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Impact of Treatment with Some Plant Extracts and Fungicides on Sugar Beet Powdery Mildew and Yield Components

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Abstract: Powdery mildew, caused by *Erysiphe betae* is a major foliar disease of sugar beet in areas with dry and relatively warm weather conditions throughout the world, devastated foliar disease affecting plant growth and hence sugar production. In the present study, two commercial plant extracts (Sincocin® and Agrispon®) and three triazole derivative fungicides (Score® Eminent® and Opus®) were evaluated in two successive growing seasons, (2009-2010 and 2010-2011) in all compounds were applied at the recommended dose and plants were left for natural infection. Plants were sprayed when average disease severity reached 0.1%. Each compound was tested either as one, two or three sprays. Sincocin® was the most efficient in reducing disease severity followed by Mixture of Sincocin® and Agrispon® then Agrispon® in descending order, Concerning fungicides, Eminent® caused the highest effect in reducing disease severity of powdery mildew disease, followed by Score® then Opus®. In general, fungicides were mere highly efficient in reducing the disease comparing to natural plant extracts. Mixture of Sincocin® and Agrispon® (1:1 v/v) increased root weight, It also increased sugar content, Agrispon® ranked the second in this regard, Sincocin® gave similar results, it increase both root weight and sugar content, but it come in the last order. Fungicide treatments came, in general in the second order after plant extracts. Eminent® and Score® were the best fungicides, they increase root weight and sugar content followed by Opus® in descending order. Factors affecting sugar purity, *i.e.* potassium, sodium and alpha amino acids were greatly decreased due to spraying the tested compounds compared to control in both seasons of study.

Key words: Powdery mildew, *Erysiphe betae*, plant extracts, sugar beet and triazole derivative.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is one of the most important sugar crops and it is the second crucial sugar crop after sugar cane, producing annually about 40 % of sugar production all over the world (Mirvat Gobarah and Mekki, 2005). Powdery mildew of Sugar beet is a common disease in many sugar beet growing countries caused by *Erysiphe betae* (Vanha) Weltzien. (Kontaxis *et al.,* 1974; Hills *et al.,* 1980). *Erysiphe betae* causes sugar-beet powdery mildew, a serious fungal foliar disease resulting in sugar yield losses of up to 30%. The fungus occurs world-wide in all regions where sugar beet is grown and it also infects other edible beet crops, e.g. beetroots (garden beets) (Magyarosy, 1979 & Francis 2002).

The benzimidazole derivatives were the first systemic fungicides that became available for controlling powdery mildew on many plants and other fungal plant diseases (Georgopoulos and Dovas, 1973; He *et al.,* 1998 & Miazzi *et al.,* 1997).

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

MATERIAL AND METHODS

Plant Culture:

Experiments were carried out at Manshet Tantawy, Sanoras, El-Fauom Governorate, Egypt, during agricultural seasons 2009/2010 and 2010/2011. Field (1.5 feddan) was divided into plots (8 x 10 m^2), and three plots were specified for one tested compound and three plots were left for control. Rows (12 rows/plot) were sown by sugar beet seed 30 cm apart (Pleno cv.). Large area around the plots was left without treatment to avoid any contamination by any treated chemicals from neighboring fields. Field was fertilized and irrigated as usual.

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Tested Compounds:

The following plant water extract and fungicide solutions were sprayed on sugar beet plants as the following table (Table, 1).

Table 1: Tested compounds for powdery mildew management.

Tested compounds	Concentration	Active ingredient	Company
Agrispon®	1 ml/liter	Plants and mineral extracts	Agric. Sci. Dallas
Sincocin®	1 ml/ liter	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®

Plants were sprayed one, two or three times at three weeks intervals started when the first sign of disease was appeared.

At harvest, three replicate samples, each of twenty roots for three sprays treatment 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 polorimetric method) was estimated (Weber *et al.,* 2000). Alpha amino acids, potassium and sodium were estimated by the flourimetric methods, (Hoffman, 2005).

Disease Assessment:

Treatments were evaluates when foliage was closing the rows. Evaluation was accomplished by examining a recently matured leaf on each of at least 50 plants and rating disease intensity as the extent of leaf area covered by fungus mycelium on a scale of 0 to 4 after one week after spraying of bioactivator or fungicides. Both sides of a leaf were examined and an average rating was given.

Disease severity was determined according the scale by Whitney et al., (1983) Scale ranged from 0-4, categories whereas 0= no mildew colonies observed 1=1-25%, 2=26-50%, 3=51-75% and 4=76-100% of matured leaf area covered by mildew and the average disease rating per treatment was calculated.

