STUDIES ON SUGAR BEET RUST DISEASE IN EGYPT

I: DISEASE CONTROL AND SOME VITAL ACTIVITIES OF INFECTED SUGAR BEET PLANTS GROWN UNDER GREENHOUSE CONDITIONS

By

El-Fiki, A.I.I.[1]; Mohamed, F.G.[1] and El-Mansoub, M. M.A.[2]

[1] Department of Agric. Botany, Fac. of Agric., Benha University, Egypt.

[2] Plant Pathology Res., Institute Agric. Res. Center, Giza, Egypt.

ABSTRACT

Five isolates of *Uromyces betae* **Tul Kick**. were isolated from five governorates (Domyat, Kafr El-sheikh, Dakahliy, Gharbiya and Beheira). Vitality of urediospores, stored at 2-5ºC, was decreased gradually by increasing storage until approximately loss completely after 210 days. The loss in vitality was clearly varied between the five tested rust isolates. Younger sugar beet plants of Raspoly cultivar (30 and 60 days old) were resistant and susceptibility increased to rust infection at 90 and 120 days old than at 180-days old.

Concerning disease control, rust infection completely suppressed on plants sprayed with optimum concentration of fungicide Sumi-eight whether 24 hours before or after inoculation. Sumi-8 followed by 0.3% garlic extracts and 300 ppm of IAA weather 48 hours before or after inoculation and came to the second and third ranks, respectively after Sumi-8. Sugar beet cultivars tested showed different susceptible reactions against artificial inoculation and could be categorized as less susceptible (LS), moderate susceptible (MS) and high susceptible (HS).

Rusted leaves of all tested sugar beet cultivars contained lower photosynthetic pigments, sugars and total amino acids and higher phenols as well as higher activities of oxidative enzymes in comparison with their healthy leaves. The infected leaves of Lola and Raspoly (HS cvs.) showed the highest increase in activities of oxidative enzymes in comparison with Farida and Golria (LS cvs.) while the opposite trend was detected concerning photosynthetic pigment, reducing sugars and phenols contents.

Keywords: Rust, *Uromyces betae*, Vitality, Sugar beet, Cultivars, fungicides, plant extracts, growth substances, oxidative enzymes, pigments, sugars, phenols, amino acids.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is one of the important sugar crops in the world. The beet rust caused by *Uromyces betae* was first observed in Canada in 1935 when it occurred on sugar beet plots at two stations in British Columbia. Since 1935, this rust has been present yearly in the Saanichton district, where it attains great severity in early spring and late autumn **(Newton and Peturson, (1943)**. Since that time, the disease occurred widely and considered as one of the most problems affecting sugar beet production **(EL-Helaly**, *et al.,* **1966; Ali**, *et al.,* **1972** and **Mehiar** *et al.,* **1977**; **O'Sullivan, 1996** and **Siucra, 2004)**.

The sugar beet rust (*U. betae*) caused reduction in root size and sucrose content **(Smith and Martin**, **1978** and **Lamey, 1997)**. Many investigators extensively studied chemical control of rust disease using fungicides **(Mueller** *et al.***, 2005)**; plant extracts **(El-Kazzaz** *et al.***, 2003** and **Mahmoud, *et al.*, 2004)** and plant growth regulators **(Fayza** *et al.***, 2004** and **Zalat** *et al.,* **2004).** Great attention has been paid to use an integrated disease management approach for controlling sugar beet rust disease through utilization of resistant cultivars, minimizing fungicides application and looking for an alternative options to decrease the human health hazards **(Ramadan and Nassar, 2005)**.

The present studies aimed to evaluate some sugar beet cultivars, systemic fungicides, plant extracts and growth substances for their effect on rust disease incidence under greenhouse conditions. Effects of storage on vitality of urediospores, plant age and some of biochemical changes associated with rust infection were also investigated.

MATERIALS AND METHODS

The following laboratory and greenhouse experiments were carried out at Plant Pathology Department, Sugar Crops Research Institute, Agricultural Research Center, Giza whereas, field experiments were conducted at Sakha Agricultural Research Station, Kafr El-Sheikh governorate, Egypt.

1- Effect of storage on vitality of *Uromyces betae*-urediniospores:

Five collections (isolates) of rust urediospores (*Uromyces betae*) were trapped, using a battery powered spore collector **(Peterson *et al.*, 1957),** from heavily rusted leaves of sugar beet plants grown at Kafrsaad (Domyat), El-Hamol (Kafr El-sheikh), Belkas (Dakahliy), Bassioun (Gharbiya) and El-Rehmania (Beheira). Spores for each isolate were dried separately in desiccators for at least 18 hours and stored at 2-5ºC according to **Sackston (1960)**. After storing spores of a known isolate for 0, 60, 90, 120, 180 and 210 days, spore suspension (10^4spores/ml) was made from each storage treatment then sprayed onto 100-days old plants of the highly susceptible sugar beet cv. Raspoly grown in 50cm diameter pots under greenhouse conditions at 20 ± 2 °C and 95 -100 % relative humidity adjusted by a digital hygrometer (Legrand 037Micro). Five replicates were used for each particular treatment. The disease assessment was carried out in term of number of uredia pustules/leaf counted 12-14 days after inoculation then spore vitality (SV) was determined according to the following formula.

$$SV\ \% = \frac{\text{Number of pustules/leaf in particular storage period}}{\text{Number of pustules/leaf formed by fresh spores}} \times 100$$

2-Effect of plant age:

Seeds of sugar beet (Raspoly cv.) were sown monthly (in pots) along 6 months to get plants of 30, 60, 90, 120, 150 and 180 days old. All plants, at different ages, were sprayed simultaneously by fresh urediniospores (10^4 urediniospores /ml) collected from the abovementioned locations. Disease assessment was recorded after 12-14 days from inoculation as mean number of pustules/leaf.

