EFFECT OF INFECTED SUGAR BEET PLANTS WITH POWDERY MILDEW DISEASE ON INVERTASE ACTIVITY AND CERTAIN QUALITY CHARACTERISTICS

By
*Samia A. El-Fahhar and ** B.M. Abou El-Magd
* Plant Pathology Dept. of Sugar Crops
** Physiology and Chem. Dept of Sugar Crops
Sugar Crops Res. Institute, ARC, Giza, Egypt

ABSTRACT

Screening and distribution as well as disease severity of powdery mildew incidence in different growing sugar beet governorates i.e., Kafr El-Sheikh, Gharbia and El-Dakhalia. was done on district level for the cultivated varieties Disease severity (%) of powdery mildew ranged between 25.5 to 62.8 % in Kafr El-Sheikh governorate. While in Gharbia governorate it ranged between 19.8 to 28.4 %. While at El-Dakahlia governorate, it was 47.75, which gave the highest average among all governorates. Different varieties i.e. Sultan, Ras Poly, and Kawamira recorded the highest incidence of powdery mildew, while, the lowest incidence as obtained by Glorius, cv.

Greenhouse experiment was carried out at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt during 2006/2007 season. Two sugar beet cultivars representing two extremes of susceptibility to powdery mildew disease were selected. The two cultivars; Glorius and Sultan were grown in a split plot design with three replicates.

Artificial inoculation was done by using conidiospores suspension of *Erysiphe polygoni*. Each cultivar was grown in a plot of 2x3 m. Different characters were recorded starting from 90 days from sowing until maturity with 15 days intervals to study the effect of powdery mildew disease on invertase activity, chlorophyll content in leaves, root weight and sugar yield as well as Na+, K+, α-amino N on leaves, reducing sugars, recoverable sugar (%) and sugar loss to molasses in roots.

Disease severity % of powdery mildew disease was increased under infected than non-infected plots. Sultan cv. was more susceptible than Glorius cv. Root weight, TSS%, sucrose and purity (%) showed significant differences under inoculated and non inoculated plant samples. Chlorophyll content decreased by increasing disease severity (%), invertase enzyme gradually increased until harvest. Na, α-amino N, while K+ content behave in opposite way either on leaves and/or roots. Reducing sugars, recoverable sugar as well as sugar loss to molasses (%) were affected by disease incidence that they increased in roots by increasing disease severity under infected and non-infected conditions.

INTRODUCTION

Powdery mildew disease caused by *Ersiphe polygoni* DC, is a serious disease in arid climates of the Middle East, the Soviet Republics of Central Asia, Europe and South-Western USA Mukhopadyay,(1987). Severe epiphytotics are infrequent in Northern USA or Western European countries or in the temperate zones of USA. Egypt environmental conditions help the fungus to spread rapidly specially in the late sowings after September. Weltzien (1963) renamed the fungus *E. betae* on the specificity of the fungus to *Beta* species. Powdery mildew is probably the next most significant disease of sugar beet, after virus yellows infections, the disease can reduce sugar yields up to 20%. Asher (1986) reported that, disease severity of the fungus (*E. polygoni*) can affect enzymatic activity and some related quality characters. The enzymes of importance for the processor are those which lead to sugar loss, breakdown of the beet tissues or color formation. acid invertase is involved in sugar loss during processing. Koltz (1999) reported that the major enzymes involved in sucrose catabolism are invertase and sucrose synthitase. The enzymes occur in plants as a number of different isoenzymes. Invertase catalyzes the hydrolysis of sucrose to glucose and fructose. Most leaf beet diseases lead to lower sugar content Vukov, (1977), juice purist from diseased plants will therefore be lower than from healthy plants, the non-sugars or another chemical compounds do change, for example, Oldfield *et al.* (1977) found a doubling of amino nitrogen in plants infected with virus yellow compared with uninfected plants. There is a report of viral and fungal diseases increasing the content of reducing sugars Vukov, (1977). Other changes in processing quality are dependent upon the timing of virus yellows and other fungal diseases infection Heijbroek, (1988). moreover in recent studies, Asher and Williams, (1991); Bayford, (1996) and Karaoglanidis and Karadimos, (2006) they found that under severe attacks of powdery mildew occur in southern Europe and north America, reduction in root yield may exceed 22 % and that of root sucrose may exceed 13 %, Francis *et al.* (2007), reported also that, powdery mildew is economically significant for sugar beet growers worldwide and can cause sugar yield losses of up to 30%. So, this study was undertaken to emphasize on the effect of powdery mildew incidence on yield loss, quality characters and the activity of invertase enzyme.