The data were statistically analysed by analysis of variance (ANOVA) followed by Duncan multiple range test for means separation ($P \leq 0.05$)

Results:

Effect of Bioactivator Agents and Fungicides on Disease Severity of Powdery Mildew Disease:

Spraying of plant extracts Agrispon, Sincocin and their mixture as well as the fungicides Eminent, Opus and Score reduced powdery mildew disease in all treatment and during growing seasons of 2009/2010 and 2010/2011**.** (Table, 2)

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

Final determination of disease severity indicates clearly that three sprays gave the best results in management the disease (Table 2).

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

The averages of disease severity were reduced from 3.15 in non-sprayed plants to 1.25 in case of spraying Sincocin and 1.65 in mixture of Agrispon and Sincocin and to 2.55 in case of spraying Agrispon.

By calculating the efficiency of tested natural extracts, data obtained indicated that Sincocin gave 60.3 % and mixture of Agrispon and Sincocin gave 47.6 %, and Agrispon gave 19 % efficiency (Table3).

Concerning fungicides, Eminent caused the highest effect in reducing disease severity of powdery mildew disease; being 87.3 reduction followed by Score then Opus 79.3 %.

In general, fungicides were mere highly 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 two seasons of study concerning root weight and sugar content %.

Table (4) clearly shown that all treatments led to considerable increase of root weight comparing to non-treated ones.

Mixture of Sincocin and Agrispon (1:1 v/v) increased root weight by 169.0 % in the first season and to 164.1 % in the second season. It also increased sugar content to 124.5 % in the first season comparing to control, and in the second season up to 128.3 %.

Agrispon ranked the second in this regard, where root weight increased by 165.1 % in the first season and up to168.1% in the second season. Sugar content (%) was also increased up to 124.5 % in the first season and 128.3 % in the second season.

Table 2: Effect of different treatments by plant extracts and fungicides on powdery mildew disease of sugar beet under field condition during two successive growing seasons, *i.e.* 2009/2010 and 2010/2011.

Treatment	Disease severity (%)								
	2009/2010			2010/2011			Average of the 2 years		
	One spray	Two sprays	Three sprays	One spray	Two sprays	Three sprays	One spray	Two sprays	Three sprays
Agrispon	2.2 ^{b}	2.4 ^{b}	2.5 ^{b}	2.3^{a}	2.3 ^{a}	2.6 ^{b}	2.25	2.35	2.55
Sincocin	2 ^{bc}	1.9 ^{c}	1.5 ^{c}	1.5^{bc}	1.3 ^{c}	1 ^{d}	1.75	1.6	1.25
Agrispon +Sincocin	2 ^{bc}	2.2 ^{bc}	1.6 ^{c}	2^{ab}	1.8 ^{b}	1.7 ^{c}	2	2	1.65
Eminent	1.5 ^{e}	0.8 ^{e}	0.3 ^{e}	0.9^{d}	0.8 ^{d}	0.5 ^{e}	1.2	0.8	0.4
Opus	1.8 ^{cde}	1.3^{d}	0.7 ^{d}	1.2^{cd}	0.9 ^{d}	0.6 ^{e}	1.5	1.1	0.65
Score	1.6 ^{de}	1 ^{e}	0.5 ^{e}	0.9^{cd}	0.7 ^{d}	0.4 ^{e}	1.25	0.85	0.45
Control	2.5 ^{a}	3^{a}	3.3 ^{a}	1.5^{b}	2.1^{a}	3^{a}	2	2.55	3.15
M.S.D.	0.014	0.011	0.008	0.036	0.014	0.166	-	-	-

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).

Table 3: Efficiency of different treatments with different plant extracts and fungicides on powdery mildew severity on sugar beet plants under field condition during two successive growing seasons, *i.e.* 2009/ 2010 and 2010/2011

Treatment	Efficiency (%) of the tested compounds average of the 2 seasons 2009/2010 - 2010/2011		
	One spray	Two sprays	Three sprays
Agrispon	-12.5	7.8	19.0
Sincocin	12.5	37.2	60.3
Agrispon + Sincocin	0	21.5	47.6
Eminent	40	68.6	87.3
Opus	25	56.8	79.3
Score	37.5	66.6	85.7
Control	0	0	0

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

Sincocin gave similar results, it increase both root weight and sugar content, however it come in the last order.

Fungicide treatments came, in general in the second order after plant extracts. Eminent and Score were the best fungicides, its increases root weight up to 142.5 % and 125.8 in the first season and up to 131.3 and 145.4 % and in the second season and increased sugar content up to 113.8 and 113.3 % in the first season and up to 109 and 116.5 % in the second season in descending order. Opus followed Eminent and score in its effect, where it increases root weight up to 118.7 % in the first season and up to 116.6 % in the second season. Sugar content increased also, up to 104.3 % in the first season and up to 111.5 in the second season.