3- Disease control under greenhouse conditions:

3-a- Effect of fungicides:

This experiment was conducted to determine the optimal fungicide having the ability to control rust infection under greenhouse conditions. Plants of sugar beet cv. Raspoly (100 days old) were sprayed with one of the following fungicides (at its recommended dose) i.e. Eminent (1.0ml/l), Caramba (1.0ml/l), Plantvax (1.0ml/l), Impact (1.0ml/l), Saprol (1.0ml/l), Anvil (0.25ml/l) and Sumi-8 (0.35ml/l). Spraying with fungicide was made 24 hours before or after spraying (inoculation) plants with spore suspension containing fresh urediospores of *U. betae* isolate-A (10^4spores/ml). The control plants were sprayed with water. Inoculation and incubation procedures were carried out as previously mentioned. Data were recorded in terms of number of pustules per leaf 14 days after inoculation.

3-b - Effect of plant extracts:

This experiment was conducted to evaluate effect of different plant extracts on infection of sugar beet cv. Raspoly with the sugar beet rust disease caused by *U. beta*e. Leaves of thyme (*Thymus vulgaris*) eucalyptus (*Eucalyptus* sp.), Black nightshade (*Solanum nigrum*) and Christmas berry tree (*Schinus terebenthifolius*), cloves of garlic (*Allium sativa*), and flowers of toothpick weed (*Ammi visnaga*) were extracted according to **Managamma** and **Srevamulu (1991)**. A series of concentrations of each plant extract (0.1%, 0.2% and 0.3%) were prepared from the crude extract and sprayed, using hand sprayer, onto sugar beet plants 48 hours before or after inoculation with fresh urediniospores of *U. betae* (10^4spores/ml). Inoculation and incubation were performed as mentioned before. Each treatment had three replications. Disease severity was estimated as a number of pustules/leaf after 14 days from inoculation.

3-c- Effect of plant growth regulators:

In this experiment, 70 days old sugar beet plants (Raspoly cv.) were sprayed until complete coverage with certain concentrations (100, 200 and 300 ppm) of the growth regulator

substances indole acetic acid (IAA), naphthalene acetic acid (NAA) and gibberellic acid (GA3). Spraying with growth substances was performed 48 hours before or after inoculation with fresh urediniospores of *U. betae* isolate-A (10^4spores/ml). Plants sprayed with water served as control. Disease severity as affected by tested treatments was estimated as a number of pustules per leaf after 14 days from artificial inoculation.

3-d- Evaluation of sugar beet varietal resistance:

In this study seeds of the sugar beet cultivars namely Gloria, Toro, Top, Raspoly, Kawmeia, Gazail, Nagma, Lola, Farida, and Pleno were sown in sterilized potted soil (pots 50cm ϕ) at rate of 5 seeds/pot. Three replicates were used for each cultivar. Pots were kept under greenhouse conditions and irrigated regularly. Four weeks later, seedlings were thinned to 2 plants/pot. After 100 days from sowing, the plants were sprayed with spore suspension containing fresh urediospores (10^4 urediospores/ml) of *U. betae* isolate-A (isolated from Kafr-Saad, Domiate). The inoculated plants were kept for 28 hours in completely dark moist chamber with a water-saturated atmosphere then transferred to normal greenhouse conditions, under continuous high-output fluorescent lamps. Sugar beet plants left without inoculation were used as control. Plants were visually inspected 15 days post inoculation, looking for the presence of opened pustules. Assessment of disease severity was recorded as number of pustules/leaf.

4- Biochemical changes associated with infection with sugar beet rust disease:

After disease assessment in the above study, the fourth leaf from the top of plant) were detached from control plants (healthy) as well as the inoculated plants of Farida and Gloria (as LS cvs.) and Kawmeia, Lola and Raspoly (as HS cvs.). Some healthy and rusted leaves from each cultivar were immediately used to determine the photosynthetic pigments (Chlorophyll a, Chlorophyll a, b and carotenoids) according to **Wettestien (1957)**. The rest of leaf samples (healthy and infected) were used to determine their phenol contents **(Bray and Thrope**, **1954)**, sugars content **(Shaffer and Hartmann, 1921** and **A.O.A.C., 1985)**, total amino acids **(Rosen, 1957)** and the oxidative enzymes i.e. peroxidase **(Allam and Hollis, 1972)**, catalase **(Maxwell and Bateman, 1967)** and polyphenoloxidase "PPO" **(Matta and Diamond, 1963)**.

