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EFFECT OF NITROGEN FERTILIZER RATES AND DATE OF SOWING ON RUST DISEASE OF SUGAR BEET

BY

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ABSTRACT

This study was carried out during 2004/2005, 2005/2006, 2006/2007 and 2007/2008 seasons, at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt, to study the effect of nitrogen levels and date of sowing of sugar beet on disease incidence of rust disease caused by *Uromyces betae*. A general survey of sugar beet rust disease was carried out during 2004/2005 season in the four major sugar beet growing governorates, i.e. Kafr El-Sheikh, Gharbia, El-Dakahlia and Damietta. Data showed that Kafr El-Sheikh Governorate ranked the first for disease incidence followed by El-Dakahlia. Top cv. recorded the highest disease severity. Ten sugar beet cvs. were artificially inoculated in screenhouse during 2005/2006 season using urediospores suspension when the plants were 90 days old, compared with protected plants using Sumi-8 (35 cm^3/100 L). Disease severity %, chlorophyll content, root weight/plant, TSS%, sucrose %, and purity % were significantly increase under protected conditions for most of the cvs. Top cv. showed the lowest infection, while Pleno cv. was the highly infected one Top and Fareda cvs. gave good results for all the studied characters. In addition two experiments were conducted in the field to study the effect of nitrogen fertilizer levels (0, 90 and 120 kg urea/fed.) and date of sowing (Sept., 15, Oct. 15 and Nov. 15) on rust infection and some other related characters for sugar beet cvs. (Pleno, Ras Poly, Fareda and Top) during 2006/2007 and 2007/2008 seasons. The level of 90 kg urea/fed. gave good results for all studied characters followed by the protected plots. Regarding date of sowing and its relation to disease incidence of rust under three dates of sowing i.e. September 15th, October 15th, and November 15th, by using four sugar beet cvs. in the previous experiments. Split plot design was used also in this experiment. Data showed that there were significant differences between date of sowing and incidence of rust disease severity for the tested cvs. the least disease severity was obtained from the first date of sowing; September 15th for all cvs., while high disease severity values were obtained for the plants grown on November 15th. Under both protected or non-protected conditions. Significant differences were obtained for root weight and TSS% for the three dates of sowing and the four cvs. sucrose (%) was high when grown on September 15th for all cvs. tested, while it recorded the least when sown on November 15th. Purity % was affected also by dates of sowing. In general loss % either in sucrose or in root were less when sown on September 15th, while, it recorded the highest when sown on November 15th, AUDPC behaved the same as loss% of sucrose and root yield, increased by delaying the date of sowing.

INTRODUCTION

Symptoms of rust disease caused by *Uromyces betae* consists of small rust orange-yellow pustules surrounded by chlorotic haloes scattered over both leaf surfaces, sometimes, occurring in clusters. Late summer symptoms consist of darker brown, more eventually spread pustules. The disease usually occurs too late in the season and

reduces yields of root crops but it is more of a problem in the seed crop (Parry, 1990). This disease was recorded by Mehiar *et al.* (1977), in Egypt. Moreover, El-Fahhar (1997) observed the rust disease in a vast area of Kafr El-sheikh Governorate in the northern part of the delta. Rust disease in not only causing losses for root and sucrose content, but also decreases purity of the juice derived from diseased roots (Smith and Martin, 1978). Moreover, sucrose loss due to rust disease could be reached to 30% in recoverable sucrose is fairly common under moderate disease conditions. Beet rust is controlled by the use of partially resistant varieties, supplemented with fungicides. It could be easily become more important in future years of weather patterns change in summers and autumns (Francis, 1999, Lamey, 1997). Nowadays in Egypt, sugar beet cultivation is spreading, so, it must be focused on all foliage diseases such as rust, which became spreading over.

Such disease is favored by temperatures around 18°C and may be reached to damaging levels late in the season. Severe attacks can cause yield losses up to 15% for root yield and 10% of sugar content (EPPO, 1994) in Egypt Ata *et al.* (2005), reported that significant differences were recorded between healthy and diseased plants concerning root weight, sucrose %, purity, root weight, sucrose % and quality were reduced parallel to disease severity. Consequently, sugar recovery was reduced due to the increase in non-sugar component, which impade sugar crystallization and finally white sugar yield. In general, the beet rust usually occurs too late approaching maturity (El-Sayed 2000).

Many studies proved an evidence of the occurrence of changes in leaf color as result of infection by most foliage disease including rust, this can affect the metabolic activity and reduce photosynthetic rate. Abnormalities in form and function of chloroplasts are a common feature of diseased tissues, so, there is a typically declining in photo-synthetic phosphorylation (Berghaus and Reisener, 1985 and McGrath and Penny Packer, 1990).

Studies on sugar beet rust must cover all aspects regarding sowing dates and fertilizers requirements as integrated factors to minimize disease severity as well spreading the disease in vast areas.

So, this study was undertaken to focus on date of sowing and fertilizers applied to some sugar beet cvs. and its relation to disease severity of rust disease under Egyptian conditions.

MATERIALS AND METHODS

This work was conduced at Sakha Agricultural Research Station during 2004/2005, 2005/2006, 2006/2007 and 2007/2008 seasons to make survey and evaluation of sugar beet cvs. against rust disease under both artificial and natural infection. Different steps were performed to test sugar beet cvs., as well as study the effect of rust disease on different traits.