MATERIALS AND METHODS

Screening for powdery mildew incidence was done for sugar beet fields at Kafr El-Sheikh, Gharbia and El-Dakahlia Governorates according to Hills *et al.* (1980).

Greenhouse experiment was performed at Sakha Agricultural Research Station, Sakha, Kafr El-Sheikh, Egypt during 2006/2007 season. Two sugar beet cultivars i.e. Glorius and Sultan were selected which representing the two extremes of resistance and susceptibility. The two cultivars were grown in a split plot design. Cultivars were allocated in the main plots. Inoculated plants as well as non inoculated plots were devoted to sub-plots. Three replicates were used in this experiment. The greenhouse plots were constructed from cement with diameters of 2 meter width and 3 meter length. Each cultivar was cultivated in rows 20 cm between hills and cultivated in rows.

Artificial inoculation was done 60 days after sowing by using a spore suspension of conidiospores of *Erysiphe polygoni* DC. Spore collected by rinsing symptomatic leaves with 0.1% Tween 20 into a volumetric flask (1 liter), the same method was adopted by Francis *et al.* (2007). Inoculum was sprayed at a rate of 40 x 10^3 conidiospores. Plastic sheets were put between plots to prevent movement of spores from inoculated lots to non-inoculated ones. Seven readings were recorded, and seven samples were collected, the first sample was taken just before inoculation to measure all studied traits as follow:

- Disease severity (%) was recorded according to the scale assessment of powdery mildew incidence of Hills *et al.* (1980).
- Root weight (kg/ plant) the two central ridges of each plot were estimated in Kilograms.
- Percentage of sugar was determined according to Carruthers and Oldfield (1960).
- Gross sugar yield was calculated by multiplying root yield by sugar %.
- Percentage of sugar loss to molasses and recoverable sugar percentagewere determined according to the following equation adopted by Reinfield *et al* (1974).

  Sugar loss % = 0.343 (K + Na) + 0.094 (α-amino-N) -0.31.

  Recoverable sugar % = pol - [.343 (K+Na) +0.094(α-amino-N) + 0.29]
- Reducting sugar content was determined as described by A.O.A.C. (1990).
- Invertase enzyme activity (unit/100 g root/hour) was determined according to the procedure stated by Vukov (1962) in leaves and roots.
- Impurities in roots and leaves such as sodium (Na+), potassium (K+) and alpha amino nitrogen (α-amino-N) (milliequivalents / 100 g beet) were determined according to the method described by Williams (1984).

- Total soluble solids percentage (TSS %) were determined in fresh root for each cultivar using hand refractometer (McGinnis, 1982).
- Total chlorophyll content of leaves was measured in mg by using chlorophyll meter (SPAD-502), (Yoshida et al., 1976).
- Percentage of purity was calculated by dividing sucrose (%) by total soluble solids % according to Carruthers and Oldfield (1960).

- Loss percentage (sucrose and root yield) =

$$\frac{\text{Protected} - \text{infected}}{\text{Protected}} \times 100$$

- The first reading of disease incidence was taken after one month from inoculation as described by Whitney, (1989), and the other readings were taken every 15 days until maturity (last reading).

Data were statically analyzed according to Gomez and Gomez (1983).

RESULTS AND DISCUSSION

Data presented in Table 1, show the distribution and disease severity (%) of powdery mildew on sugar beet cultivars grown in Kafr El-Sheikh, Gharbia and El-Dakahlia governorates. Disease severity (%) of powdery mildew ranged from 25.5 for Glorius cv to 62.8 % for sultan cv in Kafr El-Sheikh Governorate, with an average of 37.14. While in Gharbia Governorate, disease severity was ranged from 19.8 for Glorius to 28.4% for Peta Poly, with an average of 27.3%. In El-Dakahlia Governorate disease severity was higher (47.75%) than those of the other two governorates.

Table (1): Distribution and disease severity (%) of powdery mildew disease on sugar beet plants grown in different Governorates during 2006-2007 growing season.

Governorate	District	Variety	*Disease severity (%)
Kafr El-Sheikh	Sidi-Salem El-Hamoul El-Read Desouk Beiala Fowa Kafr El-Sheikh Metobis Sakha Research Farm	Glorius Kawamira Top Pleno Ras Poly Ras Poly Sultan Glorius Ras Poly	25.5 37.5 40.7 33.9 35.9 31.2 62.8 28.3 38.6
	-	-	37.14**
Gharbia	Kotour El-Mahlla Tanta	Peta Poly Glorius Pleno	28.4 19.8 24.1
	-	-	27.3**
El-Dakablia	Dekernes Belkas	Ras Poly Top	35.8 59.7
	-	-	47.75**

* According to Hills *et al.* (1980).
** Average of disease severity (%)

