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SOME QUALITY CHARACTERS AND INVERTASE ENZYME ACTIVITY IN RELATION TO CERCOSPORA LEAF SPOT DISEASE CONTROL IN SUGAR BEET

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ABSTRACT

Screen house experiment was carried out at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate during 2007/2008 season to study the relation between fungicide and plant extract application on *Cercospora beticola* incidence and related characters as well as invertase enzyme on sugar beet. Two cultivars of sugar beet were selected; the two cultivars; Ras Poly and Fareda were used and planted in a split plot design. Topsin M70 (1 gm/liter) and plant extract Khella "*Ammi visnaga*" or pick-tooth (4000 ppm) were sued to control the disease. Artificial inoculation was done by using conidiospores suspension of *Cercopora beticola*. Inoculation was done 90 days after planting. Chemicals were applied three days before inoculation. Different traits were measured like, disease severity (%), root weight/plant, sugar percentage, sugar loss to molasses %, invertase enzyme activity, impurities in leaves and roots (Na^+, K^+ and α-amino-N), TSS %, chlorophyll content of leaves, purity (%), loss % for root and sugar. Seven readings to asses the disease incidence were taken.

Disease severity (%) of cercospora leaf spot disease incidence was increased gradually especially for Ras Poly cv. than Fareda cv. under infected condition, but showed less values when treated with Topsin M70 followed by Khella. On the other hand, root weight, TSS%, sugar percentage, purity were highly affected than those under fungicide and plant extract treatments and loss percentages for root and sugar reached to maximum for Ras Poly than Fareda cv.

Enzymatic activity of invertase reached the maximum under inoculation, while it was less when treated by Topsin M 70 and Khella plant extract. Na^+ and α-amino N increased by increasing disease severity (%), while K^+ behaved in different manner. Concerning reducing sugars in roots, recoverable sugar (%) and sugar loss to molasses increased by increasing disease severity (%), low values were obtained under fungicidal and plant extract treatment. Plant extract and resistant cvs, must be recommended to reduce the pollution either in water or in the soil of sugar beet plantations.

INTRODUCTION

Cercospora leaf-spot is the most destructive foliar disease of sugar beet (*Beta vulgaris* L.) in areas with humid and warm summers, e.g. Mediterranean basin (Rossi, *et al.,* 1995). In the absence of control measures the yield losses range from 25 to 50% (Byford, 1996) and (El-Fahhar, 2003). In, Egypt, the diseases is mainly controlled by fungicide treatment, whereas resistant varieties and crop rotation merely contribute to successful disease control. Application of fungicide generally gives adequate levels of protection against *C. beticola*. Moreover, to have non-polluted crop with chemicals either in the roots or in the soil and air, plant extracts is an efficient way to

reduce the hazards of chemical fungicide. Mode of action of the chemical fungicide and plant extracts needed to be discovered-like the disruption of the energy cycle of the pathogen (Bartlett, 2002). Important, for crop protection, feature of this fungicide class is that it possessed and extremely broad spectrum of activity including deuteromycetes (Wong and Wilcox, 2001). Integrated disease management system by utilizing resistant cultivars, applying bio-control agents to the crop, minimizing fungicide application and looking for alternative options to decrease hazards on health of humanity (Karadimos, *et al.,* 2004) and (Khan and Smith, 2005).