1. Survey and distribution of rust disease:

Screening and survey of rust disease were done at Kafr El-Sheikh, Gharbia, El-Dakhlia and Damietta governorates in which sugar beet crop is mainly cultivated. Symptoms of *Uromyces betae* were recognize (Fig. 1) and classified according to modified scale adopted by Peterson *et al.* (1948). Survey was done during 2004/2005 season.

2. Screen house experiments:

Varietal screening was done under artificial inoculation in the screen house in micro plots to test the varietal reaction of sugar beet cvs. to *U. betae*. During 2005/2006 season, ten cvs. viz. Ras Poly, Top, Sultan, Kawamira, Pleno, Glorious, Fareda, Beta Poly, Pamela, and Lola, were tested. These microplots consist of cement plots of 2 meter width and 3 meter length. Each cv. was grown in the plot with spacing of 50 cm between rows and 20 cm between individuals plants within rows.

Fig. (1): Symptoms of rust (*Uromyces beta*) on sugar beet leaves of Pleno cv.

3. Varietal testing under artificial inoculation:

Plants were grown during the second half of November.

Inoculum preparation and inoculation methods:

During 2004/2005 urediospores were collected from the diseased plants and kept at refrigerator (2-5°C) to be used during 2005/2006 season for inoculation (Fig. 2). Urediospores were suspended in sterile tap water at concentration of 10^4 to 10^5 urediospores/ml and mixed with Tween 20 at rate of 25 ml liter, prior to plant inoculation (Sackston, 1962).

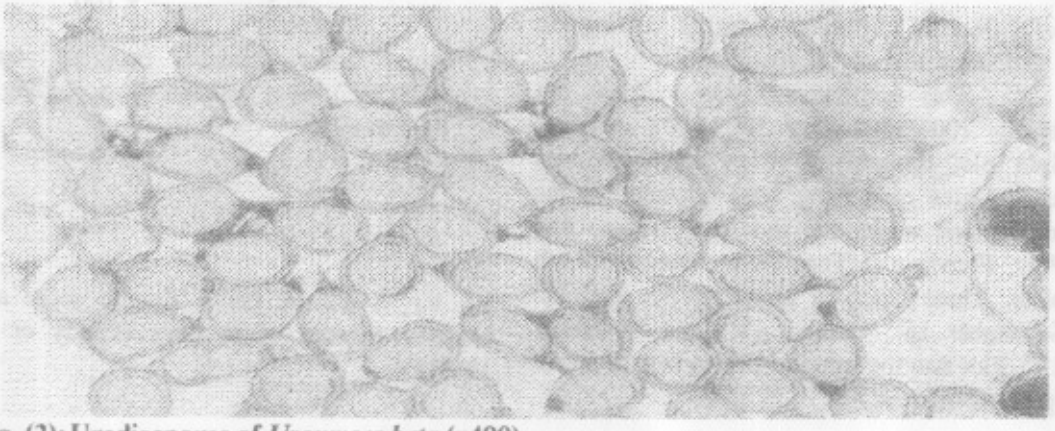

Fig. (2): Urediospores of *Uromyces beta* (x400)

Sugar beet plants 90 days old, grown in the screen house were used (3 rows/cv). Spraying the tested rows/plants with a suspension of urediospores (10^4 to 10^5/ml) with an automizer spores, like all beet rust spores, germinate on the plant surface and then grown down through the stomata (leaf pores) into the leaf tissue. So, inoculation after 90 days from sowing is the best to reach to the symptoms of the disease. Inoculated plants were kept wet under polyethylene sheets at 20 ± 2°C and 100% relative humidity for 36 hours in the screen house, after removing polyethylene, plants were daily examined for rust infection. Some plots were kept without inoculation and sprayed by Sumi-8 at a rate of 35 cm^3/100 liter of w[illegible] comparison.

4. Field experiments:

Two field experiments were conduced during 2006/2007 and repeated on 2007/ 2008 season for confirmation as follows:

a. Effect of different levels of nitrogen on disease incidence of rust disease:

Four cvs. were used i.e. Pleno, Ras Poly, (susceptible to rust disease), and Fareda and Top cvs. less sensitive to rust disease. Three levels of nitrogen as urea fertilizer (46.5%) were used i.e. 0, 90 and 120 kg/ feddan. One plot was left and sprayed with Sumi-8 as chemical fungicide for comparison, fertilizers were applied for this plot as recommended.

Split plot design was used, fertilizers were allocated in the main plot, while the cvs. devoted to sub-plots, three replicates were used. Date of sowing was fixed on the first week of November during the two seasons of 2006/2007 and 2007/2008. Each cv. was grown in a plot of 3x /7 m^2 (50 cm between rows and 20 cm between plants within the row). The first reading of disease severity just after appearing of the disease symptoms, 5 readings were recorded with 15 days intervals.

5. Effect of different dates of sowing on disease severity of rust disease:

This experiment was carried out during 2006/2007 and 2007/2008 seasons. Split plot design with three replicates was used. Dates of sowing were allocated in the main plots, while, the four cvs. (Pleno, Ras Poly, Fareda and Top) were assigned to sub plots. Three dates of sowing were used i.e. September 15th, October 15th, and November 15th. Plot size the same as previous experiment (plot size was 3x 7 m^2).