Data in Table 2, show the effect of powdery mildew disease severity % on certain traits i.e. root weight, TSS%, sucrose % and purity %, of two sugar beet cultivars; Glorious and Sultan grown in a greenhouse. From the data obtained in Table 1, severity % of powdery mildew disease under artificial inoculation showed that there was significant difference among the 7 readings for the two sugar beet cultivars. It is clear from the obtained data that disease severity % of Sultan cv. was higher than those obtained in Glorious cv. throughout the age of plants. However, the inoculated plants were higher in their disease severity % than those of the non-inoculated plants Table (2). Also, it is obvious that disease severity percentages

Table (2): Effect of disease severity (%) of powdery mildew incidence on different traits under artificial inoculation of two sugar beet cultivars during 2007/2008 season.

Cultivar (V)	*Scoring (reading) (R)	**Disease severity (%)		Root weight (kg)		TSS (%)		Sucrose (%)		Purity (%)		Losses (%)	
		Inoculated	Non-inoculated	Inoculated	Non-inoculated	Inoculated	Non-inoculated	Inoculated	Non-inoculated	Inoculated	Non-inoculated	Root weight	Sucrose
Glorius	1-	0	0	0	0. 350	0	4.61	0	3.39	0	73.54	0	0
	2-	0.6	0	0. 400	0. 510	7. 29	6.32	4.50	5.02	61.73	79.43	19.60	10.36
	3-	1.9	0.1	0. 573	0. 756	9. 30	9.64	6.21	7.60	66.77	78.84	23.60	18.29
	4-	3.5	0.4	0. 588	0. 740	10. 58	10.82	7.30	8.95	69.00	82.72	24.50	18.44
	5-	7.3	0.8	0. 615	0. 835	13. 60	15.95	9.85	13.25	72.43	83.07	26.34	25.66
	6-	18.9	2.5	1. 050	1. 550	13. 41	19.87	9.69	15.68	72.26	78.91	32.25	38.20
	7-	25.7	4.6	1. 142	1. 730	12. 20	21.90	7.71	16.89	63.20	77.12	33.98	54.35
	8-	43.5	11.7	1. 180	1. 830	11. 60	24.40	6.64	18.62	57.24	76.31	35.51	64.34
Sultan	1-	0	0	0	0. 300	0	4.40	0	2.89	0	65.68	0	0
	2-	2.3	0.1	0. 410	0. 542	4. 68	5.84	4.00	4.72	64.53	80.82	24.35	15.04
	3-	6.5	0.3	0. 545	0. 785	7. 09	8.46	4.88	6.87	68.83	81.20	30.50	28.96
	4-	14.3	0.9	0. 488	0. 860	7. 71	10.03	5.42	8.31	70.30	82.85	42.36	34.78
	5-	25.10	1.6	0. 510	0. 992	11. 92	13.66	9.40	11.36	78.77	83.16	48.23	17.34
	6-	48.9	5.8	0. 650	1. 410	11. 21	14.57	7.77	10.95	69.31	75.15	53.90	29.04
	7-	62.5	12.9	0. 678	1. 681	9. 87	14.27	4.09	9.88	41.44	69.23	59.66	58.60
	8-	80.8	21.3	0. 312	1. 680	8.50	12.49	2.02	8.20	18.71	65.65	80.36	75.36
L.S.D. 0.05 a		2.16		0.120		1.27		1.78		1.67		1.87	
L.S.D. 0.05 b		1.46		1.116		1.11		1.51		1.59		1.39	

* Started at 90 days from sowing until harvest with 15-days intervals

** caused by *Erysiphe polygoni* DC

a 2 varieties at each of treatments

b 2 Treatments at each of V x R

increased gradually by increasing the age of the plants. Root weight in kg/plant for inoculated and non-inoculated plots increased gradually and then declined before harvest for the two tested cultivars inoculated with the fungus. These data agree with the other reports of Frate *et al.* (1979) and Hills *et al.* (1980).

Total soluble solids percentages and purity (%) were highly affected by disease severity percentages of powdery mildew incidence under both inoculated and non-inoculated plots. TSS% and purity (%) recorded higher values for Glorius than Sultan cultivar. Moreover, the trend of the data increased up to the fifth reading (after 135 days from sowing) and then declined again because of high disease incidence. The obtained data were in closely agreement with those obtained by Hills (1983).

As a result of infection by powdery mildew of sugar beet, sucrose percentages were affected too much for the two sugar beet cultivars in inoculated plots. Sultan cultivar was highly affected than Glorius cv. Sucrose % sharply decreased after inoculated compared to the non-inoculated plots. These results agree with the other reports and results which obtained by Frate *et al.* (1979), who reported that the yield losses of 20-30% in gross sucrose can occur when sugar beet powdery mildew is not controlled. The other reports also agreed that the yield loss and severity of disease were strongly correlated Hills *et al.* (1980) and Hills (1983).