All the factors which affect and reduce the level of susceptibility by C. *beticola* increase invertase enzyme activity which affects sugar crystallization and transform of sucrose to glucose and fructose (Vukov, 1977). As reported by Rosenkranz, *et al.,* (2001), the role of acid invertase isoforms was studied in sugar beet tap-root, a specialized tissue which stores up to 22% sucrose. During harvest, mechanical wounding of tap-roots causes a sustained metabolic response, leading to significant post harvest sucrose losses. Wounding of sugar beet tap-root causes an induction of invertase activity. Induction of acid invertase in response to wounding help in invading by pathogens which increases the induction of acid invertase enzyme can affect sucrose losses. From some sources, e.g. sugar beet and sugar cane sucrose is directly extracted without any modification. Sugar beet contain 75% moisture,16-18% sucrose, 5-6% fibers and 2-3% other compounds, diseases can affect these ratios (Bhowmik, *et al.,* 2001), In most plants, the transported sugar is sucrose. Sucrose is a non-reducing disaccharide, in which glucose and fructose are linked. Sucrose is transported through the phloem from source organs to sink organs. It is subsequently hydrolyzed by invertase. Invertase is a hydrolysis cleaving sucrose into glucose and fructose (Suthumchai *et al.,* 2006). Losses due to this disease can approach 40 percent, and are presented by both root tonnage and sugar percentage in roots. Beets with low sugar levels do not store well, and losses in storage result from increased storage decay. Profitable yields are additionally reduced due to greater levels of impurities in roots and increased sugar loss to molasses during processing (Harveson, 2007). So, this study was designated to investigate the effect of fungicide and plant extract on *C. beticola* incidence as well as the effect on invertase enzyme and some other economic traits which affecting sugar production.

Also, the objective was extended to study the effects of sugar beet cultivars expressing different levels of susceptibility to cercospora leaf-spot, and evaluation of resistance of *C. beticola* to fungicide and plant extract.

MATERIALS AND METHODS

1. Fungicides and plant extract:

The chemical fungicide; Topsin M70 (thiophenate-methyl) as a systematic one was used with dose of 1 gm/liter. On the other hand, Khella (*Ammi visnaga*) as plant extract was used. The recommended dose of Khella

was 4000 ppm as recommended by El-Kazzaz *et al.* (2003). Preparation of the plant extract was done according to Managamma and Srevamulu (1991). Fresh plant materials (seeds) were collected, washed with tap water and then with distilled water and dried at room temperature. The dried seeds were ground into powder; this powder was extracted using ethyl alcohol and acetone (1:1-v/v). One hundred grams from the final powder of the seeds were soaked in 200 ml of solvent and shake for 48 hrs, then blended for 5 minutes and filtered. The solvent was evaporated under reduced pressure and the crude extract was stored in amber bottles and kept in refrigerator until used.

Application of both Topsin M70 and Khella was done three days before inoculation.

2. Pathogen:

C. beticola isolate, was collected and purified during summer of 2006 from sugar beet field from Kafr El-Sheikh Governorate. Plants were artificially inoculated with conidial suspension containing 50 x 10^3 conidia/ml. El-Fahhar,(1997). Before inoculation one droplet of 0.1% Tween 20 was added to each suspension. The inoculation was done with a spray atomizer and plants was sprayed until run off on both leaf surfaces and covered with plastic sheets for four days. Inoculation was done 90 days after planting as recommended by El-Fahhar (2003). Some plots were left without inoculation and sprayed either by chemical or plant extract for comparison, three days before inoculation.

3. Experimental design:

This experiment was conducted during 2007/2008 season at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, in the screen house. The experiment was designed in a split plot design with three replicates. Micro plots (2 x 10 meters) in the screen house were used to carry out this experiment and planted during September with Ras Poly and Fareda cvs., which were chosen according to the previous studies done by El-Fahhar, 1997; and 2003 in rows, each row was planted with 50 cm apart and 20 cm distance between plants. Cultivars were allocated in main plots while, the treatments (fungicide and plant extracts) in addition to the inoculated treatments, occupied the sub-plots. All cultural practices were applied according to the recommendations.

Different traits were measured as follow:

1. Disease severity (%) was recorded according to Shane and Teng (1992) scale E for Cercospora beticola incidence assessment.
2. Root weight (kg/ plant) the two central ridges of each plot were estimated in Kilograms.
3. Sugar percentage was estimated according to Carruthers and Oldfield (1960).
4. Percentages of sugar loss to molasses (S.L.) and recoverable sugar (R.S.) were determined according to the following equation adopted by Reinfield *et al.* (1974).

   S.L.% = 0.343 (K + Na) + 0.094 (α-amino-N)-0.31.

   R.S. % = pol-[0.343(K + Na) +0.094 (α-amino-N) + 0.29].