The following characters were recorded:

a. Disease severity: was estimated according to the scale of Peterson *et al.* (1948). This scale was used for determination and estimation of the infection of leaf rust on sugar bet plants. Score started one month after inoculation, five readings were taken with 15 days intervals. Symptoms develop from orange pustules approximately 1 mm in diameter, which break through the epidermis of the leaf (Fig. 1). Spores have spikey, spore walls (Fig. 2).

b. Root fresh weigh /plant: ten roots were randomly harvested and weighted for each cultivar in each treatment.

c. Total soluble solids (TSS): were determined in fresh roots by using hand refractometer (McGinnis, 1982).

d. Sucrose percentage: It was measured by saccarometer as mentioned by Le-Docte (1927).

e. Purity %: It was calculated by dividing percentage of sucrose on total soluble solids (TSS).

f. Chlorophyll content: Total chlorophyll content was determined in mg by using chlorophyll meter (SPAD-502).

g. Loss percentage (sucrose and root yield) = $\frac{\text{Protected - nonprotected}}{\text{Protected}} \times 100$

h. Area under disease progress curve (AUDPC), was calculated according to the formula:

$$AUDPC = D\left[\frac{1}{2}[(Y_1+Y_k)+(Y_2+Y_3)+...(Y_{1k-l})\right]$$

Where:

Y_1, Y_2 ... Y_l are the K disease score at a constant interval of D days (Pandy *et al.*, 1989).

RESULTS AND DISCUSSION

Distribution and survey of rust disease was severely done during 2004/2005 season in different governorates and districts in the Northern part of the delta where sugar beet is grown in vast areas. These governorates are Kafr El-Sheikh, Gharbia, El-Dakahlia and Damietta. Varieties were identified in each district and disease severity of rust disease was assessed as shown from Table 1. Average of diseases severity at Kafr El-Sheikh Governorate was the highest among all surveyed governorates, it ranged from 18.9% on Top cv. at Sidi Salem to (65.4%) on Pleno cv. at El-Reyad on the contrary the lowest disease severity (15.3) was detected at Gharbia Governorate. Moderate infection was

observed at Dakhlia Governorate with 23.9% on Kawamira cv. in Dekernes and 42.6% on Beta poly at Sherbeen.

The data illustrated that rust disease started to be increased gradually in the areas where sugar beet is grown and spreading. Changes in climate to be more humid is the main reason for increasing of disease severity of rust disease. Spring spores, like all beet rust spores, germinate on the plant surface and often grow down through the stomata into leaf tissue. When the weather becomes cooler (17-20°C is the optimum) and damper, the rust begins to reproduce itself by means of spores. It is at this time of the year during March that the disease is most noticeable (Asher, 1999 and Francis, 1999). Beet rust although very noticeable on plants in the autumn, it appears late and can cause losses and can be adequately controlled by recently developed fungicide. However this disease will be easily become more important in future years if weather patterns change to wetter summers and autumns. (Francis, 1999). The disease severity varied in different seasons and surveyed provinces and districts as mentioned by El-Mansoub (2006), he showed that variations were obvious in Kafr El-Sheikh, Dakahlia and Gharbia governorates, such variations might be affected by the prevalent races or pathotypes of the rust pathogen and the used sugar beet cultivars (Lewellen and Skoyen, 1988).

Table (1): Distribution and disease severity (%) of *U. betae* on sugar beet plants grown in different governorates during 2004/2005 growing season.

Governorate	District	Variety	Disease severity* (%)
Kafr El-Sheikh	Kafr El-Sheikh	Kawamira	21.7
	Sakha Research Farm	Ras Poly	43.5
	El-Hamoul	Fareda	20.2
	Sidi-Salem	Top	18.9
	Beiala	Kawarmira	25.4
	El-Reyad	Pleno	65.4
	Desouk	Ras Poly	50.1
Average	-	-	35.02
Gharbia	Kotour	Top	15.03
Average			15.03
El-Dakahlia	Sherbeen	Beta Poly	42.6
	Belkas	Pleno	35.2
	Dekernes	Kawamira	23.9
Average			33.9
Damietta	El-Sirw	Pleno	29.44
Average			29.44

* was recorded according to Peterson *et al.* (1948).

Under artificial inoculation in the screen house during 2005/2006 season, data in Table 2 show that there were a significant differences for disease severity % among the ten cultivars under study and ranged from 1.2% for Top cv. to 15% for Pleno under protected conditions by Sumi-8, while under artificially inoculated or non-protected conditions disease severity (%) ranged from 5.5% for Top cv. to 52.3% for Pleno cv.

Chlorophyll content as shown form Table 2, recorded the highest under protected conditions and reached to 85.1 and 82.3 mg for Top and Fareda cvs., respectively. While Pleno and Ras Poly recorded the least, under protected and non-protected conditions.

In other words, reduction (%) in chlorophyll content recorded the lowest for Top (9.8%), and (Fareda 13.9%), while the highest reduction was obtained for Pleno and

Ras Poly cvs. As reported by McGrath and Pennypacker (1990), changes in leaf color as result of infection by most foliage diseases including rust.

Abnormalities in the form and function of chloroplasts are common characteristics of diseased tissues, so it can be used as a result of that photosynthetic declining as mentioned before. Significant differences were obtained among all cultivars for root weight which ranged from 1.572 kg/plant for Pleno to 2.611 kg/plant for Top cv. under protected conditions. Under non-protected conditions low values for root weight/plant were obtained for Pleno, RAs Poly and Beta Poly. For TSS%, Top and Fareda cvs. Recorded the highest under protected conditions sucrose (%), recorded the highest under protected conditions for Top (21.9%) and Fareda (21.9%) cvs., while it was affected under non-protected conditions. Purity (%) behaved in the same manner for all tested sugar beet cvs. under both protected and non-protected conditions.