Data in Table(3) show that invertase activity, it is of a great importance for sugar transformation and plays a rule in sugar losses, moreover, impurities are increasing due to disease incidence Vukov, (1977).

Moreover, Vukov and Hangyal (1985) pointed out that pathological processes, such as mechanical damage, wilting, freezing and microbiological damage, greatly add to invert sugar accumulation via enzymatic reactions, as shown from the data in Table 3, it is clear that values of the enzyme activity were higher under inoculated rather than non-inoculated plants. The enzyme activity for Glorius is less than that of Sultan cultivar because of the degree of susceptibility by powdery mildew disease. However, Leight *et al.* (1979) mentioned that high sucrose was associated with low activity of acid-invertase in the vacuoles of beet tissue.

The equimolar mixture of glucose and fructose, referred to as "invert sugar", is obtained from sucrose by acid or enzyme (invertase) hydrolysis:-

$$\underset{342\ g}{\text{Sucrose}} + \underset{18\ g}{\text{water}} \xrightarrow{\text{Acid or enzyme}} \underset{180\ g}{\text{glucose}} + \underset{180\ g}{\text{fructose}}$$

As reported by many investigators glucose and fructose are not principal reducing sugar in sugar beet but the reducing sugar galactose is also present. Whilst sucrose is quit stable under normal processing conditions, glucose, fructose and galactose having reactive free carbonyl groups, are not. For that, reducing sugar is an undesirable quality parameter because:-

1- At the basal level in beet it breaks down in carbonatation to yield acids and some colour .
2- At higher level, it represents sugar lost and greater acid and colour production.

From this point of view , determination of reducing sugar in sugar beet roots represents an important factor for acceptance or rejection. Sucrose will be inverted to glucose and fructose sugars by the aid of acid enzyme Burba and Nitzschke, (1973). There are also reports of substantial increase in inverted sugar caused by downy mildew Vukov, (1977) and particularly noticeable increase in other impurities Pollach, (1984a) and Bertuzzia and Zavanella, (1988). All reports agreed with the obtained results under this study.

Data also show that sodium concentration (Na^+) was affected by disease severity (%) of powdery mildew and behaved in the same trend of disease severity (%) since it increased by increasing disease severity (%) as shown in Table (3). Under inoculated conditions Na^+ increased sharply than

Table (3):Effect of disease severity (%) of powdery mildew disease incidence on enzyme activity Na+, K+ and α-amino-N and some other quality characters in root of two sugar beet cultivars under artificial inoculation during 2007/2008 season.

Cultivar (V)	*Scoring (reading) (R)	**Disease severity (%)		Enzyme activity (unit/100 g/hour)		Na+		K+		α-amino N		Reducing Sugar %		Recoverable sugar (%)		Sugar loss to molasses (%)	
		Inoculated	Non-inoculated	Inoc.	Non-inocu.	Inoc.	Non-inocu.	Inoc.	Non-inocu.	Inoc.	Non-inocu.	Inoc.	Non-inocu.	Inoc.	Non-inocu.	Inoc.	Non-inocu.
Glorius	1-	-	0	2.4	2.1	0.10	0.10	7.95	5.85	1.15	1.15	0.10	0.100	0	0.95	3.18	1.84
	2-	0.7	0	2.5	2.2	1.18	0.13	7.26	5.28	2.60	1.32	0.131	0.119	1.08	2.76	2.82	1.66
	3-	1.9	0.1	2.8	2.4	1.26	0.24	6.86	4.95	2.69	1.54	0.172	0.130	2.89	5.38	2.72	1.62
	4-	3.5	0.4	3.3	2.5	1.31	0.41	6.18	3.65	2.78	1.81	0.261	0.138	4.18	7.10	2.52	1.25
	5-	7.3	0.8	3.9	2.8	1.43	0.60	5.94	2.83	2.93	2.32	0.416	0.145	6.76	11.56	2.49	1.09
	6-	18.9	2.5	5.8	2.9	1.59	0.78	5.61	1.91	3.17	2.41	0.640	0.180	6.63	14.24	2.46	0.84
	7-	25.7	4.6	7.2	3.1	1.71	0.96	3.32	1.12	3.30	2.50	0.710	0.235	5.39	15.65	1.72	0.64
	8-	43.5	11.7	8.4	3.8	1.93	1.10	0.87	0.87	3.48	2.64	0.851	0.274	5.06	17.41	0.98	0.61
Sultan	1-	0	-	2.3	2.2	0.36	0.36	9.39	7.31	1.38	1.38	0.10	0.109	0	0	3.16	2.45
	2-	3.5	0.1	2.8	2.3	1.28	0.43	8.83	6.24	2.70	1.59	0.140	0.125	0	1.99	3.41	2.13
	3-	6.5	0.3	3.3	2.4	1.30	0.61	8.24	5.97	2.85	1.75	0.179	0.134	1.05	4.16	3.23	2.11
	4-	14.3	0.9	4.2	2.7	1.47	0.87	7.95	5.38	2.96	1.92	0.280	0.155	2.19	5.70	3.20	2.01
	5-	25.10	1.6	6.8	3.1	1.95	0.98	7.61	4.01	3.15	2.41	0.442	0.182	5.51	9.13	3.27	1.63
	6-	48.9	5.8	9.9	3.8	2.14	1.10	6.81	3.83	3.49	2.53	0.685	0.226	4.08	8.73	3.09	1.62
	7-	62.5	12.9	11.9	4.6	2.65	1.35	3.62	2.05	3.65	2.69	0.987	0.271	1.31	8.12	2.18	1.16
	8-	80.8	21.3	12.8	4.9	2.89	1.56	1.12	1.12	3.81	2.90	1.468	0.340	0	6.72	1.42	0.88
L.S.D. 0.05 a		2.16		1.22		0.73		0.56		0.49		0.125		1.18		0.46	
L.S.D.0.05 b		1.46		0.99		0.59		0.81		0.33		0.119		1.13		0.31	