RESULTS and DISCUSSION

1- Effect of storage period on vitality of *Uromyces betae*-urediniospores:

Data in **Table (1)** reveal that the vitality of rust spores of the different tested spore rust collections (isolates) was decreased to different extents as storing period of these spore collections increased from 60 to 210 days comparing with the fresh spores in control treatments. The highest reduction in spore vitality after storing spores for 180 days was associated with isolate-A (22.8%) followed by isolate-E (30.0%), isolate-D (40.2%), isolate-C (48.1%) and isolate-B (56.3%), respectively. After storage for 210 days, isolate-E shows the highest vitality (6.0%) followed by isolates D, C, B and A (1.3%), respectively. Thus, the negative effect of storage on vitality of urediniospores was increased as storage period increased. Degree of vitality losses was based on source of spore collection (rust isolate). This reduction in spore vitality might be due to continuing respiration during storage and this will be lead to exhaustion of the energy substances necessary to spore germination, consequently vitality of stored urediospores well be gradually decreased

2-Effect of plant age on development of rust disease:

Data in **Table (2)** indicate that no rust infection due to any tested rust isolate was observed on the 30 and 60 days old sugar beet plants. However, the rust infection was clearly appeared on the 90-days old plants and increased progressively till plants aged 150 days then decline with increasing age to 180 days. The disease assessment in term of number of pustules/leaf was significantly affected by plant age, rust isolate as well as the interaction in between. The 90 and 120 days old plants seems to be more susceptible to rust infection more than those of 180-days old. At all susceptible plant ages, the rust isolate A was the most virulent followed by isolates B, C, D and E, respectively with statistical differences between any two isolates at any plant age. These results could supported by **Shaik (1985)** who found that, the

successful inoculation and infection correlated with the age of the leaf at the time of inoculation. **Ata, (2005)** found also that, artificial inoculation revealed that plants of 90 to 150-day old were suitable for the course of infection. One hundred and five-day old plants showed the highest infection which gradually decreased by aging. Young plants (30-60 old) were not susceptible.

Table (1): Percentage of urediniospores vitality for five *U. betae* suspension isolates stored at different periods on Raspoly sugar beet cultivar and measured as number of pustules/leaf.

Storing period (Days)	Percentage vitality					Mean
	Isolate (A)	Isolate (B)	Isolate (C)	Isolate (D)	Isolate (E)	
0 d	100.0	100.0	100.0	100.0	100.0	100.0
60 d	91.8	92.4	92.9	91.8	92.1	92.2
90 d	72.9	78.0	77.1	76.9	76.5	77.6
120 d	55.8	74.4	71.9	68.8	69.4	72.4
150 d	38.1	69.3	70.9	71.6	69.6	69.8
180 d	22.8	56.3	48.1	40.2	30.0	47.5
210 d	1.3	2.8	3.4	4.3	6.0	4.5
Mean	47.1	62.2	60.7	58.9	57.3	60.7

Table (2): Relationship between age of sugar beet plants (cv. Raspoly) and infection with different isolates of *U. betae*.

Plant age (days)	Number of pustules/leaf caused by different rust isolates					Mean
	Isolate (A)	Isolate (B)	Isolate (C)	Isolate (D)	Isolate (E)	
30	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0
90	124.7	121.0	117.7	115.7	114.0	118.6
120	167.3	158.7	144.3	134.0	122.3	145.3
150	169.0	155.0	144.0	134.7	125.7	145.6
180	122.3	102.3	87.7	75.3	69.3	91.4
Mean	97.2	89.5	82.3	76.6	71.8	---

LSD. at 5%	
Isolates (I)	0.359
Plant age (P)	0.898
I x P	1.796

3-Effect of certain systemic fungicides:

Data in **Table (3)** reveal that spraying sugar beet plants with fungicides 24 hours before rust inoculation was significantly better for decreasing number of rust pustules comparing with spraying them 24 hours after rust inoculation. Sumi-eight fungicide was the best of all as it completely prevent rust infection weather used 24 hours before or after inoculation. However, the fungicides Caramba, Plantvax and Eminenat used 24 hours before rust inoculation and Anvil used 24 hours after rust inoculation completely prevented rust infection also. These findings indicate that the fungicide Sumi-eight can be used at its recommended dose whether 24 hr before or after inoculation.

In fact, most fungicides were used as protectants and others as chemotheraputic agents. Several investigators recorded that the single spray with certain systemic fungicides at the first appearance of the rust disease symptoms on the sugar beet plants reduced the disease incidence by 70 % or greater when compared with unsprayed controls **(EPPO, 1994; O'Sullivan, 1996)**. **Sorensen and Marcussen (1996)** in Denmark obtained best control of beet rust *(Uromyces betae)* using Lyric (flusilazole) and Score (difenconazole). Corbel (fenpropimorph) has also shown good control. **Siucra (2004)** stated that sugar beet in Ireland is susceptible to the rust (*U. betae*). The disease is a major serious foliage disease but can be effectively controlled with a single chemical spray regime. In Egypt**,** the sugar beet rust appeared at the end of the season but

at low severity. **Ata (2005)** in Egypt, evaluated Caramba, Sumi-8, Score, Opus and Eminent fungicides to control the sugar beet rust disease under field natural infection at the recommend field dose when the disease first appears. Disease severity was markedly decreased as compared to the untreated control. Regarding fungicide efficacy, Eminent ranked first followed by Opus, both Score and Sumi-8 and Cramba.

Table (3): Effect of spraying sugar beet plants with different systemic fungicides before and after inoculation on average number of pustules on cv. Raspoly.

