FORECASTING MODEL FOR CERCOSPORA LEAF SPOT DISEASE OF SUGAR BEET

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ABSTRACT

This study was conducted at Sakha Agricultural Research Station Farm, Kafr El-Sheikh, Egypt during 2003/2004, 2004/2005, 2005/2006 and 2006/2007 on sugar beet plants to study the relationships between disease severity (%) and no. of spores of *Cercospora betieola* fungus and certain meterorological elements i.e., maximum and minimum air temperature, maximum and minimum relative humidity, rain and wind velocity. Accordingly, some forecasting models were proposed and correlation coefficients between all variables were studied.

To study the epidemiology of *C. beticola* in sugar beet, two cultivars were used namely Ras Poly and Fareda which were grown in three dates of sowings i.e. September 15th, October 1st, and October 15th. Spore trap was used to monitor spore collections. Meteorological data was used from the meteorological Station. Each cultivar was grown in a plots of 3 x 7 m^2. Some plots were left for natural infection and the other were protected with topsin M 70 (1 gm/liter). Some characters were measured i.e., disease severity %, root fresh weight, TSS%, sucrose % as well as losses in root and sugar yield. From the data obtained, disease severity varied according to date of sowing, climate elements and no. of spores.

Disease severity (%) recorded the highest in late sowing of October 15th and correlated significantly with maximum, minimum air temperature, maximum, minimum relative humidity, rain amount, wind velocity and number of spores around the canopy of the plant. The disease severity (%) of *C. beticola* recorded the highest when maximum relative humidity was more than 80% and minimum was from 40-50%. Air temperature of 20-30°C gave the highest disease severity (%) and high number of spores (> 10 spores/m^3/day). In the presence of rain and wind velocity ranged from 80-100 km/hr help in spreading/the spores of the fungus, these conditions can occurred on the second half of January up to March in the presence of rains and wind.

Using different regression equations as models for predicting disease severity (%) of Cercospora leaf spot in relation to all weather conditions resulted in proposing general model for three years data

2003/2004, 32004/2005 and 2005/2006 seasons, which led to predict the disease severity consequently control such destructive disease. Determination coefficients of such models showed high level of reliability and acceptability those multifactor model for such area of sugar beet plantation which increased gradually in Egypt.

According to the obtained data, spraying by chemical fungicides was done on the first of January to protect the plants from disease infection.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is suffering from several foliage diseases. Of all the foliage diseases, Cercospora leaf spot disease which caused by *Cercospora beticola* Sacc. is considered to be the most common and destructive one. The causal fungus beside infecting sugar beet it can infect table beet, Swiss chard, wild *Beta* species and a wide range of weed species (Francis, 2000; Kerr and Weiss, 1990). The disease is of economic importance in Egypt (El-Kholi, 1995; El-Fahhar, 1997 and 2003, and El-Sayed, 2000) as well as in sugar beet growing countries (Arjmand *et al.*, 1998 and Bittner, 1999) causing serious damage to the plant foliage consequently affects drastically the total yield of roots as well as sugar yield. Integrated management approach seeks a combined control effort involving all available technologies with emphasis on prevention of the disease spurt (Jones and Windels, 1991). This includes use of resistant varieties, clean cultivation, eliminating the weedy alternate hosts, elimination of soil inoculum through crop rotation, use of disease free and healthy seed, cultural practices creating unfavorable environment to disease spread, adoption of control measures at most effective stage following forecasting system and increased use of human friendly biological control.

Ruppel (1986) and Windels *et al.* (1998) devised a Cercospora management system which consists of compounds like planting approved varieties in fields with a minimum rotation interval of one year and use of Cercospora spray advisory in conjunction with field monitoring to determine need and timing for fungicide application. Lamey (1997), suggested integrated management of Cercospora leaf spot disease which includes crop rotation, use of varieties that are less susceptible, scouting of disease, timely application of fungicide and more frequent applications when disease conditions are favourable. He stressed on avoiding of repeat planting specially when the field had Cercospora incidence in the previous year. Wolf *et al.* (1998) evolved a model based on collaboration between Kiel University, sugar beet industry and the State Advisory

Service in Germany to ensure sugar beet yield and yield and quality by giving a highly effective control of *C. beticola* disease with reduced chemical load on environment. The model is based on threshold level. They found that fungicide spray at early stages of epidemic progress to be most effective.

Rosi and Battilani (1986) attempted on statistical model for predicting the incidence of *C. beticola* on sugar beet. They predicted disease probability for each sum of effective temperature in relation to corresponding sum of effective temperature in relation to corresponding sum of relative humidity as well as cultivar susceptibility and crop growth stage. Kerr and Weiss (1990) recorded that optimum conditions for spore production, germination and penetration into the host plant are 90-95% relative humidity and 25-35°C with night temperature above 16°C. A minimum temperature of 20°C is needed for the disease to become epidemic (Francis, 2000).

Maier *et al.* (2000) reported a forecasting system developed in Germany on the basis of data collected from 1993 to 1995. This involves collaboration with sugar beet Growers Association and State Consultation Agencies. A monitoring net consisting of around 200 locations with 1-2 monitoring stocks is set up in the target areas A warning message is sent over all available media to the growers to monitor the stocks for threshold value and adopt control measures.

MATERIALS AND METHODS

To study the epidemiology of *C. beticola* in sugar beet fields two cultivars of sugar beet were used viz, Ras Poly and Fareda which were grown at Sakha Agricultural Research Station Farm, Kafr El-Sheikh during 2003/2004 up to 2006/2007 seasons. The two cultivars were planted in a split plot design with three replicates. Varieties allocated in the main plots, while three dates of sowing i.e., September 15th, October 1st and October 15th, were assigned in sub-plots

Air born spores of *C. beticola* were monitored by using the continuous Automatic spore sampling trap in different experiments. Care was taken to fix the trap at a position where air reached through the sugar beet plants picking up the spores from all directions. The spores were deposited in the form of hourly band (24 bands) each day. Counting of the spores was done on the hourly basis under the microscope. Average of data were calculated after 15 days intervals.

Meteorological data was used from the main meteorological station at Sakha which adjacent to experimental plots of sugar beet.

Each cultivar was grown in a plots of 3 x 7 m^2. Plots for each cultivar in each date of sowing were left for natural infection and the other plots were treated and sprayed once with Topsin M70 [Dimethyl (1,2 phenylene) biocarbamate, Farm chemicals Handbook 99 (1999)]. One g/liter of Topsin M70 was applied when the first lesion of Cercospora leaf spot appeared.

After applying the forecasting model spraying by Topsin M 70 was applied according to the need which the model pointed out modeling protected for disease severity was assessed.