* Started at 90 days from sowing until harvest with 15-days intervals

** caused by *Erysiphe polygoni* DC

a 2 varieties at each of treatments

b 2 Treatments at each of V x R

those under non inoculated ones for the two cultivars Glorius and Sultan.

The opposite trend was obtained with K^+ content in roots as shown in Table (3). This means that K^+ content in root decreased by increasing the disease severity for both cultivars. Similar results were obtained by Pollach (1984) and Bertuzi and Zavanella (1988).

Sodium and potassium ions play an important role on physiological equilibrium condition in cellular solution for sugar contents of sugar beet yield.

Regarding to α-amino nitrogen, the obtained data show that it increases with the increase of disease severity under non inoculated conditions. Also there were significant differences between the 7 readings for the two cultivars; Glorius and Sultan. Also, sodium, potassium and α-amino nitrogen are quantitatively and qualitatively important because they are the major non-sugar components in sugar beet roots quality.
The nitrogenous compounds in sugar beet roots especially those containing α-amino nitrogen have a highly deleterious effect on juice purification and sucrose crystallization Jensen *et al.*, (1983); Dutton and Tumer, (1984); Armstrong and Milford, (1985)and Marcussen, (1985).

Reducing sugars increased gradually under infected plots for Glorius cultivar and ranged from 0.131 to 0.851 %, while it ranged between 0.140 to 1.468 % for Sultan sugar beet cultivar. High values of reducing sugars under non inoculated plots (0.100 and 0.109 for Glorius and Sultan, respectively especially 60 days from sowing because at this stage plants still at vegetative stage and the sugar concentration is high at this stage then start to decline.

How ever clear cut trend showed under non-inoculated plots for both cultivars.

Recoverable sugar (%), increased by increasing disease severity (%) of powdery mildew under inoculated and non inoculated plots for the two tested sugar beet cultivars, obtained throughout the 7 readings from inoculation up to harvest.

Sugar loss to molasses (%) under inoculated plots increased by increasing disease severity (%) for the two tested sugar beet cultivars as shown in Table (3). Besides reducing root yield, the disease also seriously affected the potential recovery of extractable sugar. This effect resulted from both the reduced sucrose concentration and the increased NH_2-N and NA concentrations of roots of the affected plants. The combined effects of these root-quality factors reduced juice purity, which is the ratio of sucrose concentration to total soluble solids Skoyen *et al.* (1975).

As shown in Table (4), Glorius and Sultan cvs., chlorophyll content of leaves reached its maximum levels at 75 days plant age, then declined after words in both inoculated lots, chlorophyll content was highly affected because powdery mildew infection decreased photosynthetic activity, than on leaves under inoculated or non-inoculated conditions increased by increasing disease severity (%) of powdery mildew, however, Sultan cv. has a higher values than Glorius cv, under both conditions.

Data in Table (4) also show that Na^+ content of leaves was affected by disease severity (%) of powdery mildew and correlated with the increasing of disease severity (%). Na^+ content of leaves increased sharply in inoculated than those under non inoculated conditions, for the two cvs. Glorius and Sultan.

K^+ it content showed different trend than Na^+ content. K^+ level decreased by increasing disease severity under both inoculated and non-inoculated conditions.