Used fungicide and conc.	24 hr before inoculation	24 hr after inoculation
Anvil (0.25 ml/l)	3.33	0.00
Caramba (1.0ml/l)	0.00	2.33
Eminenat (1.0ml/l)	0.00	2.38
Impect (1.0ml/l)	1.33	4.33
Plantvax (1.0ml/l)	0.00	3.33
Saprol (1.0ml/l)	2.33	5.33
Sumieight (0.35 ml/l)	0.00	0.00
Mean	1.00	1.33

LSD at 5%	
Time of spraying	0.040
Fungicides	0.115
Interaction	0.461

3-b. Effect of plant extracts:

Data in **Table (4)** reveal that pre-spraying (24 hr before rust inoculation) with any of the tested plant extracts was more effective for controlling rust infection on sugar beet plants (cv. Raspoly) than the post-spraying (24 hr after rust inoculation). Among tested extracts, Garlic (*Allium sativa*) and thyme (*Tymus vulgaris*) extracts, respectively were the most effective for minimizing numbers of rust pustules/leaf particularly when used at the highest concentration (0.3%). The toothpick weed (*Ammi visnaga*) extract was the least effective at both times of inoculation. Some of the tested plant extracts were reported as resistance inducer or inhibitors for spore germination (**Sarvamangala *et al.*, 1993** and **Hammouda *et al.*, 1999)**. **El-Kazzaz, *et al.* (2003)** reported that different extracts viz. *Ammi visnaga* and *Cumin cyminus* reduced the root rot of sugar beet as well as disease severity in the field and increased yield per plot. **Mahmoud *et al.* (2004)** stated that activities of peroxidase, catalase and pectinase in faba bean plants infected with *Botrytis fabae* were markedly reduced in healthy plants and changed widely under different biocontrol treatments (*Eucalyptus citriodora*, *Ipomoea carnea*, *Cuminum cyminum*, *Allium sativum* and *Hyoscyamus muticus* leaf extracts).

3-c. Effect of growth regulator substances:

Data in **Table (5)** reveal that number of pustules/leaf was significantly lower on sugar beet plants sprayed with growth substances 48 hr before than 48 hr after rust inoculation. Reduction in number of pustules/leaf decreased as concentration of a tested growth substance increased. The growth substance IAA was the most effective for decreasing number of pustules particularly when used at conc. of 200ppm or 300ppm before rust inoculation or 300ppm after rust inoculation comparing with any other treatment. The growth substances, in general, might affect the hormonal balance in the treated plant and this well be reflect on their reaction against infection with plant pathogens. **Saftner and Wyse (1980)** observed that sucrose transportation across the tonoplast on the sink cells apparently stimulated by the hormones IAA and ABA. Also they stated that GA_3 and IAA affected sucrose uptake by sugar beet root tissue.

Table (4): Effect of spraying sugar beet plants with different concentrations of the crude plant extracts before or after artificial rust inoculation on average number of rust pustules/leaf for sugar beet cv. Raspoly.

Plant extracts	48 hr before inoculation			48 hr after inoculation		
	0.1%	0.2%	0.3%	0.1%	0.2%	0.3%
Allium sativa	14.7	12.3	12.7	20.7	19.3	18.3
Ammi visnaga	33.0	31.7	30.3	38.0	37.3	35.7
Eucalyptus globbulus	22.0	21.7	19.7	30.7	29.3	28.3
Schinus terebenthifolius	30.3	28.3	26.7	37.0	36.3	35.3
Solanum nigrum	26.3	24.7	24.0	33.7	33.7	32.7
Tymus vulgaris	20.3	19.7	17.7	24.7	27.3	26.0

L.S.D. at 5%	Before inoculation	After inoculation
Extracts "E"	0.218	0.185
Concentrations "C"	0.145	0.123
Interaction	0.873	0.740

Table (5): Number of pustules/leaf on sugar beet cv. Raspoly as affected by time of spraying with some plant growth regulators under greenhouse conditions.

	48 hr before inoculation			48 hr after inoculation		
Growth substance	100 ppm	200 ppm	300 ppm	100 ppm	200 ppm	300 ppm
GA3	18.0	18.0	16.3	21.3	20.3	19.0
IAA	12.3	11.3	11.0	17.3	18.3	16.7
NAA	15.3	14.3	13.3	20.3	19.3	18.7
Mean	15.20	14.53	13.53	19.63	19.30	18.13

LSD at 5% for:	Before inoculation	After inoculation
Substances	0.46	0.41
Concentrations	0.48	0.75
Interaction	1.46	1.28

3-d- Varietal resistance:

Data presented in **Table (6)** show that, all sugar beet cultivars tested were susceptible to different extents with *U. betae* and could be categorized as follow. The sugar beet cvs. Farida, Gloria, Top and Toro considered as less susceptible. (LS cvs.) as they showed the lowest average numbers of pustules/leaf, respectively. Meanwhile, Negma, Gazail and Pleno classified as moderate susceptible (MS cvs.) Raspoly, Lola and Kawmeia cvs., on the other hand, were highly susceptible (HS) The difference between any two of these cultivars was significant. The variations in reaction of tested sugar beet cultivars against rust infection could be attributed to their genetic background and metabolic activities. As shown below, the photosynthetic pigments (chlorophyll a and chlorophyll b and carotene), sugar contents (reducing, non-reducing and total sugars) and total amino acid contents were higher in the less susceptible than the high susceptible sugar beet cvs. These constituents might play an important role in reaction of plants against rust infection.

4- Effect of infected sugar beet plants by *U. betae* on some biological and biochemical activities:

After disease assessment in the above study, samples of healthy and rusted leaves were detached from plants of Farida and Gloria (as LS cvs.) and Kawmeia, Lola and Raspoly (as HS cvs.) and subjected to the following studies.

4-a- Photosynthetic pigments:

Data in **Table (7-A)** indicated that, amounts of the photosynthetic pigments (chlorophyll a and chlorophyll b and carotene) were lower in the infected leaves than the healthy ones. This trend was true in all tested sugar beet cvs. The highest reduction (change) in any photosynthetic pigment was reported in infected leaves of the HS cvs. (Lola, Raspoly and Kawmeia) followed

by the LS cvs. (Farida and Golria), respectively. The occurrence of changes in leaf color as a result of infection by most diseases was proved by many investigations. The chlorophyll pigment plays an important rule in metabolic activity in the plant extremely affected by disease incidence. **Wood (1967)** stated that striking changes in the amount and distribution of photosynthetic pigments resulted from the infection by obligate parasites. He added that loss in photosynthetic pigments occurred in most diseases at early stages of growth. Also, obtained results are similar to those reported by **Bala and Dhillon (1987)** and **EL-Kholi (1995)**.