Disease severity (%) was first recorded after the lesions were appeared and assessed according to the disease severity scale (Shane and Teng, 1992) Epidemiological study was carried out during 2003/2004, 2004/2005, 2005/2006 and 2006/2007 seasons to establish the relationships between fungus and its environment which includes the main weather parameters such as maximum, minimum temperature, maximum and minimum relative humidity, rain and wind velocity. Weather parameters were taken daily by using meteorological station. To develop the disease progression model, the proportion of leaf spot disease incidence was used as the dependent variable and weather variables which were taken as an average of 15 days preceding disease appearance.

Record observations regularly done on trapped spores count of the fungus (*C. beticola*) along with all relevant meteorological variables and subjecting them to biometrical analysis.

Statistical analysis:

The collected data were analyzed for finding correlation coefficients between disease severity, number of trapped spores and weather parameters following Snedecor and Cochran (1981).

The model was developed according to general multiple regression equation:

$$Y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 \ldots . b_n x_n.$$

Where:

Y	=	(Dependent variable) disease severity
a	=	(Constant) as intercept
bn	=	Slope of line (the partial regression coefficient value).
x_n	=	Independent variables.

Disease severity (%) was recorded according to Shane and Teng (1992). Statistical analysis was done according to Gomez and Gomez (1983).

Root fresh weight as well as total soluble solids (TSS) were determined in fresh roots of each cultivar using hand refractometer (McGinnis, 1982).

Loss percent of sucrose and root yield was determined by using the simple equation adopted by Calpouzos *et al.* (1976) as follows:

$$\text{Loss \%} = \frac{\text{Protected - infected}}{\text{Protected}} \times 100$$

Sucrose percentage was estimated according to A.O.A.C. (1990).

Total chlorophyll content of leaves was determined in mg by using chlorophyll meter (SPAD-502), (Yoshida *et al.*, 1976).

RESULTS AND DISCUSSION

A. Performance of different sugar beet cultivars at different dates of sowing:

Data presented in Table 1 illustrated the disease severity % of Cercospora leaf spot disease for the two sugar beet cultivars i.e. Ras Poly and Fareda under three sowing dates as well as under protected and infected conditions during 2003/2004 and 2004/2005 seasons. The data show that disease severity (%) of Ras Poly was higher than Fareda cv. under both infected and protected conditions in the first date of sowing during 2003/2004 season. While in the second date of sowing, disease severity (%) was higher (35.2%) for Ras Poly than Fareda cv. (18.9%) under infected conditions. While, under protected conditions, Fareda cultivar recorded the lowest values comparing with Ras Poly. On the other hand, the third date of sowing, October 15th recorded the highest disease severity (%) for Ras Poly(49.9%) than Fareda (24.5%) under infected conditions. Lower values were obtained under protected conditions for the two cultivars.

Table 1, show also that during 2004/2005 season same trend was obtained for the two sugar beet cultivars under the dates of sowing and infection conditions (either infected or protected), but the values of disease severity (%) were higher than that of the first season 2003/204 due to different weather conditions as shown from the climatology data.

Table 2, show also the disease severity (%) of Cercospora leaf spot during 2005/2006 and 2006/2007 seasons, under three dates of sowing as well as infected and protected conditions for Ras Poly and Fareda sugar beet cvs. Disease severity (%) values increased by increasing the plant age consequently disease incidence increased.

Table (1): Disease severity (%) of Cercospora leaf spot caused by *Cercospora beticola* on two sugar beet cvs. under three dates of sowing under three dates of sowing during 2003/2004 and 2004/2005 season.

Variety	Reading (15 days intervals)	Date of sowing during 2003/2004						Date of sowing during 2004/2005					
		1st		2nd		3rd		1st		2nd		3rd	
		Infected	Protected	Infected	Protected	Infected	Protected	Infected	Protected	Infected	Protected	Infected	Protected
Ras Poly	1	0.3	-	0.5	-	0.8	-	0.9	-	1.3	-	1.9	0.3
	2	1.63	0.2	1.8	-	1.7	-	2.5	0.8	3.5	0.5	5.6	1.3
	3	3.7	0.8	4.7	0.3	5.3	0.8	8.4	1.5	6.6	1.2	10.4	4.5
	4	8.9	1.9	10.5	1.1	11.1	1.1	19.6	4.4	11.2	3.3	19.9	9.8
	5	18.4	4.9	18.9	3.5	1.4	2.5	28.3	9.1	20.7	5.6	27.9	12.5
	6	-	-	27.4	5.1	33.6	5.9	-	-	31.3	8.7	42.5	16.8
	7	-	-	35.2	9.9	49.9	16.6	-	-	48.8	17.5	76.8	26.5
Fareda	1	0.3	-	-	-	0.2	-	0.5	-	0.1	-	0.5	0.1
	2	0.9	-	0.5	-	0.9	-	1.6	-	0.6	-	1.2	0.8
	3	2.8	0.5	0.9	-	2.3	0.3	3.7	-	1.2	-	5.4	1.5
	4	5.3	1.1	1.8	0.3	4.4	0.8	8.4	-	2.6	1.4	10.9	3.0
	5	10.6	2.3	5.6	0.9	8.4	1.6	15.9	0.5	6.4	2.7	19.3	5.2
	6	-	-	10.4	1.6	15.6	3.9	-	1.8	11.6	4.8	26.1	7.5
	7	-	-	18.9	4.5	24.5	8.8	-	3.5	23.9	6.5	46.9	15.6

L.S.D. 0.05:
2 infected/protected treatments at each reading x varieties = 1.91
2 readings at each variety x infection = 1.32
2 varieties at each reading x infection = 1.49

L.S.D. 0.05:
2 infected/protected treatments at each reading x varieties = 1.78
2 readings at each variety x infection = 1.51
2 varieties at each reading x infection = 1.66

Table (2): Disease severity (%) of Cercospora leaf spot caused by *Cercospora beticola* on two sugar beet cvs. under three dates of sowing under three dates of sowing during 2005/2006 and 2006/2007 season.

Variety	Reading (15 days intervals)	Date of sowing during 2005/2006						Date of sowing during 2006/2007								
		1st		2nd		3rd		1st			2nd			3rd		
		Infected	Protected	Infected	Protected	Infected	Protected	Infected	Protected	Modeling protected	Infected	Protected	Modeling protected	Infected	Protected	Modeling protected
Ras Poly	1	0.6	-	1.0	-	-	-	0.9	-	-	1.1	-	-	-	-	-
	2	1.1	0.5	2.1	-	3.1	0.6	1.8	-	-	3.0	0.9	0.3	2.8	1.9	0.9
	3	4.5	0.9	5.4	0.8	8.5	1.2	4.9	0.5	0.4	8.3	1.5	0.7	11.5	5.9	1.8
	4	11.7	2.5	10.0	2.1	15.9	3.2	15.7	2.9	1.1	16.6	3.6	1.4	22.4	10.2	3.1
	5	21.8	5.2	20.1	4.4	29.7	6.4	31.5	12.1	5.2	29.5	7.4	3.7	35.8	16.6	7.7
	6	-	-	29.3	6.8	42.5	10.6	-	-	-	40.8	13.5	8.2	52.6	21.4	10.9
	7	-	-	40.8	13.6	65.8	18.5	-	-	-	55.9	21.8	14.9	88.6	30.8	18.5
Fareda	1	0.1	-	-	-	-	-	0.3	-	-	0.8	-	-	0.2	-	-
	2	0.9	-	0.5	-	1.1	0.3	1.1	-	-	2.0	-	-	1.1	0.8	0.3
	3	3.1	0.3	1.5	0.5	2.5	1.5	2.5	0.3	0.2	5.4	0.5	0.2	5.6	2.4	1.1
	4	6.4	0.4	4.6	1.4	6.9	2.9	10.4	1.9	0.9	11.9	0.9	0.6	15.8	6.6	2.3
	5	11.5	1.0	11.5	2.7	12.9	4.3	18.6	5.4	1.9	17.5	2.7	1.8	20.5	9.8	4.8
	6	-	-	18.6	4.8	20.8	6.6	-	-	-	24.2	6.4	3.2	31.2	12.2	6.7
	7	-	-	26.9	8.5	38.7	12.5	-	-	-	31.6	13.5	6.3	47.5	16.4	9.4