Invertase activity increased gradually by increasing disease severity of powdery mildew incidence Table (4) under inoculated and non-inoculated conditions for both sugar beet cvs. Glorius and Sultan. As mentioned before by Leight *et al.*

Table (4): Effect of disease severity (%) of powdery mildew disease incidence on chlorophyll content, enzyme activity, Na+, K+ and α-amino-N in leaves of two sugar beet cultivars under artificial inoculation during 2007-2008 season.

Cultivar(V)	*Scoring (reading) (R)	**Disease severity (%)		Chlorophyll content (mg/gm)		Enzyme activity (unit/100 g/hour)		Na+		K+		α-amino N	
		Inoculated	Non-inoculated	Inoculated	Non-inoculated	Inoculated	Non-inoculated	Inoculated	Non-inoculated	Inoculated	Non-inoculated	Inoculated	Non-inoculated
Glorius	1	0	0	31.9	30.6	1.80	1.10	1.70	1.70	2.89	2.19	2.14	2.14
	2	0.7	0	41.6	40.5	1.88	1.15	1.76	1.64	2.83	2.28	2.18	2.09
	3	1.9	0.1	68.1	75.8	2.10	1.20	1.83	1.56	2.76	2.32	2.23	2.02
	4	3.5	0.4	55.3	63.2	2.47	1.25	1.94	1.50	2.71	2.37	2.30	1.95
	5	7.3	0.8	48.5	60.4	2.92	1.40	2.02	1.44	2.66	2.40	2.36	1.91
	6	18.9	2.5	40.9	58.3	4.35	1.45	2.23	1.38	2.63	2.49	2.49	1.85
	7	25.7	4.6	32.3	52.7	5.40	1.85	2.30	1.31	2.61	2.54	2.56	1.79
	8	43.5	11.7	24.8	45.3	6.30	2.90	2.95	1.23	2.59	2.99	2.67	1.71
Sultan	1	0	0	33.3	33.19	1.60	1.30	1.92	1.92	2.98	2.11	2.27	2.27
	2	3.5	0.1	48.4	50.1	1.93	1.35	1.98	1.86	2.95	2.23	2.33	2.21
	3	6.5	0.3	65.2	78.23	2.29	1.452	2.02	1.80	2.89	2.31	2.38	2.16
	4	14.3	0.9	50.6	72.8	2.90	1.60	2.11	1.74	2.84	2.40	2.46	2.10
	5	25.10	1.6	41.5	65.3	4373	1.83	2.18	1.68	2.80	2.46	2.51	2.04
	6	48.9	5.8	31.4	55.8	6.90	2.24	2.27	1.61	2.75	2.52	2.58	1.96
	7	62.5	12.9	23.2	47.5	7.27	2.72	2.38	1.58	2.69	2.57	2.66	1.90
	8	80.8	21.3	18.8	42.9	8.90	4.10	2.49	1.50	2.63	2.63	2.73	1.81
L.S.D. 0.05 a		2.16		1.51		1.09		0.49		0.47		0.39	
L.S.D.0.05 b		1.46		1.32		0.98		0.40		0.37		0.28	

* Started at 90 days from sowing until harvest with 15-days intervals

** caused by *Erysiplie polygoni* DC

a 2 varieties at each of treatments

b 2 Treatments at each of V x R

(1979) high increase was associated with low activity of acid-invertase in the vacuoles of beet tissues.

REFERENCES

A.O.A.C. (1990). Official Methods of Analysis. Association of Official Analysis Chemists, 15th, Ed. Washington, 25 DC, USA.

Armstrong, M.J. and G.F.J. Milford (1985). The nitrogen nutrition of sugar beet the background to the requirement for sugar beet yield and amino-N accumulation. Brrit. Sugar Beet Rev.: 53: 42-44.

Asher, M.J.C. (1986). The occurrence and control of sugar beet powdery mildew. Aspects of Applied Biology. 1986, No. 13. 131-137.

Asher, M.J.C. and Williams, G.E. (1996). Forcasting, epidemiology and Control of powdery mildewin sugar beet. In: 59th International Institute of Beet Research (IIRB)conference. Pp. 83-93

Bertuzzi, S. and M. Zavanella (1988). Determinazione di K, Na, acoto alfa-aminico in zuccherificio. IMplicazioni technologiche ed agronomiche. L'Industria Succarifera Italian, 81, 135-8.

Burba, M. and U. Nitzschke (1973). Glucose, fructose, galacetose. Undraffinose. Zucker, 1256: 356-58.

Byford,W.J. (1996). A survey of foliar diseases of sugar beet and their control in Europe In; 59th International Institute of Beet Research (11RB) conference. Pp : 1-10.