Table (6): Evaluation of ten sugar beet cultivars towards infection with *U. betae* (isolate-A).

Cultivars	Number of pustules/leaf	Descriptive disease response
Farida	60.3	LS
Gazail	113.7	MS
Gloria	74.0	LS
Kawmeia	141.0	HS
Lola	162.0	HS
Negma	106.0	MS
Pleno	131.3	MS
Raspoly	175.0	HS
Top	84.0	LS
Toro	89.8	LS
L.S.D. at 5%	1.25	

Table (7-A): Effect of infection with sugar beet rust disease on the chlorophyll a&b and carotene contents (mg/g fresh weight) in healthy (H) and infected (I) leaves of different sugar beet cultivars.

Cultivar	Chlorophyll (a)			Chlorophyll (b)			Carotene		
	H	I	* Increase %	H	I	* Increase %	H	I	* Increase %
Farida	1.49	1.19	20.13	0.67	0.64	4.48	0.49	0.48	2.04
Gloria	1.35	1.04	22.96	0.61	0.58	4.92	0.47	0.45	4.26
Kawmeia	1.30	0.89	31.54	0.55	0.50	9.09	0.35	0.31	11.43
Lola	1.39	0.75	46.04	0.41	0.32	21.95	0.39	0.23	41.03
Raspoly	1.13	0.63	44.25	0.43	0.36	16.28	0.31	0.25	19.35

4-b- Activity of oxidative enzymes:

Data in **Table (7-B)** indicated that activities of oxidative enzymes (peroxidase, polyphenoloxidase and catalase) were higher in infected than in healthy leaves. **Goodman *et al.* (1967)** stated that, the disease development was closely correlated with a markedly increase in the major phenol oxidizing enzyme activities in infected tissues, such as peroxidase and polyphenoloxidase. Regardless infection, the highest activities of the oxidative enzymes were found in leaves of the LS sugar beet cvs. (Farida and Golaria) followed by the HS cvs. (Kawmeia, Lola and Raspoly), respectively. The highest rate of increase in enzyme activity due to infection i.e. (Healthy – Infected / Healthy x 100) was in the HS cvs., followed by the LS cvs., respectively. Thus, the highest increase (%) in activity of peroxidase (22.4 & 21.7%), polyphenoloxidase (44.3 & 47.6%) and catalase (30.8 & 32.6%) were detected in the rusted leaves of the HS cvs Lola and Raspoly, respectively. Similar findings were recorded by **Johnson and Cunningham (1972)**. **Barakat *et al.* (1979)** indicated that the activity of oxidative enzymes has increased in sugar beet leaves infected with *Erysiphe betae*. The activity of these enzymes decreased in leaves with 100% infection. The changes in peroxidase activity in wheat cultivars, expressing different level of leaf rust resistance, were studied also by **Southerton and Dcveral (1990)**. They found that the increment in peroxidase activity was greater during resistance expression than in susceptible infected leaves. **Moustafa Nabila (2000)** estimated the activity of peroxidase and polyphenol oxidase enzymes in plants of barely (cv. Giza 124). A

considerable increase was found in barely plants due to the artificial inoculation with the causal pathogen of powdery mildew in comparison with uninoculated leaves. Moreover, the activity of polyphenoloxidase enzyme was lowered than that of peroxidase enzyme.

Table (7-B): Activities of peroxidase, polyphenoloxidase and catalase (optical density/minute/gram fresh weight) in leaves of sugar beet as affected by rust infection.

Cultivar	Oxidative enzymes								
	Catalase			Polyphenoloxidase			Peroxidase		
	H	I	* Increase %	H	I	* Increase %	H	I	* Increase %
Farida	0.482	0.561	16.4	0.288	0.389	35.1	0.694	0.883	27.2
Gloria	0.470	0.553	17.7	0.271	0.372	37.3	0.681	0.865	27.0
Kawmeia	0.439	0.521	18.7	0.238	0.336	41.2	0.627	0.813	29.7
Lola	0.405	0.493	21.7	0.206	0.304	47.6	0.574	0.761	32.6
Raspoly	0.420	0.514	22.4	0.221	0.319	44.3	0.598	0.782	30.8

$$* \text{ Increase } \% = \frac{\text{Value in healthy (H) - Value in infected (I)}}{\text{Value in healthy (H)}} \times 100$$

4-c- Phenols content:

Data in **Table (7-C)** show that the amounts of free, conjugated and total phenols were higher in infected leaves of all tested cultivars than their healthy leaves. The highest phenol contents, in general, was detected in healthy and infected leaves of the LS cvs. (Farida and Golria) followed by the HS cvs. (Kawmeia, Lola and Raspoly), respectively. These results are parallel to those reported by **Saber (1993)** who reported that free, conjugated and total phenols were higher in pea plants inoculated with powdery mildew than in uninoculated ones.

Table (7-C): Effect of infection with sugar beet rust disease on phenol contents (mg/g fresh weight) in leaves of sugar beet plants.