L.S.D. 0.05:
2 infected/protected treatments at each reading x varieties = 1.76
2 readings at each variety x infection = 1.56
2 varieties at each reading x infection = 1.64

L.S.D. 0.05:
2 infected/protected treatments at each reading x varieties = 1.82
2 readings at each variety x infection = 1.63
2 varieties at each reading x infection = 1.67

Under infected conditions, high value of disease severity was obtained for Ras Poly (65.8%) while Fareda recorded the lowest (38.7%) for the third date of sowing during 2005/2006 season due to the favorable conditions, of infection, while under protected conditions, low values of disease severity (%) were obtained for the two sugar beet cultivars.

During 2006/2007 season, high disease severity (%) values were obtained for the two cultivars and increased gradually from the first date of sowing up to the third date of sowing. Ras Poly cultivar recorded the highest (88.6%) rather than Fareda (47.5%) under infected conditions. Lower values were obtained under protected conditions. While, under modeling protected (applying the model) during 2006/2007, disease severity % was less than those of infected and protected conditions. Disease severity % ranged from 0.4 to 5.2% for Ras Poly in the 1st of sowing, but for Fareda cv. it ranged from 0.2 to 1.9%. In the second date of sowing, disease severity (%) ranged from 0.9 to 14.9%, and for Fareda it ranged from 0.2 to 6.3%, disease severity % of Ras Poly, under modeling protected for the third date of sowing ranged from 0.9 to 18.5%, while it ranged from 0.3 to 9.4% for Fareda.

Results obtained reveled that such disease was prevalent in most sugar beet fields of the middle Delta due to sugar beet plantations increased from year to another. In Egypt disease severity of Cercospora leaf spot started to be increased. These findings are supported by El-Kholi (1995) and El-Fahhar (1997 and 2003). Root weight and sucrose % losses due to infection with Cercospora leaf spot disease reached 33.9 and 46.4%, respectively, as reported by Mukhopadhyay and Rao (1978). While El-Fahhar (2003), reported that the losses in root weight and sucrose of sugar beet cv. reached 62.43% and 45.29%, respectively. In this study loss percentages for root weight reached 67.85 and 42.94% for Ras Poly and Fareda cvs. respectively, while, loss % for sucrose reached 78.51 and 45.58% for Ras Poly and Fareda cvs., respectively.

B. Relation between Cercospora leaf spot disease severity (%), number of trapped spores and weather elements at 3 dates of sowing:

a. Relation between disease severity and weather elements:

Disease severity (%) of both cvs. Ras Poly (the highly susceptible infected cv.) and Fareda (the least infected one) were selected to perform such study.

Data presented in Tables (3, 6, 7 and 9) revealed that disease severity started to appear in the second half of January 2003/2004 and reached its maximum by the end of April in the third date of sowing,

(49.9%) on October 15th of 2004. It is also obvious from the present data that the disease severity (%) started to be recorded on January 30, with the increase in relative humidity and clear increase in number of trapped spores. Also, the data show that the more increase in air temperature, the more the increase in disease severity %, rainfall reached its maximum during January, 2004 (2.33 mm) (Table 3) where the Cercospora leaf spot disease started to appear on the tested cultivars.

During 2004/2005 season (Table 5), disease incidence of Cercospora leaf spot disease appeared also in the second half of January 2005, and reached the maximum (76.8%) on May 30 for the third date of sowing(October 15th), for Ras Poly. Fareda cv. showed the least disease severity than that of Ras Poly cv. in the three dates of sowing, this due to the increase in the air temperature, relative humidity, along the period of rains, high speed of wind, and consequently no. of spores m^3/day.

Data in Table 7 during 2005/2006 season show that the maximum disease severity (%) reached 65.8% in the second half of May 2006 in the third date of sowing October 15th for Ras Poly cv., while it reached 38.7% for Fareda on the same date of sowing. Disease severity was very much affected by air temperature, relative humidity, rain amount, wind velocity as well as no. of trapped spores.

During the last season of testing 2006/2007, data in Table (9) show that disease severity of Cercospora leaf spot disease % reached its maximum (88.6%) in October 15th for Ras Poly cv., while it reached 47.5 for Fareda cv. in the same date of sowing due to high air temperature, high relative humidity, long rain fall period, high speed of wind. By the aid of those elements, no. of trapped spores reached the highest values.

Generally, in Egypt across the four years of testing, Cercospora leaf spot disease started to appear on the tested sugar beet cvs. in the second half of January whereas the favorable conditions for the fungus infection started, and become optimum to enhance disease incidence.

Correlation coefficients between each of Cercospora leaf sot disease severity % on Ras Poly and Fareda cvs., number of trapped spores and weather elements were estimated and presented in Tables (4, 6 and 8).

Tabulated data show that disease severity % of Ras Poly cv. was significantly positively correlated with maximum and minimum relative humidity, rain, wind velocity and number of spores/m^3/day. Likewise, the same trend was obtained with Fareda cv. at the four seasons of testing.

Table (3): Relation between Cercospora leaf spot disease severity (%) of Ras Poly and Fareda cvs. and temperature, relative humidity (RH%), rain, wind velocity and number of spores/m^3/day at Sakha during 2003/2004 season.