Factors affecting sugar purity, *i.e.* potassium, sodium and alpha amino acids were greatly decreased due to spraying the tested compounds (Table 4) compared to control in both seasons of study.

Discussion:

Sugar beet powdery mildew, caused by *Erysiphe betae*, is among the most important foliar diseases of sugar beet worldwide. In the conditions of high disease pressure and in the absence of control measures, the reduction of root yield may exceed 22% and root sucrose content may exceed 13% (Skoyen, *et al.,* 1975; Ruppel, *et al.*, 1975; Forster, 1979 ; Magyarosy, 1979 & Shane and Teng, 1992). The control of disease is mainly achieved by applications of broad spectrum of systemic fungicides, mainly belonging to the ergosterol biosynthesis inhibitors class (EBIs) which are also active against *Cercospora leaf spot* caused by *Cercospora beticola* or by applications of the protective fungicide sulfur which is *powdery mildew* specific (Byford, 1996).

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 very great extent. Average of the two seasons of study indicated that Eminent 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.

Table 4: Effect of different treatments on some crop parameters of sugar beet after three sprays (A) 2009/ 2010 and (B) 2010/2011 growing season (A).

Treatment	2009/2010						
	Root weight (kg)	Root weight % from Control	Sucrose %	Sugar % from control	Potassium (mM)	Sodium (mM)	Alpha amino acid (mM)
Agrispon	2.56 ^{a}	165.1	18.65^{a}	124.5	5.54 ^{c}	3.45 ^{c}	1.34 ^{e}
Sincocin	2.26 ^{b}	145.8	18.15 ^{b}	121.2	5.26 ^{c}	3.57 ^{c}	1.45 ^{d}
Agrispon +Sincocin	2.62 ^{a}	169.0	17.87 ^{bc}	119.0	5.46 ^{c}	3.24 ^{c}	1.32 ^{e}
Eminent	2.21 ^{b}	142.5	17.04 ^{cd}	113.8	6.88 ^{b}	3.52 ^{c}	1.95 ^{b}
Opus	1.84 ^{c}	118.7	16.66 ^{d}	104.3	6.84 ^{b}	4.11 ^{b}	1.94 ^{b}
Score	1.95 ^{c}	125.8	16.96 ^{e}	113.2	6.95 ^{ab}	3.64 ^{c}	1.71 ^{c}
Control	1.55 ^{d}	100	14.97 ^{f}	100	7.01 ^{a}	4.5 ^{a}	3.15 ^{a}
M.S.D	0.009	---	0.11	---	0.05	0.03	0.002

Table 4: (B).

Treatment	2010/2011						
	Root weight (kg)	Root weight % from Control	Sucrose %	Sugar % from control	Potassium (mM)	Sodium (mM)	Alpha amino acid (mM)
Agrispon	3.33 ^{a}	168.1	20.42 ^{a}	128.3	4.35 ^{d}	2.01 ^{c}	1.24 ^{e}
Sincocin	3.1 ^{b}	156.5	18.65 ^{c}	117.2	4.94 ^{c}	2.43 ^{c}	1.45 ^{d}
Agrispon +Sincocin	3.25 ^{a}	164.1	19.85 ^{b}	124.7	4.85 ^{c}	2.34 ^{c}	1.31 ^{e}
Eminent	2.6 ^{d}	131.3	17.35 ^{e}	109.7	4.77 ^{c}	2.31 ^{c}	1.51 ^{d}
Opus	2.31 ^{e}	116.6	17.74 ^{d}	111.5	6.74 ^{a}	3.27 ^{b}	2.15 ^{c}
Score	2.88 ^{c}	145.4	18.55 ^{c}	116.5	5.55 ^{b}	3.45 ^{a}	2.24 ^{b}
Control	1.98 ^{f}	100	15.91 ^{f}	100	6.85 ^{a}	3.54 ^{a}	3.01 ^{a}
M.S.D	0.004	---	0.005	---	0.02	0.023	0.072

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).

These results are in harmony with the results obtained by Karaoglanidis and Karadimos (2006), as they found that fungicide effectively control powdery mildew 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 & Gado, 2007). Therefore, in the present study two bioactivators of plants with plant extract origin were tested on controlling powdery mildew 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 mixture of them.

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

Although the fungicides were more active in reducing disease severity than bioactivator, yield components of bioactivator treated plants were higher than that of the fungicides. These results indicated that the 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, Poostch, 1981 and Syltie, 1991 studied the efficacy of Agrispon on root yield and sucrose content of sugar beet, they found that such bioactivator greatly increased yield component compared with non-treated plants.

The effect of bioactivators on disease severity of different plants was studied. It was found that such bioactivators (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 2012).

It could be concluded from this study that bioactivator *i.e.*, Sincocin and Agrispon could be used as an alternative method for disease management and increasing yield component of sugar beet.

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