Cultivar	Free phenols		Conjugated phenols		Total phenols	
	Healthy	infected	Healthy	infected	Healthy	infected
Farida	56.0	68.6	157.1	166.4	213.1	234.8
Gloria	51.4	61.9	149.7	153.1	201.0	215.0
Kawmeia	45.8	53.1	139.4	147.7	185.2	200.9
Lola	34.9	43.2	138.2	136.4	173.1	179.5
Raspoly	39.1	48.1	134.5	141.1	173.5	189.2

4-d- Sugars content:

Data in **Table (7-D)** indicated that the reducing, non-reducing and total sugar contents were obviously lower in rust infected leaves than the healthy one. This reduction could attributed to the increment of respiration that occurred in the infected tissue. This trend was true in all tested cultivars. However, both healthy and infected leaves of the the LS cvs. (Farida and Gloria) contained higher sugars content than the corresponding leaves of the HS cvs. (Kawmeia, Lola and Raspoly). The infected leaves of the HS cv. Lola showed the highest reduction in the reducing sugars in comparison with infected leaves of other tested cultivars. These results could supported by several investigators. **Sindhan *et al.* (1996)** studied the biochemical changes in leaf extracts of resistant and susceptible cultivars of wheat and triticale, following inoculation of seed with teliospores of *Urocystis agropyri*. Both total and reducing sugars were higher in healthy leaves of resistant varieties than the susceptible ones. The concentrations of both sugars were reduced in infected leaves of all the tested varieties. **Hussein-mamdouha (1999)** concluded that total, reducing and non-reducing sugars were higher in healthy leaves of barely

than in mildewed ones.

Table (7-D): Effect of infection with sugar beet rust disease on reducing, non-reducing and total sugar contents in healthy and rust infected leaves of different sugar beet cultivars.

Cultivar	Sugar contents					
	Reducing		Non-reducing		Total sugars	
	Healthy	Infected	Healthy	Infected	Healthy	Infected
Farida	12.5	11.9	18.0	17.1	30.5	28.9
Gloria	13.2	12.6	15.6	15.5	29.9	28.1
Kawmeia	12.0	10.5	15.5	13.9	27.5	25.4
Lola	11.6	2.3	14.5	12.2	25.1	14.5
Raspoly	10.5	8.0	17.0	14.0	25.4	23.9

4.e. Amino acids content:

Data in **Table (7-E)** demonstrated that, the total amino acids content was higher in healthy and infected leaves of the HS cvs. than the corresponding leaves of the LS cvs. However, the infected leaves of the LS cvs., particularly cv. Farida showed the highest increase in the total amino acids content (86.5%) compared with the healthy leaves of the same cv. Similar trend was observed by **Smith and Martin (1978)** who indicated that infection with *Cercospora beticola* increased amino nitrogen and total nitrogen and decreased total sucrose yield and purity of sugar beet juice. **Omar *et al.* (1987)** found that the younger plants of faba bean contained higher amounts of amino acids. Infection with *B. fabea* increased amino acid contents at early stages of plant growth in all varieties tested. **Mahmoud (1992)** showed that the total free amino acids content was higher in diseased than in healthy leaves of faba bean. Also, *Vicia faba*, Ibe susceptible cultivar contained higher levels of total free amino acids than the moderate susceptible.

Table (7-E): Effect of infection with sugar beet rust disease on total amino acids contents (mg/g fresh weight) in leaves of sugar beet plants.

Cultivar	Total amino acids (mg/g fresh weight)		* Increase %
	Healthy leaves	Infected leaves	
Farida	3.19	5.95	86.5
Gloria	4.59	7.26	58.2
Kawmeia	5.15	7.99	55.1
Lola	5.75	8.75	52.2
Raspoly	5.52	8.56	55.1

$$* \text{ Increase } \% = \frac{\text{Value in healthy (H) - Value in infected (I)}}{\text{Value in healthy (H)}} \times 100$$

REFERENCES

Ali, M.D. H.; Morsy, A.A. and El-Sherief, M.A. 1972. Survey of Agriculture Research in Egypt, (1900-1970). The Academy of Scientific Research and Technology**.** Volume 1 (Plant Pathology) 489 pp. (In Arabic).

A. O. A. C., Association of official Analytical chemists 1985. Official methods analysis of the association of official analytical chemists Washington, 25.D.C.USA.

Allam, A.I. and Hollis, S.P. 1972. Sulfide inhibition of oxidase in rice root. *Phytopathology*, 62: 634-636.

Ata, A.A. 2005. Studies on sugar beet rust disease in Egypt. *M.Sc. Thesis*, Fac. Agric. Sci. Assiut University, pp 124.

Bala, M. and Dhillon, M.C. 1987. Chlorophyll content of Cercospora infected ground nut leaves in susceptible and resistant varieties. *Ann. Appl. Biol*., 3(3): 61-63.

Barakat, F.M.; Ahmed, I.; Fahim, M.M. and El-Hamalawi, Zeineb, A. 1979. Changes in phenols, oxidative enzymes, chlorophyll and carotenoids in sugar beet leaves infected with *Erysiphe betae*. *3rd Egypt. Phytopathol. Con*. 838-852.

Bray, H.G. and Thrope, W.V. 1954. *Analysis of phenolic compounds of interest metabolism methods of chemical Analysis*, 27-51.

El-Helaly, A.F.; Ibrahim, I.A.; Assawah, M.W.; Elarosi, H.M.; Abo El-Dahab, M.K.; Michail, S.H.; Abdel-Rahim, M. A.; Wasfy E.H., and El-Goorani, M.A. 1966. General Survey of Plant Diseases and Pathogenic Organisms in U.A.R.(Egypt) until 1965.*Alexandria Univ. press*, Alexandria, Egypt.