Month	Factor	Disease severity (%)						Air temperature (°C)		Relative humidity (%)		Rain mm/day	Wind velocity (km/hr)	No. or spores m^3/day
		Ras Poly Date of sowing			Fareda Date of sowing									
		1st	2nd	3rd	1st	2nd	3rd	Maximum	Minimum	Maximum	Minimum			
Sept. 2003	15	0.0	0.0	0.0	0.0	0.0	0.0	33.79	18.82	89.6	49.8	-	88.90	2.10
	30	0.0	0.0	0.0	0.0	0.0	0.0	32.20	18.17	87.93	47.86	-	87.86	1.80
Oct. 2003	15	0.0	0.0	0.0	0.0	0.0	0.0	30.86	16.04	88.06	48.86	-	67.03	1.20
	30	0.0	0.0	0.0	0.0	0.0	0.0	31.15	15.13	91.18	49.0	-	70.71	2.50
Nov. 2003	15	0.0	0.0	0.0	0.0	0.0	0.0	26.26	13.24	82.73	50.2	-	61.6	1.30
	30	0.0	0.0	0.0	0.0	0.0	0.0	25.18	10.97	80.66	52.13	-	66.0	1.60
Dec. 2003	15	0.0	0.0	0.0	0.0	0.0	0.0	23.26	11.24	82.73	55.86	-	67.33	3.30
	30	0.0	0.0	0.0	0.0	0.0	0.0	25.18	9.97	80.66	53.62	-	66.0	3.60
Jan. 2004	15	0.0	0.0	0.0	0.0	0.0	0.0	19.62	7.64	78.13	51.66	2.33	64.73	5.40
	30	0.3	0.5	0.0	0.3	0.1	0.0	19.26	7.13	87.56	55.12	1.43	63.27	6.90
Feb. 2004	15	1.3	1.8	0.0	0.9	0.5	0.0	19.78	6.28	87.53	55.06	1.66	81.78	14.50
	28	3.7	4.7	0.8	2.8	1.6	0.2	23.28	7.25	80.86	55.86	0.12	80.46	17.80
Mar. 2004	15	8.9	10.5	1.7	5.3	2.8	0.9	25.12	9.24	79.13	50.06	0.6	91.4	38.60
	30	18.4	18.9	5.3	10.6	5.6	2.3	25.77	8.44	83.68	49.93	-	93.31	42.10
Apr. 2004	15	-	27.4	11.1	-	10.4	4.4	28.54	10.51	79.6	48.13	-	107.4	31.40
	30	-	35.2	21.4	-	18.9	8.9	28.25	11.33	73.86	44.06	-	106.33	28.90
May 2004	15	-	-	33.6	-	-	15.6	28.64	12.24	81.33	39.46	-	116.06	21.30
	30	-	-	52.9	-	-	24.5	30.21	14.57	85.68	43.25	-	107.87	16.70

Table (4): Correlation between Cercospora leaf spot disease severity (%), number of spores/day and weather elements of Ras Poly and Fareda cvs. during 2003/2004 season.

	DS Ras Poly	DS Fareda	Maximum temp. (°C)	Minimum temp. (°C)	Maximum R.H (%)	Minimum R.H (%)	Rain (mm/day)	Wind Velocity (km/hr)	No. of spores/m^3/day
DS-Ras Poly	1	0.999**	0.805**	0.563*	0.579*	-0.744**	0.543*	0.772**	0.469*
DS-Fareda		1	0.803**	0.570*	0.581*	0.747**	0.540*	0.763**	0.470*
Maximum temp. °C			1	0.784**	0.636**	0.684**	0.602**	0.479*	0.519*
Minimum temp. °C				1	0.464	0.722**	0.602**	0.496*	0.650**
Maximum R.H (%)					1	0.129	0.139	0.741**	0.870**
Minimum R.H. (%)						1	0.378	0.749**	0.302
Rain (mm/day)							1	1	0.860**
Wind velocity (km/hr)									0.688**
No. of spores/m^3/day									1

DS = Disease severity (%)

**, * highly significant and significant at the 0.01 and 0.05 levels, respectively

Table (5): Relation between Cercospora leaf spot disease severity (%) of Ras Poly and Fareda cvs. and temperature, relative humidity (RH%), rain, wind velocity and number of spores/m^3/day at Sakha during 2004/2005 season.

Month	Factor	Disease severity (%)						Air temperature (°C)		Relative humidity (%)		Rain mm/day	Wind velocity (km/hr)	No. or spores m^3/day
		Ras Poly Date of sowing			Fareda Date of sowing									
		1st	2nd	3rd	1st	2nd	3rd	Maximum	Minimum	Maximum	Minimum			
Sept. 2004	15	0.0	0.0	0.0	0.0	0.0	0.0	30.48	20.64	96.86	49.06	-	102.01	1.80
	30	0.0	0.0	0.0	0.0	0.0	0.0	32.12	19.01	96.53	38.66	-	121.42	1.20
Oct. 2004	15	0.0	0.0	0.0	0.0	0.0	0.0	29.8	16.66	96.73	40.2	-	80.06	3.10
	30	0.0	0.0	0.0	0.0	0.0	0.0	30.57	19.38	96.68	52.12	-	87.43	2.90
Nov. 2004	15	0.0	0.0	0.0	0.0	0.0	0.0	29.32	18.78	96.33	47.66	0.4	75.2	4.40
	30	0.0	0.0	0.0	0.0	0.0	0.0	22.10	14.65	95.26	47.93	0.4	82.4	7.85
Dec. 2004	15	0.0	0.0	0.0	0.0	0.0	0.0	21.88	13.77	97.2	49.73	2.25	75.66	6.97
	30	0.0	0.0	0.0	0.0	0.0	0.0	21.01	10.92	97.56	51.56	-	44.0	11.50
Jan. 2005	15	0.0	0.0	0.0	0.0	0.0	0.0	18.49	9.94	96.4	55.8	4.4	63.26	14.70
	30	0.9	1.3	0.0	0.5	0.1	0.0	19.60	9.82	98.8	52.33	0.15	62.86	20.10
Feb. 2005	15	2.5	3.5	0.0	1.6	0.6	0.0	15.94	8.04	95.73	50.33	1.24	82.66	35.61
	28	8.4	6.6	1.9	3.7	1.2	0.5	19.65	9.24	94.76	44.53	0.02	79.46	43.70
Mar. 2005	15	19.6	11.2	5.6	8.4	2.6	1.2	24.07	12.53	97.5	47.93	0.8	100.8	48.65
	30	28.3	20.7	10.4	15.9	6.4	5.4	25.49	10.34	96.8	51.2	-	94.33	56.30
Apr. 2005	15	-	31.3	19.9	-	11.6	10.9	23.98	13.02	95.26	41.4	-	103.0	32.41
	30	-	48.8	27.9	-	23.9	19.3	26.45	15.29	96.13	38.6	0.73	102.4	29.25
May 2005	15	-	-	42.5	-	-	26.1	27.41	16.68	95.13	41.8		127.33	20.46
	30	-	-	75.8	-	-	46.9	31.06	18.83	94.37	38.87		138.13	10.50

Table (6): Correlation between Cercospora leaf spot disease severity (%), number of spores/day and weather elements of Ras Poly and Fareda cvs. during 2004/2005 season.