5. Reducing sugar content was determined as descried by A.O.A.C. (1990).
6. Invertase enzyme activity (unit/100 g root/hour) was determined according to the procedure stated by Vukov (1962) in leaves and roots.
7. Impurities in leaves and roots such as Na+, K+ and α-amino-N were determined according to the method of William (1984).
8. Total soluble solids percentages (TSS %) was determined in fresh root for each cultivar using hand refractometer (McGinnis, 1982).
9. Total chlorophyll content of leaves was measured by using chlorophyll meter (SPAD-502), (Yoshida et al., 1976).
10. Percentage of purity was calculated by dividing sucrose (%) by total soluble solids % according to Carruthers and Oldfield (1960).
11. Loss percentage for sucrose and root weight was determined as follow:

$$\text{Reduction (Loss) percentage} = \frac{\text{Protected - infected}}{\text{Protected}} \times 100$$

12. The first reading of cercospora disease incidence was taken 15 days after inoculation, seven readings were recorded. Samples were taken with each reading (8 samples were collected) to perform chemical and quality trait analysis. The first sample was taken just before inoculation and sprayed chemical or plant extract for comparison, three days before inoculation. The other seven samples were taken with each reading.
13. Data were statistically analysis according to Gomez and Gomez (1983).

RESULTS AND DISCUSSION

Data summarized in Table 1 show the scores of disease severity (%) of *Cercospora beticola* and its effect on root weight, TSS (%), sucrose (%) as well as loss percentage in root weight and sucrose for Ras Poly and Fareda sugar beet cvs, under control (artificially infected, Topsin M7 (fungicide), as well as plant extract (Pick-tooth or Khella). This experiment was performed in the screen house at Sakha Agricultural Research Station, Kafr El-sheikh, Egypt. Disease severity (%) of cercospora leaf spot disease of the infected plots ranged from 0.5 to 86.8% for Ras Poly cv., while it ranged from 0.4 up to 38.7% for Fareda cv.

By spraying Topsin M 70 to control cercospora incidence, disease severity (%) ranged from 0.4 to 2.3 (%) for Ras Poly Cv. and from 0.2 to 1.5% for Fareda cv. Plant extract (Pick-tooth) affected the disease severity (%) of cercospora leaf spot disease but less than that of the fungicide. Disease severity % of the disease ranged from 0.5 up to 26.4% for Ras Poly cv, while it ranged from 0.6 to 10.8 % for Fareda cv. after spraying plants by the recommended dose of both fungicide and plant extract. Using of plant extract reduces the disease severity as well as reduces the hazard of fungicide, although the high efficiency of fungicide in controlling the disease, but less pollution for soil, water and atmosphere is needed. The data obtained was confirmed by those obtained by Karadimos *et al.,* (2004) and Khan and Smith, (2005).

T1

Regarding root weight/plant, the lowest values of root weight were obtained for both cvs; Ras Poly and Fareda Under artificial inoculation. ON the other hand, when applying the chemical fungicide (Topsin M70), root weight/plant recorded the highest and there were significant differences among the scoring or readings every 15 days in relation to disease severity %. Ras Poly cv. was affected than Fareda cv. Data in Table 1, shows also when applying khella as plant extract, the root weight/plant affected but less than chemical application of Topsin M 70. These results were in accordance with those obtained by El-Kazzaz, (2003) and Harveson, (2007).

Total soluble solids (TSS%) were highly affected by disease severity for both cvs, Ras Poly and Fareda (Table 1), less percentages of TSS% were obtained under artificial inoculation conditions and reached to the maximum when applying Topsin M70 followed by application of plant extract (Khella or pick-tooth). These results agree with those obtained by El-Kazzaz *et al.*, (2003).

Regarding sucrose (%), the lowest values were obtained under artificial inoculation, while the highest values of sucrose (%) in roots were obtained when the disease was controlled by Topsin M70 followed by plant extract, but the differences between both of them not too much, recommending the applications of plant extracts which can easily be used in the farmers field or it can be used as plant bio-agent if its subjected to a fine extraction process.