El-Kazzaz, M.K.; El-Assiuty, E.M.; Badr, M.M.; El-Zahaby, H.M. and Gouda, M.I. 2003. Effect of some plant extracts and essential oils on controlling sugar beet root rot disease caused by *Sclerotium rolfsii*. (Under Publication).

El-Kholi, M.M. 1995. *Cercospora beticola* Sacc. and its affect on sugar beet plants. *Egypt. J. Agric., Res.*, 73(4): 1035-1045

EPPO 1994. Guideline on good plant protection practices: principles of good plant protection practice for beet. EPPO (European and Mediterranean Plant Protection Organization) Standard PP 2/1 (1) *Bulletin OEPP/EPPO Bulletin* **24**, 233-240.

Fayza, M.A. EL-Taweel; Abou EL-Magd, B.M. and Abou Shady, KH.A. 2004. Response of some sugar beet cultivars to growth regulator treatments. *J. Agric. Sci., Mansoura Univ.*, 23 (10): 5501 - 5511, 2004

Goodman R.N.; Kualy, Z. and Zaitin, M. 1967. The Biochemistry and Physiology of Infections Plant Disease. D. Van Nostrand Company. Inc., Toronto, New York.

Hammouda, A. M.; Abdel-Moneim, I.; Haifaa, S. Abdel-Ghani and Heweidy, M. A. 1999. Induced resistance in faba bean against rust disease by using natural products . *Egypt. J. Appl. Sci*., 14 (4).

Hussein, (Mamdouha) M.M. 1999. Advanced studies on barely powdery mildew disease in Egypt. *Ph.D. Thesis, Fac. Agric., Zagazig Univ.* 142 pp.

Johnson, L. B. and Cunningham, B. A. 1972. Peroxidase activity in healthy and leaf-rust infected wheat leaves. *Phytochemistry*, 11: 547:551.

Lamey, A. 1997. Sugar beet disease control. *Sugar beet Research and Extension Reports*, 28, P: 269-272.

Mahmoud, T.M.M. 1992. Studies on leaf spots of field bean *(Vicia faba* L.). *M.Sc Thesis, Fac. Agric., Moshtohor, Zagazig Univ., Egypt.*

Mahmoud, Y.A.G.; Ebrahim, M.K.H. and Magda M. Aly 2004. Influence of Some plant extracts and microbioagents on some physiological traits of faba bean infected with *Botrytis fabae*. *Turk J Bot*, 28 (2004) 519-528

Matta, A. and Dimond, A.E. 1963. Symptoms of Fusarium wilt tomato stems. *Phytopathology*, 53: 574-587.

Managamma, P. and Srevamulu, A. 1991. Garlic extract inhibitory to growth of *Xanthomonas campestris* pv. *Vesicatoria*. *Indian Phytopathology*. 44(3): 372-374.

Maxwell, D.P. and Bateman, D.F. 1967. Changes in the activities of some oxidases in extracts of Rhizoctonia infected bean hypocotyle in relation to lesion maturation. *Phytopathology*, 57: 132-136.

Mehiar, F.F.; El-Kazzaz, M.K. and El-Khadem, M.M. 1977. The occurrence of sugar beet rust in Egypt. *Egypt J. Phytopathology*, 9 : pp. 85-86**.**

Moustafa, Nabila, A.R. 2000. Implication of certain physical and chemical treatments to improve disease resistance of barely to powdery mildew. *Ph.D. Thesis, Fac. Agric.*, Cairo Univ. 146 pp.

Mueller, D.S.; Jeffers, S.N. and Buck, J.W. 2005. Toxicity of fungicides to urediniospores of six rust fungi that occur on ornamental crops. *Plant Dis.* 89:255-261.

Newton, M. and Peturson, B. 1943. *Uromyces betae* in Canada**.** *Phytopathology*, 33, 10**.**

Omar, S.A.M.; Salem, (Dorreiah) E. and El-Gantiry, S.M.M. 1987. Methods for estimating microorganisms population in faba bean phylloplane. *The 2 the Nat. Conf. Pests and Dis. Veg. and Field Crops in Egypt; Ismailia*, Oct., 886-889.

O'Sullivan, E. 1996. Effect of fungicides on the incidence o rust disease, root yield and sugar content in sugar beet. *Irish Journal of Agricultural and Food Research*, 35(2): 159-164.

Peterson, L.G.; Gerhold, N.R. and Weinhold, A.R. 1957. Two methods of collecting rust urediospores in the field. *Plant Dis. Rep*., 41 : 973-974**.**

Ramadan B.S.H. and Nassar, A.M. 2005. Effect of Nitrogen fertilization on yield and quality of some sugar beet varieties. *Egypt. J. Agric. Res*, 82 (3).1243-1252.

Rosen, H. 1957. A modified ninhydrine colrimetric analysis for amino acids. *Arch, "p Biochem. Biophys.*, 67:1051.

Saber, M.M. 1993. Pathological and genetical studies on peas powdery mildew disease. *Ph.D. Thesis, Fac. Agric.*, Cairo Univ., Egypt.

Sackston, W.E. 1960. Studies on sunflower rust**.** 1 Longevity of urediospores of *Puccinia helianthi***.** *Car J. Bot*., 38 : 883-889**.**

Saftner, R.A. and Wyse, R.E. 1980. Alkali cations/sucrose co - transport in the root sink of sugar beet. *Plant Physiol*, 66: 884 - 889..

Sarvamangala, H.S.; Govindaiah, G. and Datta, R.K. 1993. Evaluation of plant extracts for the control of fungal diseases of mulberry. *Indian-Phytopathology*, 46: 4, 398-401.