	DS Ras Poly	DS Fareda	Maximum temp. (°C)	Minimum temp. (°C)	Maximum R.H (%)	Minimum R.H (%)	Rain (mm/day)	Wind Velocity (km/hr)	No. of spores/m^3/day
DS-Ras Poly	1	0.983**	0.805**	0.587*	0.516*	0.578*	0.519*	0.722**	0.515*
DS-Fareda		1	0.832**	0.543*	0.529*	0.539*	0.520*	0.720**	0.545*
Maximum temp. °C			1	0.870**	0.665**	0.540*	0.491	0.617**	0.852**
Minimum temp. °C				1	0.267	0.735**	0.345	0.485*	0.747**
Maximum R.H (%)					1	0.057	0.106	0.499*	0.838**
Minimum R.H. (%)						1	0.463	0.705**	0.163
Rain (mm/day)							1	0.344	0.530*
Wind velocity (km/hr)								1	0.855**
No. of spores/m^3/day									1

DS = Disease severity (%)

**, * highly significant and significant at the 0.01 and 0.05 levels, respectively

Table (7): Relation between Cercospora leaf spot disease severity (%) of Ras Poly and Fareda cvs. and temperature, relative humidity (RH%), rain, wind velocity and number of spores/m^3/day at Sakha during 2005/2006 season.

Month	Factor	Disease severity (%)						Air temperature (°C)		Relative humidity (%)		Rain mm/day	Wind velocity (km/hr)	No. or spores m^3/day
		Ras Poly Date of sowing			Fareda Date of sowing									
		1st	2nd	3rd	1st	2nd	3rd	Maximum	Minimum	Maximum	Minimum			
Sept. 2005	15	0.0	0.0	0.0	0.0	0.0	0.0	32.21	21.24	96.0	44.93		96.88	2.50
	30	0.0	0.0	0.0	0.0	0.0	0.0	31.38	21.38	94.86	44.0		101.01	3.0
Oct. 2005	15	0.0	0.0	0.0	0.0	0.0	0.0	30.34	19.8	95.46	46.93		82.43	2.80
	30	0.0	0.0	0.0	0.0	0.0	0.0	26.82	17.77	94.06	46.62		87.15	1.22
Nov. 2005	15	0.0	0.0	0.0	0.0	0.0	0.0	24.25	14.8	94.46	46.6	-	75.06	3.70
	30	0.0	0.0	0.0	0.0	0.0	0.0	24.6	14.69	95.13	48.06	0.46	80.41	7.45
Dec. 2005	15	0.0	0.0	0.0	0.0	0.0	0.0	23.30	13.8	94.53	56.8	-	71.91	10.80
	30	0.0	0.0	0.0	0.0	0.0	0.0	20.36	11.25	94.5	52.81	0.53	60.73	9.18
Jan. 2006	15	0.0	0.0	0.0	0.0	0.0	0.0	21.23	6.7	92.26	65.53	0.4	52.53	15.60
	30	0.6	1.0	0.0	0.1	0.3	0.0	20.0	4.12	90.93	64.62	0.18	47.25	18.35
Feb. 2006	15	1.1	2.1	0.0	0.9	0.9	0.0	19.2	4.7	89.4	62.26	1.0	62.53	29.70
	28	4.5	5.4	0.9	3.1	1.5	0.3	21.57	6.46	90.0	61.46	0.26	77.30	35.15
Mar. 2006	15	11.7	10.0	3.1	6.4	4.6	1.1	23.26	6.8	83.8	52.26	0.14	85.86	41.50
	30	21.8	20.1	8.5	11.5	11.5	2.5	26.09	6.78	81.5	53.75	-	93.43	48.0
Apr. 2006	15	-	29.3	15.9	-	18.6	6.9	25.5	8.7	84.4	52.06	1.3	85.0	31.60
	30	-	40.8	29.7	-	26.9	12.9	28.6	10.3	77.73	42.66	0.42	97.6	25.16
May 2006	15	-	-	42.5	-	-	20.8	27.8	10.63	80.6	47.06	-	123.06	18.30
	30	-	-	65.8	-	-	38.7	31.0	13.34	88.25	46.0	-	113.12	11.50

Table (8): Correlation between Cercospora leaf spot disease severity (%), number of spores/day and weather elements of Ras Poly and Fareda cvs. during 2005/2006 season.

	DS Ras Poly	DS Fareda	Maximum temp. (°C)	Minimum temp. (°C)	Maximum R.H (%)	Minimum R.H (%)	Rain (mm/day)	Wind Velocity (km/hr)	No. of spores/m^3/day
DS-Ras Poly	1	0.997**	0.612**	0.535*	0.656**	0.551*	0.530*	0.686**	0.636*
DS-Fareda		1	0.614**	0.523*	0.623**	0.548*	0.516*	0.662**	0.611*
Maximum temp. °C			1	0.757**	0.623**	0.838**	0.441	0.811**	0.876**
Minimum temp. °C				1	0.561*	0.749**	0.449	0.487*	0.787**
Maximum R.H (%)					1	0.045	0.200	0.712**	0.747**
Minimum R.H. (%)						1	0.332	0.768**	0.417
Rain (mm/hr)							1	0.345	0.553*
Wind velocity (km/hr)								1	0.819**
No. of spores/m^3/day									1

DS = Disease severity (%)

**, * highly significant and significant at the 0.01 and 0.05 levels, respectively

Table (9): Relation between Cercospora leaf spot disease severity (%) of Ras Poly and Fareda cvs. and temperature, relative humidity (RH%), rain, wind velocity and number of spores/m^3/day at Sakha during 2006/2007 season.

Month	Factor	Disease severity (%)						Air temperature (°C)		Relative humidity (%)		Rain mm/day	Wind velocity (km/hr)	No. or spores m^3/day
		Ras Poly Date of sowing			Fareda Date of sowing									
		1st	2nd	3rd	1st	2nd	3rd	Maximum	Minimum	Maximum	Minimum			
Sept. 2006	15	0.0	0.0	0.0	0.0	0.0	0.0	32.5	15.63	98.13	55.13	-	80.93	0.70
	30	0.0	0.0	0.0	0.0	0.0	0.0	33.23	16.73	96.53	53.13	-	75.73	1.10
Oct. 2006	15	0.0	0.0	0.0	0.0	0.0	0.0	31.63	14.83	97.53	51.0	-	72.46	4.30
	30	0.0	0.0	0.0	0.0	0.0	0.0	28.75	13.56	98.62	54.31	0.33	71.06	4.90
Nov. 2006	15	0.0	0.0	0.0	0.0	0.0	0.0	23.5	9.0	96.53	58.4	0.21	66.13	6.75
	30	0.0	0.0	0.0	0.0	0.0	0.0	24.37	9.16	96.4	58.53	-	64.8	10.31
Dec. 2006	15	0.0	0.0	0.0	0.0	0.0	0.0	21.7	6.4	98.26	67.06	0.5	59.4	15.42
	30	0.0	0.0	0.0	0.0	0.0	0.0	18.90	3.75	97.68	61.87	0.16	63.43	13.98
Jan. 2007	15	0.0	0.0	0.0	0.0	0.0	0.0	18.7	4.7	99.26	61.26	0.8	62.93	25.40
	30	0.9	1.1	0.0	0.3	0.8	0.0	19.96	3.53	98.37	59.5	0.34	59.81	31.0
Feb. 2007	15	1.8	3.0	0.0	1.1	2.0	0.0	18.14	4.66	95.6	65.86	2.66	52.73	46.30
	28	4.9	8.3	0.9	2.5	5.4	0.2	22.23	6.26	96.15	63.7	0.31	59.38	55.10
Mar. 2007	15	15.7	16.6	2.8	10.4	11.9	1.8	22.03	5.1	96.33	57.93	0.4	79.06	68.24
	30	31.5	29.5	11.5	18.6	17.5	5.6	23.46	5.46	97.25	53.81	0.18	75.56	70.90
Apr. 2007	15	-	40.8	22.4	-	24.2	15.8	23.93	6.3	95.33	51.86	0.76	88.06	51.80
	30	-	55.9	35.8	-	31.6	20.5	26.56	8.5	96.26	47.0	0.08	118.73	43.71
May 2007	15	-	-	52.6	-	-	31.2	29.86	10.76	94.58	45.81	-	100.8	27.93
	30	-	-	88.6	-	-	47.5	31.21	14.28	93.86	43.51	-	123.18	15.85

