reducing the disease comparing to natural plant extracts.

Effect of plant extracts or fungicides on yield components:

Data presented in Table (4) indicate that there were no great differences among the values of the two seasons of study concerning root weight and sugar content %.

Table (4) clearly show that all treatments led to considerable increase in root weight of the treated plants compound comparing to non treated ones (control).

Agrispon increased root weight by 64.00% in the first season and 23.25% in the second season. It also increased sugar content to 30.89% in the first season comparing to the control, and in the second season up to 37%. Mixture of Agrispon and Sincocin (1:1 v/v) ranked the second in this regard, where root weight increased by 61.53 % in the first season and up to 33.37% in the second season. Sugar content was also increased up to 29.65% in the first season and 21.98% in the second season.

Table 4. Effect of different treatments on some crop parameters of sugar beet after three sprays at 2004/ 2005 and 2005/2006 growing seasons

Treatment	2004/2005						
	Root weight (kg)	Increase (%) than the control	Sugar (%)	Increase (%) than the control	Potassium (mM)	Sodium (mM)	Alpha amino acid (mM)
Agrispon	5.33^{a}	64.00	20.04^{a}	30.89	4.35^{g}	2.01^{g}	1.24^{d}
Sincocin	5.10^{b}	6.92	18.c65^{c}	21.81	4.94^{d}	2.43^{d}	1.45^{c}
Agrispon +Sincocin	5.25a^{b}	61.53	19.85^{b}	29.65	4.85^{e}	2.34^{e}	1.31^{d}
Eminent	4.60^{d}	41.53	16e.35^{f}	6.79	4.77^{f}	2.31^{f}	1.51^{c}
Opus	4.01^{e}	23.38	17.74^{e}	15.87	6.74^{b}	3.27^{c}	2.15^{b}
Score	4.88^{c}	50.15	18.55^{d}	21.16	5.55^{c}	3.45^{b}	2.24^{b}
Control	3.25^{f}	00.00	15.31^{g}	00.00	6.85^{a}	3.54^{a}	3.01^{a}
M.S.D.	0.187	-	0.0327	-	0.0269	0.0192	0.269
	2005/2006						
Agrispon	5.11^{c}	23.25	20.85^{a}	37.85	4.01^{g}	2.25^{g}	1.34^{e}
Sincocin	4.75^{e}	14.45	19.25^{b}	27.27	4.84^{e}	2.42^{e}	1.45^{d}
Agrispon +Sincocin	5.53^{a}	33.37	18.45^{b}	21.98	4.75^{f}	2.31^{f}	1.32^{e}
Eminent	5.03^{d}	21.32	17.04^{d}	12.69	5.12^{c}	2.64^{c}	1.95^{b}
Opus	5.15^{b}	24.09	17.65^{c}	16.69	5.25^{b}	3.04^{b}	1.94^{b}
Score	4.75^{e}	14.57	17.75^{c}	17.35	4.94^{d}	2.46^{d}	1.71^{c}
Control	4.15^{f}	00.00	15.12^{e}	00.00	5.85^{a}	3.45^{a}	3.15^{a}
M.S.D.	0.032	-	0.143	-	0.0329	0.027	0.032

Means in the same column followed by the same letter are not significantly different at $P \leq 0.05$ according to Duncan's multiple range tests (Duncan 1955).

Sincocin gave similar results where it increased both root weight and sugar content, but it came in the last order.

Fungicide treatments came, in general in the second order after plant extracts. Score was the best fungicide, it increase root weight up to 50.15% in the first season and up to 14.57% in the second season and increased sugar content up to 21.16% in the first season and 17.35% in the second season. Eminent followed Score in its effect, where it increased root weight up to 41.53% in the first season and 21.32% in the second season. Sugar content was increased also, up to 106.79% in the first season and 12.69% in the second season. Opus came in the last order in this respect.

Factors affecting sugar purity, *i.e.* potassium, sodium and alpha amino acids were significantly greatly decreased due to spraying the tested compounds (Table 3) compared to control in both seasons of study.

Discussion

Leaf spot disease caused by *Cercospora beticola* Sacc. is the most destructive foliar disease of sugar beet worldwide (Smith and Ruppel, 1974). It causes great reduction to the yield and quality of sugar (Shane and Teng, 1992). The control of leaf spot disease by extensive fungicide application incurs added costs to producers and repeatedly has selected for fungicide-tolerant *C. beticola* strains (Weiland and Koch 2004).Correct use of fungicides for control of Cercospora leaf spot depends on knowing when the chemicals are most needed.

In the present investigation, two plant growth activators, *i.e.* Sincocin, Agrispon and their mixture were sprayed on sugar beet plants under field condition when disease severity reached 0.1 % to evaluate their effect on disease severity and yield components. Three fungicides belonging to conazole group, *i.e.* Score, Eminent and Opus were tested also on disease severity and yield components.

Data obtained in this study revealed that the tested fungicides reduced disease severity to a great extent. Average of the two seasons of study indicated that Score was the best fungicide when sprayed three times, with low difference between the effect of two and three sprays. Moreover, all tested fungicides significantly increased root weight and sugar content.