Shaffer, P.A. and Hartmann, A.F. 1921. The iodometric of determination of copper and its use in sugar analysis. *J. Biol. Chem*., 45: 365.

Shaik, M. 1985. Race-nonspecific resistance in pea cultivars to races of *Uromyces appendiculatus* var *appendiculatus* and its correlation with leaf epidemic characteristics**.** *Phytopathology*, 75, 4, 478-481**.**

Sindhan, G.S.; Parashar, R.D. and Hooda, I. 1996. Relationship between biochemical parameters and flag smut resistance in wheat. *Indian J. Mycol. and Plant Pathol*., 26(3): 291-293.

Siucra 2004. Welcome to Irish Sugar Ltd. online. Irish Sugar Plc., Greencore Plc. Group. http://www.irish-sugar.ie

Smith, G.A. and Martin, S.S. 1978. Differential response of sugar beet culivars to Cercospora leaf spot disease. *Crop Sci*., 18: 39-42.

Sorensen, F. and Marcussen, C. 1996. Rust *Uromyces betae* in Denmark inoculum sources and effect on sugar beet yield**.** Institute International de Recherche Betteravieres Palais des congres, Bruxelles, Belgium 13-17 fevrier, 119-128.

Southerton, S.G. and Deverall, B.J. 1990. Changes in phenylalanine ammonia-lyase and peroxidase activities in wheat cultivars expressing resistance to the leaf-rust fungus. *Plant Pathol.*, 39:2, 223-230.

Wettestien, D.V. 1957. Chlorophyll Letal und form wechsel der plastiden Exp. Cel Res., 12:427.

Wood, R.K.S. 1967. *Physiological Plant Pathology*. Blackwell Scientific Publication *Ltd. Oxford and Edinburgh.*

Zalat, S.N.; M.M. Awad and El-Said Gomaa, A.M. 2004. Effect of some cultural practices on sugar beet seedlings**.** *Egypt. J. Agric. Res*, 82(3),1243-1252.

دراسات على مرضِ صدأ بنجر السكر في مصر

أولا : مقاومة المرضِ وتأثير بعض الأنشطة الحيوية فى نباتات بنجر السكر المصابة و النامية تحت ظروف الصوبة

عبد المنعم إبراهيم إسماعيل الفقى [1] ، فتحى جاد محمد [1] ، محمد عبد العاطى المنسوب [2]

[1] قسم النبات الزراعى – كلية الزراعة – جامعة بنها – مصر

[2] معهد أمراض النبات – مركز البحوث الزراعية – جيزة – مصر

الملخص العربى

أدى تخزين الجراثيم اليوريدية لعدد 5 عزلات مختلفة المصدر من الفطر يوروميسس بيتا عند درجات حرارة 2-5°م لمدة 60 يوما إلى فقد واضح فى حيويتها (تبعا لعدد البثرات التى تحدثها العدوى الصناعية على الورقة). هذا وقد تفاوتت العزلات فى مقدار الفقد فى حيوية جراثيمها كما زاد هذا الفقد تدريجيا بزيادة فترة تخزينها إلى أن فقدت الحيوية بصورة شبه كاملة بعد 210 يوما من التخزين. أظهرت النتائج أيضا عدم تكون بثرات الصدأ على أوراق نباتات بنجر السكر الصغيرة (بعمر 30 60 يوماً) بعد العدوى الصناعية وكانت النباتات أكثر قابلية للإصابة عند عمر 90 - 120 يوماً مقارنة بالعمر الأكبر (180 يوماً).

وبالنسبة لمقاومة المرض أظهرت النتائج أن رش النباتات بالمبيد "سومي-ايت) قبل أو بعد 24 ساعة من العدوى الصناعية قد أدى إلى منع كامل لتكون البثرات. كما أن رشها قبل أو بعد 48 ساعة من العدوى الصناعية بتركيز 0.3% من مستخلص الثوم أو 300 جزء فى المليون من منظم النمو اندول حمض الخليك إلى مقاومة فعالة لظهور البثرات وجاءا فى المرتبة الثانية والثالثة على التوالى بعد المعاملة بالمبيدات. كما أظهرت الدراسة أيضا أن جميع أصناف بنجر السكر تحت الدراسة كانت قابلة للإصابة بدرجات متفاوتة وطبقا لأعداد البثرات المتكونة على الورقة بعد العدوى الصناعية أمكن تجميع تلك الأصناف كما يلى: أصناف قليلة الإصابة (فريدة، جلوريا، توب و تورو) ، أصناف متوسطة الإصابة (نجمة، جزايل و بلينو) ثم أصناف شديدة الإصابة (راس بولي، ولولا و كاوميرا).

أظهرت النتائج احتواء الأوراق المصابة بالصدأ (فى جميع الأصناف المختبرة) على كميات أقل من صبغات البناء الضوئى والسكريات والأحماض الأمينية الكلية وكميات أكبر من المركبات الفينولية كما كان نشاط الإنزيمات المؤكسدة بها مرتفعا بالمقارنة مع الأوراق السليمة. هذا وقد أظهرت الأوراق المصابة فى حالة الأصناف (لولا و راس بولي) الشديدة القابلية للإصابة أعلى زيادة فى نشاط الإنزيمات المؤكسدة مقارنة بالأصناف الأقل قابلية للإصابة (فريدة و جلوريا) بينما لوحظ عكس ذلك بالنسبة لصبغات البناء الضوئى والسكريات المختزلة والفينولات.