Carruthers, A and J.E.T. Oldfield (1960). Methods for assessment of beet quality. Int. Sugar. J., 63: 72-74.

Dutton, J. and F. Tumer (1984). Correcting excessive use of nitrogen, amino-N measurements. Brit. Sugar Beet. Rev. 52: 15-17.

Francis, A. Sally; Brett, C. Roden; Michael, J. Adams; John, Weiland and Michael, C. Asher.(2007), Comparison of ITS sequences from UK and North American sugar beet powdery mildews and the designation of *Erysiphe betae*. Mycological Research ııı, 204-212.

Frate, C.A. Leach, L.D. and Hills, F.J. (1979). Comparison of fungicide application methods for systemic control of sugar beet powdery mildew. Phytopathology. 69, 1190-4.

Gomez, K. and A.C. Gomez (1983). Statistical procedures for Agricultural Research, International Rice Research Institute, Book. John Wiley and Sons. New York. pp. 403.

Heijbroek, W. (1988). The effect of virus yellows on yield and processing quality. In virus yellows Monograph, International Institute of Sugar Beet Research, Brussels, pp. 27-35.

Hills, F.J. (1983). Disease thresholds and increases in fall sucrose yield related to powdery mildew of sugar beet in California. Plant Disease Vol. 67. N. 6.

Hills, F.J.; L. Chiarappa and S. Geng (1980). Powdery mildew of sugar beet: Disease and Crop Assessment. Phytopathology. Vol. 70, No. 7: 680-682.

Jensen, V.; C. Mareussen and E. Smed (1983). Nitrogen for sugar beet in Denkmark, research and it s utilization. The Danish sugar cooperation Maribo, Hoeby. Denmark, Tech. paper. 1-12.

Karaoglanidis, G. S. and D. A. Karadimos. (2006), Efficacy of strobilurins and mixtures with DMI fungicides in controlling powdery mildew infield – grown sugar beet. Crop protection . 25977-983.

Koltz, K.L. (1999). Contribution of invertase and sucrose synthase isoenzymes to sucrose losses in sugar beet. Proceedings from the Biennial Meeting Agriculture, Orland. Florida.

Leight, R.A.; T. Rees; W.A. Fuller and J. Bomfield (1979). The location of acid invertase activity and sucrose in the vacuoles of storage roots of beet root (*Beta vulgaris*). Biochemical Journal, 178,539-47.

Marcussen, C. (1985). Amino N figures as used in Denamark. Brit. Sugar Beet Rev. 53(4): 46-48.

Mc Ginnis, R. A. (1982). Beet sugar technology 3rd edn. Beet sugar Development Foundtion for Collins.855pp.

Mukhopadhyay, A.N. (1987). Handbook on diseases of Sugar Beet. Vol. I.CRC. Press, Boca Raton, Florida, 196 pp.

Oldfiield, J.F.T.; M. Shore; J.V. Dutton; B.J. Houghton and H.J. Teague
(1977). Sugar beet quality-factors of importance to the UK Industry. International Sugar Journal. 79, 37-43, 67-71.

Pollach, G. (1984). Development and ultisation of quality criteria for sugar beet in Austria. Paper presented to the 27th Technical Conference. British Sugar Plc. 22 pp.

Reinfeld, E.; Emmerich; G. Baumarten; C. Winncer and U. Beiss (1974). The sugar beet crop. Cooke, D.A. and R.K. Scott, 2nd Ed. Chapman and Hall, London, U.K. 239-278.

Skoyen, I.D.; R.T. Lewellen and J.S. MeFarlane (1975). Effect of powdery mildew on sugar beet. Production in the Salinas Valley of California. Plant Disease Reporter. Vol. 59, No. 6, 1975.

Vukov, K. (1962). Die mechanischen Eigenschaften der zuckerrubenwurzel. In the technological value of the sugar beet. Proceedings of the XIth Session f the Commission International Technique de Sucrerie, Elseveir, Amsterdam, pp. 291-305.

Vukov, K. (1977). Physics and chemistry of sugar beet in sugar manufacture. El-Sevier. Amesterda,. 595 pp.

Vukov, K. and K. Hangyal (1985). Sugar beet storage. Sugar Technology Reviews, 12, 143-265.

Weltzien, H.C. (1963). Erysiphe beta (Vanha),Comb. Nov., the Powdery Mildew of Beets. Phytopathol. Z. 47: 123-128.

Whitney, E.D. (1989). Beta maritime as a source of powdery mildew resistance in sugar beet. Plant disease. 73: 487-489.

William, S. (1984). Methods No. 3045 in Official Methods of Analysis. 14th ED. Association of Official Analysis Chemists. Washington, Virginia, U.S.A.