Loss (%) for root weight ranged from 12.0% for Top to 68.6% for Beta poly cv., while loss (%) for sucrose (%) ranged from 9.8% for Top to 59.9% for Pleno. EPPO, 1994, reported that yield loss % can be reached to 15% and more than 10% for sucrose %, while El-Mansoub, 2006 recorded high loss (%) for yield and sucrose (%). Quality were reduced parallel to disease severity (El-Sayed, 2000).

1. Effect of three levels of nitrogen fertilizer on certain parameters of four sugar beet cultivars during 2006/2007 and 2007/2008 seasons:

During 2006/2007 season, disease severity (%) of rust disease admits relation to N levels shown in Table 3, severity of the disease differed under protected plots and ranged from 1.1% for Top to 5.1% for Pleno, while under zero level it ranged from 8.3 for Top to 23.5% for Pleno, it recoded the least under 90 kg N/fed. and it recorded 4.6, 7.5, 13.8 and 18.4% for Top, Fareda, Ras Poly and Pleno cvs. respectively, and increased again under 120 kg N/fed., for the four cvs., and reached the highest for Pleno. So, increasing N level up to 120 kg/fed. increased disease severity of the rust disease.

Root weight/plant reached the highest when plots treated with Sumi-8 (Table 3), and ranged from 2.561 kg for Top to 2.100 kg for Pleno, but under zero N level, root weight was reduced, while, under 90 kg N/feddan it ranged between 2.210 for Top cv. to 1.110 kg/plant for Pleno cv. and declined again under 120 kg N/feddan. Total soluble solids (TSS%), recorded 26.0, 26.5, 27.2 and 27.3% for Pleno, Ras Poly, Fareda and Top cvs, respectively under protected or leaf free from rust, this mean that this trait was affected by rust and reduced when no fertilizer (N) was applied as shown in Table (3).

Under 90 kg N/feddan, TSS% started to be increased and reached to 26.5% for Top cv., but it declined again under 120 kg N/feddan due to rust incidence which affect the green leaves.

Table 3, showed that sucrose (%) was high under protected conditions by Sumi-8 fungicide and ranged from 21.8% for Pleno cv. to 22.8 % for Top, while under zero N level it declined for all tested cvs. under 90 kg N/feddan it increased and ranged between 17.0% for Pleno to 22.2% for Top cv. It is also noticed that sucrose (%) decreased when applying 120 kg N/feddan and recorded the least for all cvs. under study this due to the infection by rust disease when it compared with protected plots. Purity (%) as a result of dividing sucrose (%) on TSS (%) it affected by infection with the disease when compared with protected plots. The highest purity (%) was obtained under protected plots was 83.5% for Top cv., purity % was reduced under zero N but it increased under 90 kg N/feddan and ranged between 80.2% for Pleno cv. to 83.8% for Top cv. and decreased when tread with high dose fertilizer (120 kg N/feddan) as shown from Table 3. In general during 2006/2007 season, there were a remarkable differences either between sugar beet cvs. under study or under nitrogen levels. In this experiment, all traits gave satisfactory results when Sumi-8 was applied leading to a

conclusion that rust disease under either zero N level or 120 kg N/feddan can affect all the traits under study, while 90 kg N/feddan gave good results relatively.

During 2007/2008, under protected conditions as shown from Table 4, severity (%) ranged between 0.8% for Top cv. to 3.5% for Pleno cv., while under zero level N, it increased and recorded 14.6, 10.4, 6.9 and 2.8%, for Pleno, Ras Poly, Fareda and Top cvs., respectively. Disease severity (%) under 90 kg N/feddan decreased comparable to zero level and started to be increased under 120 kg N/feddan, whereas it ranged from 5.4% for Top cv. to 18.9% for Pleno cv. because high nitrogen level enhance disease spreading and infection.

Root weight is an important trait which affected by disease severity and nitrogen levels especially under protected plots against rust disease. High root weight values as shown from Table 4, were obtained under low disease severity (Protected) plots which recorded 2.215, 2.340, 2.500 and 2.587 kg/plant for Pleno, Ras Poly, Fareda and Top cvs., respectively, while under zero nitrogen, it ranged from 0.516 for Pleno cv. to 0.711 kg/ plant for Top cv. in relation to disease severity %, root weight values stared to be increased when applying 90 kg N/feddan and decreased again under 120 kg N/feddan as shown from Table 4, This due to high disease severity under this level.

Total soluble solids (TSS) %, also as one of the important quality measure for sugar beet was affected significantly when no nitrogen fertilizers were applied or increasing the dose due to 120 kg N/feddan, while, under protected plots TSS (%) recorded the highest values as 26.5, 27.1, 27.1 and 26.9% for Pleno, Ras Poly, Fareda and Top cvs., respectively.

In Table 4, data illustrated that sucrose (%) recorded the highest values under protected conditions and ranged from 21.3% for Pleno, to 22.6% for Top cv., while under zero N level recorded less as 9.9, 10.8, 12.4 and 13.5% for Pleno, Ras Poly, Farida and Top cvs., respectively. On the other side sucrose percentages under 90 kg N/feddan increased and gave high values which ranged from 20.0% for Pleno cv. to 22.1 sucrose percentage for Top cv., and started to decrease under 120 kg N/feddan. Purity % affected also by nitrogen levels, while, high values were obtained under protected conditions as shown from Table 4, which confirmed the results shown in Table 3, during 2006/2007 season.