C. Regression equations (proposed models):

From the previous data of disease severity (%) of Cercospora leaf spot as well as metrological data, a multiple regression equations for disease severity (%) of Ras Poly and Fareda cvs. or number of trapped spores and meteorological data of weather elements around the plant canopy was proposed. The stepwise analysis used the statistical analysis to identify the independent variables with the most effect on disease severity (%) by introducing all weather parameters i.e., maximum and minimum air temperature (°C), maximum and minimum relative humidity (R.H%), rain and wind velocity into the regression equations.

Three proposed equations were used to study the relation between disease severity (%), no of spores/day and weather elements for the three seasons i.e. 2003/2004, 2004/2005 and 2005/2006 for Ras Poly and Fareda cvs., as follow:

1. Season of 2003/2004:

Multiple regression equation was practiced according to the data shown in Table (3) for the disease severity % of either Ras Poly or Fareda cvs. as independent variable and weather elements as dependent variables as follow:

Regression coefficients between disease severity (%) of the two sugar beet cvs. and weather parameters:

a. Ras Poly cv.:

$Y = 82.667 + 1.744\ x_1 + 0.724\ x_2 + 0.874\ x\ 3 + 2.549\ x_4 + 4.919\ x_5 + 0.447\ x_6 + 0.124\ x_7$.

b. Fareda cv.

$Y = 41.082 + 0.817\ x_1 + 0.339\ x_2 + 0.392\ x_3 + 1.206\ x_4 + 2.272\ x_5 + 0.206\ x_6 + 6.960\ x_7$.

Where:

Y= Disease severity (%)
x_1 = Maximum temp.
x_2 = Minimum temp.
x_3 = Maximum R.H.
x_4 = Minimum R.H.
x_5 = Rain
x_6 = Wind Velocity.
x_7 = No of trapped spores.

Coefficient of determination (R^2) were 0.780 and 0.777 for Ras Poly and Fareda, respectively, this means that the formula can be used as analytical model with an increasing its degrees of realism and

representativeness and can be used as prediction model for disease severity % on leaves.

2. Season of 2004/2005:

Regression coefficients equations between disease severity (%) of the two cvs., Ras Poly and Fareda and weather elements were calculated from the data presented in Table (5), the final results were as follow:

a. Ras Poly cv.:

$Y = 271.830 + 0.376\ x_1 + 1.800\ x_2 + 2.842\ x_3 + 0.587\ x_4 + 0.673\ x_5 + 0.528\ x_6 + 0.170\ x_7$

b. Fareda cv.:

$Y = 267.951 + 0.177\ x_1 + 1.146\ x_2 + 2.939\ x_3 + 4.152\ x_4 + 0.627\ x_5 + 0.382\ x_6 + 0.153\ x_7$.

Where: Y, x_1, x_2, x_3, x_4, x_5, x_6 and x_7 as mentioned before.

Coefficient of determinations (R_2) were 0.595 and 0.577 for Ras Poly and Fareda respectively, this means that this formula can be used as analytical model according to its degrees of reliability to be used as prediction model for such circumstances.

3. Season of 2005/2006:

Regression coefficients formulae between disease severity (%) of the two cvs., Ras Poly and Fareda and weather elements were calculated from the data presented in Table (7) were as follows:

a. Ras poly cv.:

$Y = -90.633 + 3.959\ x_1 + 6.872\ x_2 + 1.016\ x_3 + 0.857\ x\ 4 + 5.659\ x_5 + 0.671\ x_6 + 0.900\ x_7$.

b. Fareda cv.:

$Y = -67.516 + 2.594\ x_1 + 4.232\ x_2 + 0.803\ x_3 + 0.666\ x_4 + 3.752\ x_5 + 63.752\ x_6 + 0.502\ x_7$.

Where: Y, x_1, x_2, x_3, x_4, x_5, x_6 and x_7 as mentioned before.

Coefficients of determinations (R_2) were 0.884 and 0.857 for Ras Poly and Fareda cvs., respectively, this means that this model can be used as prediction model for disease severity % on leaves.

From the data obtained in Table (10), average of disease severities, weather elements, no. of spores were calculated for the three years of 2003/2004, 2004/2005 and 2005/2006.

a. Correlation coefficients:

Tabulated data (Table 11) show that disease severity (%) of Ras Poly and Fareda cvs. were significantly positively correlated with maximum, minimum relative humidity, rain, and no. of spores/day while it was highly significant positively correlated with wind velocity.

b. General regression equations (general model):

Regression equation was calculated for disease severity (%) and weather elements and no. of spores allover the three seasons (Table 11).

General equation was as follows:

1. Ras Poly cv.:

$Y = 263.86 + 2.026\ x_1 + 3.132\ x_2 + 1.577\ x_3 + 1.364\ x_4 + 3.735\ x_5 + 0.548\ x_6 + 0.398\ x_7$.

2. Fareda acv.:

$Y = 80.50 + 1.196\ x_1 + 1.905\ x_2 + 1.345\ x_3 + 2.008\ x_4 + 2.232\ x_5 + 1.446\ x_6 + 2.538\ x_7$.

Determination coefficient (R^2) for the two regression equations are 0.753 and 0.737 for Ras Poly and Fareda cvs., respectively, this means that this model can be used as prediction model for disease severity (%) on leaves and this model was applied on 2006/2007 season according to its elements.

Spraying or applying chemical fungicide of Cercospora leaf spot was done when maximum air temperature ranged from 18-22°C, while minimum air temperature ranged from 7-12°C. Maximum relative humidity ranged from 90-95, while minimum relative humidity ranged from 55-60%, in the presence of rain and wind velocity ranged from 56 to 75 km/hr and more and high number of spores (>10 spores/m^3/day). According to the previous data, spraying was done for protection on the first of January while, all the weather conditions are suitable for disease occurrence.