Yoshida, S.; D. Forno;J. Cock and K. Gomez(1976). Laboratory Manual for Physiological studies of Rice. 3rd ed. Pp.83.IRRI, los Banos, Philippines, P.O. Box 933, Manila. philippines.

الملخص العربى

تأثير الإصابة بمرض البياض الدقيقى على النشاط الإنزيمى وبعض صفات الجودة فى بنجر السكر

*سامية عبده الفحار - **باسم مصطفى أبو المجد
* قسم بحوث أمراض المحاصيل السكرية
** قسم بحوث الفسيولوجى والكيمياء
معهد بحوث المحاصيل السكرية - مركز البحوث الزراعية - الجيزه - مصر

أجرى هذا البحث عام ٢٠٠٦/٢٠٠٧، ٢٠٠٧/٢٠٠٨ذلك بهدف دراسة مدى تأثير الاصابة بمرض البياض الدقيقى على التركيب الكيماوى وبعض صفات الجودة ونشاط انزيم الانفرتيرز فى اوراق وجذور بنجر السكر.

ولقد تم فى عام ٢٠٠٦/٢٠٠٧ عمل حصر وتقييم لاصناف البنجر المنزرعة ببعض المراكز بمحافظات كفرالشيخ والغربية والدقهلية وذلك لمعرفة حجم الاصابة بمرض البياض الدقيقى على الاصناف المختلفة وتم اختيار صنفين هما جلوريا وسلطان وتراوحت الاصابة فى محافظة كفرالشيخ بين ٢٥,٥ الى ٦٢,٨ % وفى محافظة الغربية كانت نسبة الاصابة بين ١٩,٨ إلى ٢٨,٤ % بينما فى محافظة الدقهلية كانت نسبة الاصابة ٤٧,٧٥ % وكانت الاصناف سلطان وراس بولى وكواميرا اعلى اصابة عن الصنف جلوريا.

وفى موسم ٢٠٠٧/٢٠٠٨م أجرى البحث بمحطة بحوث سخا الزراعية - كفرالشيخ تحت ظروف العدوى الصناعية لدراسة تأثير الإصابة بمرض البياض الدقيقى على النشاط الإنزيمى وبعض صفات الجودة فى بنجر السكر ، وتم استخدام صنفان هما جلوريا وسلطان حيث يختلفان فى درجة الإصابة بالمرض ، وأجريت التجربة فى الصوبة تحت ظروف العدوى الصناعية بمعلق الجراثيم الكونيدية للفطر من فطر الـ اريسايف بوليجونى *Erysiphe polygoni* DC وتم زراعة التجربة فى قطاعات منشقة فى ثلاثة مكررات وكل صنف تمت زراعته فى حوض ٢ x ٣م وتم إجراء العدوى بعد ٦٠يوم من الزراعة وتم أخذ أول قراءة بعد شهر من العدوى. ومع كل قراءة تؤخذ عينة للتحاليل وقد أخذت اول عينة للتحليل قبل العدوى مباشرة أما باقى القراءات بفاصل زمنى ١٥ يوم حتى قبل الحصاد وتم تقدير النسبة المئوية للشدة المرضية ووزن الجذر ونسبة المواد الصلبة الذائبة والسكر والنقاوة ، وتم تقدير بعض الصفات وأهمها نسبة الكلوروفيل ونشاط إنزيم الإنفرتيز وأيونات الصوديوم والبوتاسيوم وكمية السكر

المفقود إلى المولاس وذلك تحت ظروف العدوى الصناعية بالمقارنة بالكنترول (بدون عدوى صناعية).

وأوضحت النتائج أن الشدة المرضية بالبياض تزداد تحت ظروف العدوى وكانت شدة الإصابة بالصنف سلطان أعلى (٨٠,٠٨%)، وهناك اختلافات معنوية تحت ظروف العدوى الصناعية لكل من وزن الجذر والنقاوة وهذا يرجع إلى تأثير زيادة الشدة المرضية.

وأوضحت النتائج أيضا أن محتوى الأوراق من الكلوروفيل يقل بزيادة الإصابة أما بالنسبه لإنزيم الإنفرتيز الذى يقوم بدور رئيسى فى تحول السكروز الى سكريات احادية يزيد نشاطه بزيادة الشدة المرضية. وبالنسبه للصفات التكنولوجية الأخرى مثل الصوديوم والبوتاسيوم وألفا - أمينو نيتروجين والسكريات المختزلة ونسبة السكر المستخلص ونسبة السكر المفقود فى مولاس ، فإن هناك اختلافات معنوية بين الأصناف والقراءات وتزداد قيم هذه المقاييس بزيادة الشدة المرضية.