Different reports showed that rust severity was decreased while TSS % and sucrose content in roots were increased significantly by using the lower and middle levels of N fertilizer while the higher levels (> 100 kg/feddan) showed the opposite results comparing with unfertilized treatment. However, applying different levels of N fertilizers significantly increased root fresh weight compared with unfertilized plots. Root fresh weight, TSS% and sucrose content were higher in some varieties like Fareda than cv. Ras Poly (El-Mansoub, 2006). Rust disease is not only causing losses in root and sucrose content but also decreases purity of the juice derived from diseased roots (Smith and Martin, 1978).

Fertilizer management may play an important role in rust disease incidence. Different fertilizers were used i.e. nitrogen (three doses zero, 90 and 120 kg/feddan). Application of 120 kg N/feddan enhanced and increased the disease severity (%) when applied in two applications, while it caused a remarkable increase in root weight/plant although it reduced both TSS and sucrose %.

Gardener *et al.* (1985), El-Fahhar (2003), reported that the older leaves have high N content than the younger leaves of sugar beet plants. In addition, cell size and water content of the cells increased by increasing nitrogen. Moreover, cell wall thickness turned to be thin, this enables the fungus to penetrate the leaves. On the other hand, applying 90 kg N/feddan reduced disease severity (%) while it increased both TSS and sucrose contents of the roots. Therefore, it is worth to recommend the usage of the dose 90 kg /feddan instead of 120 kg N/feddan in two applications. While, zero level lead to high reduction in root weight, consequently affected and show big loss in

TSS% and sucrose produced. Similar effects of these fertilizers were obtained by Wojelechouska and Miko Lajska (1988), El-Fahar (2003).

2. Effect of date of sowing on rust disease incidence and its relation to the other characters of sugar beet cvs. during 2006/2007 and 2007/2008 seasons:

Date of sowing is one of the important factors which affect disease incidence especially foliage diseases like rust, where the late sowing date can influence directly root volume and sucrose. Great attention has been paid nowadays to use an integrated approach for controlling sugar beet rust disease through the integrated disease management system by utilization of resistant cultivars, improving cultural practices like date of sowing and fertilizers (Ramadan and Nassar, 2005).

Data in Table 5, show that there were a significant differences between date of sowing regarding disease severity of rust for all tested cultivars under either protected or non-protected plots. The least disease severity of rust was obtained for the first date of sowing, September 15th, while high values of disease severity (%) were obtained when sowing on November 15th, under both protected and non-protected conditions for all the cultivars tested. Under non-protected conditions, Pleno cv. recorded the highest rust incidence and ranged from 20.3% in the first date of sowing to 42.7% in the third date of sowing (November, 15th). The least values were obtained for Top cv. allover the three dates of sowing comparing with the other cvs. Rust disease is spreading when the temperature around 18°C, which is found on the late season, but when sowing on September 15th or before, enable the plant to tolerate or even no inoculum was found at early harvesting season.

Area under disease progress curve (AUDPC) showed a highly significant differences between dates of sowing as well as between cvs. under both protected and non-protected conditions. From the data obtained on September 15th, date of sowing, AUDPC ranged from 195.50 for Top cv. to 715.81 for Pleno cv., while ranged from 343.75 for Top cv. to 1483.81 for Pleno cv. when grow on November 15th under protected conditions On the other hand, high values were obtained under non-protected conditions. Similar results were obtained by El-Mansoub (2005).

Root weight (kg/plant) recorded the highest when sugar beet grown on September, 15th, and it decreased dramatically when sown on November, 15th under both protected and non-protected conditions. Top cv. recorded the highest even in late date of sowing.

Significant differences were obtained for TSS (%) under these dates of sowing. The highest values of TSS% were obtained when sugar beet grown on September 15th. But when grown late in the season, TSS% started to declined because the plant was subjected to be affected by *U. betae* in the late season of harvest.

Sucrose (%) as shown from Table 5, differed significantly among the three dates of sowings and varieties. The highest values were obtained when sugar beet grown on September 15th. Late sowing date reducing sucrose %. Top cv. had the highest sucrose % at early date of sowing comparing with the other cvs.

Purity % also affected with the date of sowing, when sugar beet cvs. grown early, disease severity (%) were less than in late sowing plots.

As mentioned in many reports that early sowing (September 15th), gave the lowest loss (%) in root yield, while growing on October 15th, root yield loss increased gradually in late sowings. Loss (%) in sucrose recorded the highest when sugar beet sown on November 15th, and reached to 47.9% for Pleno in the third date of sowing.

These results were in accordance with those obtained by Ata (2005) who found that significant differences were recorded between healthy and diseased plants concerning root weight, sucrose (%), purity (%), consequently, sucrose and root weight losses.

Data presented in Table 6, showed that there were a significant differences among the three dates of sowing for disease severity (%) and cvs. tested.

Table (2): Severity of rust disease, chlorophyll content (mg/gm), root weight (kg/plant), TSS%, sucrose (%), purity (%) and loss % in yield and sucrose of ten sugar beet cvs. under artificial inoculation with *U. betae* during 2005/2006 season.