These results were confirmed by Windels *et al.* (1998) and Francis (2000) and El-Fahhar (2003) reported that there were a strong relationship between disease spread and period of high humidity and rainfall, the optimum conditions for spore production, germination and penetration into the host plant are 90-95% relative humidity and air temperature 25-35°C with night temperature above 16°C.

Table (10): Relation between the averages of Cercospora leaf spot disease severity (%) of Ras Poly and Fareda cvs. and air temperature, relative humidity (RH%), rain, wind velocity and number of spores/m^3/days at Sakha for 2003/2004, 2004/2005 and 2005/2006 seasons.

Factor / Month		Disease severity (%)						Air temperature (°C)		Relative humidity (RH %)		Rain mm/day	Wind velocity (km/hr)	No. of spores m^3/day
		Ras poly date of sowing			Fareda Data of sowing									
		1st	2nd	3rd	1st	2nd	3rd	Max.	Min.	Max.	Min.			
Sept.	15	0	0	0	0	0	0	32.16	10.23	94.15	47.93	0	95.92	2.13
	30	0	0	0	0	0	0	31.9	198.52	93.10	43.50	0	103.43	2.0
Oct.	15	0	0	0	0	0	0	30.3	17.23	93.41	45.36	0	76.50	2.36
	30	0	0	0	0	0	0	29.51	17.42	93.97	45.36	0	81.61	2.20
Nov.	15	0	0	0	0	0	0	26.61	15.60	91.17	48.15	0.12	70.62	3.13
	30	0	0	0	0	0	0	23.96	13.43	90.35	49.04	0.28	76.77	5.63
Dec.	15	0	0	0	0	0	0	22.81	12.93	91.48	54.13	0.84	712.63	7.02
	30	0	0	0	0	0	0	22.06	10.71	90.90	52.66	0.93	56.91	8.09
Jan.	15	0	0	0	0	0.2	0	19.78	8.09	88.93	57.66	0.07	70.71	11.9
	30	0.6	0.9	0	0.3	0.7	0	19.62	7.02	92.43	57.35	0.66	57.65	15.11
Feb.	15	1.6	2.5	0	1.3	1.4	0.3	18.30	6.34	90.88	55.88	0.78	75.64	26.60
	28	5.5	5.6	1.2	3.2	3.3	1.1	21.50	7.65	88.54	53.95	0.29	81.74	32.21
Mar.	15	13.4	10.6	3.5	6.7	7.8	3.4	24.15	9.52	84.89	50.28	0.31	92.68	42.41
	30	22.8	19.9	8.1	12.7	13.5	7.4	25.78	8.52	87.32	46.44	0	93.66	48.8
Apr.	15	0	29.3	15.6		23.2	13.7	26.0	10.74	86.42	47.17	0.43	98.46	31.80
	30	0	41.6	26.3			20.8	27.76	12.30	82.67	41.77	0.24	102.1	27.77
May	15	0	0	39.5			36.5	27.28	13.24	85.86	42.77	0	122.15	20.02
	30	0	0	64.8	0			31.05	15.61	89.43	42.70	0	119.70	12.90

Table (11): Correlation between Cercospora leaf spot disease severity (%), number of spores/day and weather elements of Ras Poly and Fareda cvs. during 2003/2004, 21004/2005 and 2005/2006 season.

	DS Ras Poly	DS Fareda	Maximum temp. (°C)	Minimum temp. (°C)	Maximum R.H (%)	Minimum R.H (%)	Rain (mm/day)	Wind Velocity (km/hr)	No. of spores/m^3/day
DS-Ras Poly	1	0.993**	0.841**	0.558*	0.883**	0.557*	0.597*	0.726**	0.540*
DS-Fareda		1	0.850**	0.545*	0.888**	0.545*	0.525*	0.715**	0.542*
Maximum temp. °C			1	0.803**	0.4175	0.687**	0.511*	0.635**	0.749**
Minimum temp. °C				1	0.431	0.535*	0.465	0.659**	0.661**
Maximum R.H (%)					1	0.077	0.148	0.684**	0.585*
Minimum R.H. (%)						1	0.391	0.535*	0.294
Rain (mm/day)							1	0.479	0.581*
Wind velocity (km/hr)								1	0.620**
No. of spores/m^3/day									1

DS = Disease severity (%)

**, * highly significant and significant at the 0.01 and 0.05 levels, respectively

These are consistent with previous observations. The general model had a coefficient of determination value (r^2) suggest that all weather elements contribute in this model with high validity and probability to use and apply. Moreover, Mainibhashanrao and Krishnan (1991) suggested a computerized forecasting system developed to stimulate the incidence and progress of disease in the field.

The data in Table 12, summarized the whole vision and interactions between dates of sowing, naturally infected, protected and modeling protected (spraying according to the model apply) and some other characters like disease severity (%), root weight (kg), TSS (%), sucrose (%), purity (%) and loss percentages in root and sucrose yield.

Disease severity (%) increased for Ras Poly from the first date of sowing up to the third date of sowing under naturally infected plots (31.5 to 88.6%, respectively) while under protected conditions it reduced to 12.1% in the first date of sowing to 30.08% for the third date of sowing. In contrary, it ranged from 5.2 to 18.5% for Ras Poly under modeling protected or after applying the model and spraying on time of the critical stage of infection. The proposed model focused mainly on the date of sowing, temperature degrees, relative humidity, wind velocity as well as the number of trapped spores/m^3/day. Different models were suggested and developed by using a step wise regression analysis which were used to evaluate the model for best fit in predicting and counting the disease severity (%) according to the weather conditions and number of trapped spores. It is obvious that all weather elements exerted a significant effect on disease severity and number of spores.

For Fareda cv., less disease severity (%) were obtained under the three dates of sowing and infected, protected and modeling protected conditions.

All characters studied like chlorophyll content was very much affected by disease %. Under infected plots, Raspoly cultivar gave the highest amount of chlorophyll when sown in September 15, the same trend was obtained for Fareda cultivar. The data show also that high concentration of chlorophyll was obtained under modeling protected.

Root weight data in kgs affected too much by infection especially in the late date of sowing which the disease severity is high for the two sugar beet cultivars (Table 12), the benefit from applying the modeling equations resulted in high root weight yield even in the late date of sowing under the infection conditions (Table 12). Fareda cv. recorded the highest root yield comparing with Ras Poly cv. due to the low disease severity percentages obtained.

Table (12): Disease severity (%), chlorophyll content (mg), root weight (kg), TSS (%), sucrose (%), purity (%) and loss (%) in root weight and sucrose (%) for Ras Poly and Fareda cvs. in three dates of sowing under infected, protected and after forecasting during 2006/2007 season.