These results are in harmony with the results obtained by Khan and Smith (2005), as they found that conazole derivative fungicides effectively controlled Cercospora leaf spot disease in sugar beet and increased yield component.

It is well established that rapidly usage of triazoles lead to reduce sensitivity of *C. beticola* to the fungicides (Karoaglanidis *et al.*, 2000). Therefore, in the present study two bioactivators of plants with plant extract origin were tested on controlling Cercospora leaf spot under field condition compared with the three fungicides. Data obtained indicated clearly that bioactivator caused a great reduction in disease severity and the mixture of Agrispon and Sincocin was more effective than each of them alone.

The reduction of disease severity was reflected on yield components, *i.e.* root weight and sugar content, and decrease of impurities, *i.e.* sodium, potassium and alpha amino acid contents.

Although the fungicides were more active in reducing disease severity than bioactivators, yield components of bioactivator treated plants were higher than that of the fungicides. These results indicated that decreasing of disease severity is not the main factor affecting yield components. Although disease severity was higher in case of using bioactivator treatments compared to fungicides, yield components were better in case of using bioactivators. In this respect, Poostchi (1981) and Syltie (1991) studied the efficacy of Agrispon on root yield and sucrose content of sugar beet, they found that such bioactivators greatly increased yield component compared with non treated plants. It was found that such bioactivators, *i.e.* Sincocin, Agrispon and other plant extracts, induced resistance in tomato plants against root-knot nematode (Mostafa *et al.*, 2006) and induced resistance in potato plants against late blight disease by inducing phytoalexins in treated plants (Mostafa and Gado 2007).

It could be concluded from this study that bioactivators, *i.e.* Sincocin and Agrispon, might be used as an alternative materials for disease management of Cercospora leaf spot of sugar beet and for increasing yield component of sugar.

Acknowledgements

Deep thanks to Prof. Dr. Moustafa Helmy Mostafa Prof and Head of Plant Pathology Dept., Fac. Agric., Ain Shams Univ. for helping and revising the manuscript.

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(Received 17 06 2007;
in revised form 02 09 2007)

مكافحه مرض التبقع السيركوسبورى في بنجر السكر بواسطة بعض المبيدات الفطرية وبعض المستخلصات النباتية

عماد الدين على مصطفى جادو
معمل البيولوجيا الجزيئية لأمراض النبات - قسم أمراض النبات - كلية الزراعة - جامعة عين شمس - مصر.

يعتبر مرض تبقع الأوراق السيركوسبورى في بنجر السكر والمتسبب عن الفطر *Cercospora beticola* من الأمراض المدمرة التي تصيب المجموع الخضري للبنجر ومن ثم محصول السكر الناتج. ونظرا لعدم وجود أصناف مقاومة لهذا المرض فقد أجريت هذه الدراسة بغرض مكافحة المرض تحت الظروف الحقلية المصرية ، لذا فقد اختير حقل يقع في قرية العباسة مركز الرياض محافظة كفر الشيخ لأجراء الدراسة حيث يكثر انتشار المرض . وقد أجريت الدراسة خلال موسمي الزراعة ٢٠٠٤/٢٠٠٥ و ٢٠٠٥/٢٠٠٦.

أستخدم في هذه الدراسة بعض المستخلصات النباتية المعروفة تجاريا (سنكوسين ، أجريسبون و خليط السنكوسين والأجريسبون بنسبة ١:١ حجم/حجم) وكذلك بعض المبيدات الفطرية من مشتقات التراى أزول (سكور ، أيمننت و أوبص) بالجرعات الموصى بها رشا على المجموع الخضري كرشه واحده أو رشتين أو ثلاث رشات وذلك عندما بلغت الأصابه فى النباتات ٠,١ % وتركت النباتات للأصابة الطبيعية.

أثبتت جميع المعاملات فاعليه في مكافحة المرض وكان أفضل المستخلصات النباتية خليط السنكوسين والأجرسبون يليهم السنكوسين ثم الأجرسبون على التوالي ، وعند مقارنة قدرة المستخلصات النباتية والمبيدات على السيطرة على المرض نلاحظ ان المبيدات كانت أكثر كفاءة في ذلك وكان أفضلهم المبيد سكور ثم الأ مننت ثم الأبص على التوالى. بالنسبة للأنتاجيه فكان الأجرسبون أفضل المعاملات تلاه المعاملة بخليط السنكوسين والأجرسبون ثم المعاملة بالسنكوسين. أدت جميع المعاملات السابقة لزيادة وزن الجذور والنسبة المئوية للسكر وكذلك خفض البوتاسيوم ، الصوديوم و الأحماض الألفا أمينيه.

كما أثبتت المبيدات فاعلية فى زيادة الإنتاجية وكان أفضل المبيدات في ذلك مبيد اسكور تلاه امننت ثم اوبص على التوالى.

لم تظهر فروق كبيره بين رش النباتات رشتين او الثلاث رشات في كل المعاملات كذلك لم توجد فروق كبيرة بين موسمي الزراعة ٢٠٠٤- ٢٠٠٥ و ٢٠٠٥- ٢٠٠٦