Cultivar (cv)	Disease severity (%)*		Chlorophyll content (mg/g)			Root weight kg/plant		TSS (%)		Sucrose (%)		Purity (%)		Loss (%)	
	Protected	Non-protected	Protected	Non-protected	Reduction (%)	Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	Root	Sucrose
Top	1.2	5.5	85.1	76.8	9.8	2.611	2.300	26.0	24.2	21.9	19.5	78.5	80.6	11.9	10.9
Pleno	15.8	52.3	63.4	22.4	64.7	1.572	0.612	20.9	11.3	15.2	6.1	72.7	53.9	61.1	59.9
Kawamira	3.7	13.8	80.1	68.14	14.6	2.408	1.810	25.8	21.0	20.2	16.4	78.3	78.1	24.8	18.8
Ras Poly	12.5	41.7	69.9	28.8	58.2	1.850	0.685	21.7	13.6	16.9	8.5	77.9	62.5	6.23	49.7
Beta Poly	4.4	36.4	71.5	33.6	53.0	2.112	0.790	22.8	15.2	18.0	11.1	78.9	73.0	62.6	38.3
Sultan	8.3	34.5	73.2	34.8	52.5	2.174	0.789	23.8	15.9	18.9	11.6	79.4	72.9	63.9	38.6
Fareda	2.5	9.4	82.3	70.8	13.9	2.597	1.998	26.6	22.3	21.9	17.4	82.3	78.0	23.1	20.5
Bamella	7.2	25.6	75.4	38.5	49.8	2.209	0.950	23.6	18.2	18.9	13.9	80.1	76.4	51.9	26.5
Lola	7.9	28.7	75.0	36.9	50.0	2.189	0.904	23.5	17.1	18.4	12.8	78.3	74.9	56.7	30.4
Glorious	4.5	18.5	78.9	48.9	38.0	2.338	1.377	24.5	19.6	19.8	15.1	80.8	77.0	41.1	23.7
L.S.D. 0.05 2 cv. means	**2.78**		**1.81**			**0.36**		**1.9**		**2.03**		**2.9**		**3.6**	
2 T means	**3.1**		**2.1**			**0.43**		**1.7**		**3.1**		**2.7**		**3.1**	

* According to Peterson *et al.* (1948)

** Reduction % = $\frac{\text{Protected - non - protected}}{\text{Protected}}$ x 100

Table (3): Effect of three levels of nitrogen fertilizer on certain parameters of four sugar beet cultivars during 2006/2007 season.

Cultivar (cv)	Disease severity (%)				Root weight (kg/plant)				TSS (%)				Sucrose (%)				Purity (%)			
	Protected	Fertilizer level (kg/fed)			Protected	Fertilizer level (kg/fed)			Protected	Fertilizer level (kg/fed)			Protected	Fertilizer level (kg/fed)			Protected	Fertilizer level (kg/fed)		
		Zero	90	120		Zero	90	120		Zero	90	120		Zero	90	120		Zero	90	120
Pleno	5.1	23.5	18.4	27.8	2.100	0.615	1.110	0.831	26.0	14.0	21.2	18.4	21.8	10.4	17.0	14.0	82.7	74.3	80.2	76.1
Ras Poly	4.3	18.6	13.8	21.9	2.216	0.665	1.315	1.091	26.5	15.2	22.6	19.7	22.0	11.4	18.5	15.4	83.1	75.0	81.9	78.2
Fareda	2.5	11.9	7.5	16.4	2.431	0.714	1.872	1.184	27.2	17.3	25.6	22.8	22.6	13.1	21.3	18.4	83.1	76.8	83.2	80.7
Top	1.1	8.3	4.6	11.5	2.561	0.830	2.210	1.661	27.3	17.5	26.5	23.9	22.8	13.8	22.2	19.4	83.5	78.9	83.8	81.2
L.S.D. 0.05 2 cv. means	2.53				0.81				0.34				0.54				2.26			
2 T means	3.1				0.92				0.41				0.63				2.31			

Table (4): Effect of three levels of nitrogen fertilizer on certain parameters of four sugar beet cultivars during 2007/2008 season.

Cultivar (cv)	Disease severity (%)				Root weight (kg/plant)				TSS (%)				Sucrose (%)				Purity (%)			
	Protected	Fertilizer level (kg/fed)			Protected	Fertilizer level (kg/fed)			Protected	Fertilizer level (kg/fed)			Protected	Fertilizer level (kg/fed)			Protected	Fertilizer level (kg/fed)		
		Zero	90	120		Zero	90	120		Zero	90	120		Zero	90	120		Zero	90	120
Pleno	3.5	14.6	4.8	18.9	2.215	0.516	1.997	1.330	26.5	13.8	25.1	20.5	21.3	9.90	20.0	15.9	80.4	71.7	79.7	77.6
Ras Poly	2.2	10.4	6.2	14.5	2.340	0.642	2.080	1.551	27.1	14.9	25.6	21.4	22.4	10.8	20.9	16.8	83.4	72.5	81.6	78.5
Fareda	1.6	6.9	3.5	10.2	2.500	0.680	2.275	1.795	27.1	16.8	26.3	23.9	22.6	12.4	21.7	19.1	83.7	73.8	82.5	79.9
Top	0.8	2.8	1.3	5.4	2.587	0.711	2.510	2.189	26.9	17.9	26.6	25.7	22.6	13.5	22.1	20.8	84.0	75.4	83.1	80.9
L.S.D. 0.05 2 cv. means	2.31				0.60				0.24				0.77				2.38			
2 T means	2.83				0.71				0.38				0.67				2.62			

Table (5): Effect of date of sowing on disease severity (%) of rust disease and some other related characters for four sugar beet cvs. under field conditions during 2006/2007 season.