Variety	Date of sowing	Disease severity (%)*			Chlorophyll content (mg)			Root weight (kg)			TSS (%)			Sucrose (%)			Purity (%)			Loss (%)	
		Infected	Protected	Modeling protected	Infected	Protected	Modeling protected	Infected	Protected	Modeling protected	Infected	Protected	Modeling protected	Infected	Protected	Modeling protected	Infected	Protected	Modeling protected	Root weight	Sucrose
Ras Poly	1st	31.5	12.1	5.2	58.4	76.9	88.7	1.45	1.95	2.35	18.95	23.71	27.60	13.90	19.50	23.80	73.35	82.22	86.23	25.64	28.71
	2nd	55.9	21.9	14.9	43.8	69.5	75.8	0.85	1.60	1.85	12.40	20.16	22.50	8.50	16.10	18.9	68.54	79.86	84.0	46.87	47.0
	3rd	88.6	30.08	18.5	10.6	61.3	72.6	0.45	1.40	1.78	7.25	19.52	22.70	3.10	14.43	17.40	42.75	73.42	76.69	67.85	78.51
Fareda	1st	18.6	5.4	1.9	75.1	93.5	98.9	1.88	2.46	2.78	23.0	27.50	28.84	18.80	22.20	24.20	81.73	80.72	83.91	23.57	15.31
	2nd	31.6	13.5	6.3	61.4	79.8	93.5	1.38	1.89	2.29	19.4	2340	26.50	14.10	18.45	21.40	72.68	78.84	80.75	26.98	23.57
	3rd	47.5	16.4	9.4	53.7	70.6	85.4	0.97	1.70	2.10	14.80	22.16	25.15	9.25	17.0	19.70	62.5	76.71	78.33	42.94	45.58
L.S.D 0.05		1.88			2.87			0.38			0.45			1.46			2.35				

* According to Shane and Teng (1992)

Total soluble solids (TSS%) as shown from Table 3, decreased by increasing disease severity, and delaying date of sowing, higher values were obtained for TSS% in the early sowing and when applying modeling protected equation. Fareda cv. recorded the highest TSS (%) than Ras Poly cv. under both protected and modeling protected conditions.

Data in Table 12 showed that, sucrose (%) was very much affected by disease severity (%) of Cercospora leaf spot, sucrose percentages were less under infected conditions while it increased under protected conditions and after applying modeling protected. High sucrose percentages were obtained for the first date of sowing (September, 15) even under protected conditions. Similar results were obtained for purity (%), the highest values of purity were obtained under protected conditions and at early sowing date, while the late date of sowing reduced sucrose as well as purity percentages.

Root yield losses were low at early date of sowing rather than the late date of sowing for both sugar beet cvs.

On the other hand, reduction and losses in sucrose % were high in the late sowing for both cvs., Ras Poly and Fareda, while least values of losses for sucrose % were obtained for Fareda than of Ras Poly cultivar.

These results were entirely agreed with those obtained by El-Fahhar (2003). Which reported that the disease severity for all the tested cvs. were high. Maximum and minimum temperature ranged from 18 to 32°C, and from 6 to 19.5°C, respectively. Relative humidity was more than 90 (maximum), while, the minimum R.H ranged from 41 up to 57%. She also reported that, number of spores and wind velocity were significantly correlated with disease severity %. Moreover, the study of Cercospora leaf spot disease forecasting model considered of extremely important to predict the disease incidence and consequently starting control measure and applying chemicals.

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نموذج للتنبؤ المرضى للإصابة بفطر التبقع الورقى السركوسبورى فى بنجر السكر

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الملخص العربى

أجرى هذا البحث بمحطة بحوث سخا الزراعية ــ كفرالشيخ ــ مصر خلال المواسم ٢٠٠٣/٢٠٠٤م ، ٢٠٠٤/٢٠٠٥م ، ٢٠٠٥/٢٠٠٦م ، ٢٠٠٦/٢٠٠٧م على نباتات بنجر السكر وذلك لدراسة العلاقة بين الشدة المرضية وعدد الجراثيم لفطر الـ *C. beticola* وبين بعض العوامل المناخية مثل درجات حرارة الهواء العظمى والصغرى ودرجات الرطوبة النسبية العظمى والصغرى وكميات الأمطار وسرعة الرياح وبناءا على ذلك تم عمل نماذج عدة باستخدام معاملات الانحدار (الارتداد) وكذا دراسة التلازم بين شدة الإصابة بالمرض وعدد الجراثيم مع العناصر الأخرى. ولدراسة وبائية هذا الفطر فى زراعات بنجر السكر وتم اختيار صنفين هما راس بولى وفريدا وتم زراعتهم فى ثلاثة مواعيد زراعية ١٥ سبتمبر ، وأول أكتوبر ، ١٥ أكتوبر ، وتم استخدام مصيدة الجراثيم فى حقول هذه الأصناف لقراءة أعداد الجراثيم اليومية.

وتم أخذ القراءات المناخية من محطة الأرصاد بمحطة بحوث سخا ــ كفرالشخ وتم اجراء التجربة فى قطاعات كاملة العشوائية منشقة مرة واحدة وزرع كل صنف فى قطع تجريبية ٣ × ٧م^2 وتركت بعض القطع للعدوى الطبيعى وأخرى تم حمايتها. بإضافة مبيد توبسن م ٧٠ ١جم/لتر. وتم تقدير الصفات المحصولية مثل وزن الجذر والمواد الذائبة الكلية ونسبة الخسارة فى وزن الجذر والسكر نتيجة الشدة المرضية فى المواعيد المختلفة والأصناف المختلفة وأيضا تم تقدير نسبة الكلوروفيل.

وأظهرت الدراسة أن الشدة المرضية بلغت أعلاها فى مواعيد الزراعة المتأخرة (١٥ أكتوبر) وكانت متلازمة معنويا مع درجات الحرارة العظمى والصغرى والرطوبة النسبية العظمى والصغرى والمطر والرياح وعدد الجراثيم.

وسجلت الشدة المرضية للفطر أعلاها عندما تراوحت درجات الحرارة القصوى من ٢٠ الى ٣٠°م ونسبة الرطوبة القصوى أعلى من ٨٠% والصغرى من ٤٠-٥٠% وتوافرت هذه الظروف فى النصف الثانى من يناير واستمرت حتى شهر مارس فى وجود الأمطار وسرعة الرياح (٨٠-١٠٠كم/ساعة).

وتم استخدام معادلات ارتداد لكل موسم على حده وأيضا تم استخدام معادلة أو نموذج عام تم تطبيقه فى عام ٢٠٠٦/٢٠٠٧م وذلك للتنبؤ بالشدة المرضية وإمكانية المقاومة حيث أن معامل التقدير لقياس كفاءة هذا النموذج كانت عالية مما يعنى إمكانية استخدام هذا النموذج بكفاءة فى حقول بنجر السكر التى بدأت تزداد مساحتها فى مصر.

ولقد تم الرش بالمبيدات الفطرية فى أول يناير للوقاية من مرض التبقع السركوسبورى على بنجر السكر.