Date of sowing	Cultivar (CV)	Disease severity (%)		AUDPC (%)		Root weight (kg/plant)		TSS (%)		Sucrose (%)		Purity (%)		Loss (%)	
		Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	Root	Sucrose
September 15th	Pleno	6.2	20.3	715.81	1920.51	2.188	1.083	24.6	19.2	20.3	15.1	82.5	78.6	50.5	25.6
	Ras Poly	4.9	15.8	380.00	1583.40	2.24	1.310	25.5	21.0	21.2	17.3	83.1	82.3	40.8	18.4
	Fareda	2.8	9.4	273.42	1059.75	2.504	2.041	26.3	23.7	22.2	19.4	84.7	81.5	18.5	12.6
	Top	1.6	5.2	195.50	467.35	2.550	2.310	26.5	25.3	22.4	21.4	84.5	84.5	9.6	4.4
October 15th	Pleno	10.5	28.6	945.72	2241.80	1.950	0.871	22.6	17.5	18.6	13.5	82.3	77.1	55.3	27.4
	Ras Poly	17.8	23.8	811.75	2053.11	2.149	0.985	23.5	18.5	19.3	14.8	82.1	80.00	54.2	23.3
	Fareda	4.8	17.9	356.00	1748.71	2.225	1.215	25.6	20.2	21.5	16.4	83.9	81.1	45.4	23.7
	Top	2.7	11.8	284.10	1255.35	2.442	1.410	26.3	22.5	22.2	18.5	84.4	82.2	42.3	16.6
November 15th	Pleno	14.1	42.7	1483.81	3891.34	1.358	0.632	21.6	13.5	16.9	8.8	78.2	65.1	53.5	47.9
	Ras Poly	11.8	35.4	1199.10	3280.10	1.510	0.771	22.2	15.3	18.6	10.9	83.8	71.2	48.9	41.3
	Fareda	8.6	22.8	943.94	2115.0	2.110	0.942	23.1	18.9	19.5	14.2	84.4	75.1	55.4	27.2
	Top	4.5	15.9	343.75	1569.55	2.280	1.267	25.4	20.2	21.6	15.9	85.0	78.7	44.4	26.3
L.S.D. 0.05: 2 means at each date x cv.		2.71		6.48		0.36		2.1		1.96		3.1		2.8	
2 T means at each D x cv		4.1		7.1		0.41		2.2		2.1		3.0		2.9	

Table (6): Effect of date of sowing on disease severity (%) of rust disease and some other related characters for four sugar beet cvs. under field conditions during 2007/2008 season.

Date of sowing	Cultivar '(CV)	Disease severity (%)		AUDPC (%)		Root weight (kg/plant)		TSS (%)		Sucrose (%)		Purity (%)		Loss (%)	
		Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	Toot	Sucrose
September 15th	Pleno	4.5	14.7	371.15	1438.13	2.338	1.410	25.5	21.6	21.3	17.7	83.5	81.9	38.9	16.4
	Ras Poly	2.6	5.3	290.12	427.82	2.644	2.311	26.4	25.3	22.3	21.1	84.5	83.9	12.6	5.4
	Fareda	1.8	3.4	210.30	339.14	2.675	2.552	26.5	26.1	22.6	22.0	85.3	84.3	4.5	2.7
	Top	0.9	1.9	165.0	180.40	2.691	2.637	26.5	26.5	22.8	22.6	86.0	85.3	0.5	0.8
October 15th	Pleno	7.9	18.5	651.14	1862.31	2.203	1.236	23.3	20.0	19.1	16.0	81.9	80.0	43.9	16.2
	Ras Poly	5.7	14.6	415.61	1398.25	2.286	1.379	25.1	21.5	21.0	17.5	83.7	81.9	39.7	16.2
	Fareda	3.1	9.7	312.10	1020.50	2.560	2.133	26.1	23.4	22.8	19.2	84.3	82.1	16.7	12.7
	Top	1.2	4.8	175.44	360.17	2.665	2.397	26.6	26.0	22.5	22.0	84.6	84.0	10.0	2.2
November 15th	Pleno	10.8	25.3	1120.51	2210.32	2.010	0.894	22.9	17.8	17.8	13.3	77.7	74.7	55.5	25.3
	Ras Poly	8.6	17.5	938.11	1732.46	2.158	1.228	23.3	20.4	19.2	16.0	81.5	78.4	43.1	16.6
	Fareda	4.7	12.4	360.0	1284.17	2.402	1.560	25.2	21.8	20.7	17.6	82.3	80.7	35.1	14.9
	Top	2.5	7.7	278.13	1913.89	2.638	2.161	26.8	23.5	22.4	19.5	83.5	82.9	18.1	4.7
L.S.D. 0.05: 2 means at each date x cv.		1.96		6.22		0.42		3.1		2.1		2.91		2.87	
2 T means at each D x cv		2.31		7.61		0.65		3.5		2.5		3.1		4.1	

During 2007/2008, disease severity (%) of rust disease ranged from 0.9 for Top cv. to 4.5% for Pleno cv. under protected conditions, while it ranged from 1.9 to 14.7% under non-protected condition on September 15th, while it increased for the third date of sowing; November 15th for cvs. under both protected and non-protected conditions. This variation was due to the differences in environmental conditions (temperature, relative humidity which encourage the wide spread of the disease during the late sowing (Francis, 1999)

As shown from Table 6, AUDPC recorded the highest for the plants grown on November 15th and reached the maximum for Pleno cv. (2210.32). In general, in the early sowings on September 15th, less diseases severity will be appeared during maturity. Low values of AUDPC were obtained for the plants sown on September 15th. These results confirmed the previous results shown in Table 5.

Root weight, TSS (%), sucrose and purity (%) increased for September 15th and decreased by delaying date of sowing. Loss % in root yield was low for September 15th and started to be high for the plants grown on October 15th and got higher on November 15th. The highest loss % in root weight was obtained for Pleno cv. on November 15th loss % in sucrose varied significantly and reached to 25.3% for cv. Pleno for November 15th, due to the infection by rust as well as the temperature is not suitable for sucrose crystalization due to the disturbance in the metabolic process during the late harvest.

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تأثير معدل التسميد الأزوتى وميعاد الزراعة على الإصابة بمرض الصدأ فى بنجر السكر

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أجريت هذه الدراسة خلال المواسم ٢٠٠٤/٢٠٠٥م ، ٢٠٠٥/٢٠٠٦م ، ٢٠٠٦/٢٠٠٧م ، ٢٠٠٧/٢٠٠٨م وذلك بمحطة بحوث سخا الزراعية بمحافظة كفرالشيخ ــ جمهورية مصر العربية وذلك لدراسة العلاقة بين التسميد الأزوتى فى صورة يوريا بمستويات مختلفة والشدة المرضية لمرض صدأ الأوراق فى بنجر السكر والذى يسببه فطر *Uromyces betae* وأيضا تأثير مواعيد الزراعة على الإصابة بمرض صدأ البنجر.

أجريت دراسة لحصر المرض فى موسم ٢٠٠٤/٢٠٠٥م بمحافظات شمال الدلتا والتى أوضحت أن مرض الصدأ بدأ ينتشر فى كل المحافظات التى تزرع البنجر خاصة محافظة كفرالشيخ التى يعد ترتيبها الأول فى إصابة الأصناف فيها يليها محافظة الدقهلية وكان أكثر الأصناف إصابة وشدة هو الصنف بلينو Pleno.

ولاختيار القدرة المرضية للفطر ثم تقييم عشرة أصناف بالصوبة السلكية وذلك تحت العدوى الصناعية بالجراثيم اليوريدية للفطر وذلك لعدوى نباتات عند عمر ٩٠ يوم وللمقارنة تركت بعض القطع التجريبية وتم رشها بمبيد الـ Sumi-8 بمعدل ٣٥سم^{3}/١٠٠ لتر ماء وذلك للمقارنة.

وأوضحت الدراسة أن الصنف توب كان أقل شدة مرضية تحت ظروف العدوى الصناعى بينما كان الصنف بلينو ذات شدة مرضية عالية. ولقد كانت نسبة الكلوروفيل عالية للأصناف توب وفريدة. وأوضحت البيانات أيضا أن الأصناف اختلفت فيما بينها فى وزن الجذر والمواد الصلبة الذائبة الكلية والسكر والنقاوة تحت ظروف العدوى الصناعى والرش بالمبيد. أما عن الخسائر فى وزن الجذر والسكر فكانت عالية للصنف بيتابولى وللصنف بلينو.

وأجريت تجربتان فى الحقل خلال موسم ٢٠٠٦/٢٠٠٧م و ٢٠٠٧/٢٠٠٨م لدراسة العلاقة بين مستويات التسميد الأزوتى (صفر ــ ٩٠ ــ ١٢٠كجم يوريا/للفدان) والشدة المرضية لمرض الصدأ فى بنجر السكر وتم استخدام أربعة أصناف لإجراء التجربة (بلينو ــ رأس بولى ــ فريده ــ توب) وتم إقامة التجربة فى قطاعات منشقة مرة واحدة فى ثلاثة مكررات.

وأوضحت النتائج أن الشدة المرضية اختلفت معنويا بين معدلات التسميد وكذا الأصناف وأن المعدل ٩٠كجم يوريا/فدان أعطى أقل شدة مرضية وكذا الصنف توب. أما باقى الصفات مثل وزن الجذر والسكر والنقاوة فكانت جيدة تحت مستوى ٩٠كجم يوريا/فدان وخاصة بالنسبه للصنفين توب وفريده.

وأوضحت الدراسة أن الزراعة فى ١٥ سبتمبر كانت أقل شـدة مرضـية بالمقارنـة بالمواعيـد المتأخرة، ١٥ أكتوبر ، ١٥ نوفمبر ولوحظ أن هناك فروق معنوية بين المواعيد والأصناف تحت ظـروف العدوى الطبيعية وظروف الرش بالمبيد. وفى المواعيد المتأخرة فإن وزن الجذر ونسـبة السـكر والمـواد الصلبة الذائبة الكلية والنقاوة تأثرت معنويا بالإصابة المرضية وكانت الخسائر فى السكر ووزن الجذر عالية عن الميعاد الأول للزرعة فى ١٥ سبتمبر.

وأوضحت الدراسة أيضا أن المساحة تحت منحنى التقدم المرضى زادت فى المواعيد المتأخرة عن الميعاد المبكر ١٥ سبتمبر حيث وصلت إلى أقصاها للصنف بلينو.

وخلاصة النتائج فى كلا الموسمين أن أنسب ميعاد للحصول على شدة مرضية أقل هو ١٥ سبتمبر والتأخير فى الزراعة يساعد على زيادة الشدة المرضية ويؤثر ذلك على باقى الصفات الأخـرى مثـل وزن الجذر والسكر والنقاوة والخسائر والمساحة تحت منحنى التقدم المرضى.

ويشير هذا البحث إلى الإعتدال فى التسميد الأزوتى خاصة وأن الإفـراط الزائـد فـى التسـميد الأزوتى يساعد فى زيادة الإصابة بمرض الصدأ وأيضا اختيار الميعاد المناسب للزراعة حيث أن التـأخير فى ميعاد الزراعة يؤدى إلى تهيئة الظروف الملائمة لانتشار هذا المرض. مما يكون له الأثر السلبى علـى وزن الجذر ونسبة السكر الناتج.