Accordingly, disease severity (%) of cercospora leaf spot disease affected the juice purity and sucrose as shown from Table 1. Application of either chemical fungicide or plant extract had no differences in purity thereby there are behaving the same manner in controlling the disease, here the plant extract is preferred.

A severe attack will reduce both yield and sugar content significantly. At harvest, the economic threshold occurs when 3% of the leaf surface is covered with spots. The cercospora leaf spot fungus feeds on the sugar beet's sap, infecting portions of outer leaves first, subsequent loss of the whole leaf interferes with normal root growth and sugar accumulation; decreased photosynthetic capacity lowers yield and sugar content, this resulted in reduced yield, sugar content and juice purity of root Poindexter, (2008). Loss percentages in root weight reached the highest under artificial inoculation followed by when applying plant extract and chemical fungicide "Topsin M70"-Moreover, the direct effect of the disease was obvious in sugar loss % for Ras Poly (72.4%) and Fareda (46.4%) sugar beet cultivars. Wolf and Verret, (2002) showed that the yield losses of 10-30% have been obtained for the disease, on the other hand, Harveson,(2007) reported that losses due to this disease can approach 40% and are represented by both root tonnage and sugar percentage in roots.

Table (2) show that the effect of disease severity (%) of cercospora disease on chlorophyll content of Ras Poly and Fareda sugar beet cvs, chlorophyll content was very much affected by cercospora infection, while under chemical control plots either by Topsin M70 or plants extract (Khella), chlorophyll content recorded the highest infecting portions of older leaves first

was occurred, subsequent loss of the whole leaf or large leaf portions interferes with normal root growth and sugar accumulation and decreasing photosynthetic capacity lowers yield and sugar content. The further lowered by energy expended to grow new leaves and this ultimately affect sugar accumulation in roots, these findings agrees with those obtained by Poindexter, (2008).

Regarding to enzyme activity of invertase enzyme under infected, chemical fungicide and plant extract, as shown from Table 2, the highest enzyme activity values were under artificially infected conditions, followed by application of plant extract, while the lowest activity of the enzyme was recorded under fungicide treatments because high disease incidence related to high enzymatic activity and vice versa. The highest enzymatic activity obtained for Ras Poly because it had a high disease severity comprising with Fareda cv. Invertase enzyme known to have an effect on sugar crystallization, if it presented in high amount, it can affect sugar crystallization in the root. In different crops like wheat and sugar beet, sucrose content was negatively correlated with acid invertase activity in seedling. Earlier studies have shown that high activity of invertase is associated with activity growing tissues such as young seedlings, leaves and roots Bhowmik *et al.,* (2001), also they found that highly significant negative correlation was also found between sucrose synthetase activity and sucrose content. Moreover, other soluble sugars, glucose and fructose were positively significant when enzyme activities were high.

Regarding Na^+ and α-amino N on the leaves as shown in Table 2, high concentration of Na^+ of leaves incased by increasing disease incidence for artificially infected leaves either for Ras Poly or Fareda cvs.

K^+ content of leaves behaved in different manner. K^+ content decreased by increasing disease severity % either for Ras Poly or Fareda cvs., while under artificial inoculation, K^+ content of leaves recorded the highest compare with the other two treatments.

For α-amino N content of leaves increasing ascending by increasing disease severity % of leaves. So plants under artificial inoculation have highly concentration of α-amino-N followed by plant extract and Topsin M70, respectively Jensen *et al.,* (1983), reported that nitrogenous compounds in sugar beet roots, especially those contain α-amino nitrogen have a highly deleterious effect on juice purification and crystallization of sucrose.

As shown form Table 3, quality characters in roots of the two sugar beet cvs. affected by disease severity % of cercospora leaf spot disease, the same trend of enzymatic activity of leaves, Na^+, K^+ and α-amino N content were obtained and behaved in the same manner of leaves.

Regarding recoverable sugar (%), the highest values was obtained under chemically controlled plants followed by plant extract application, while it was less under infected plots.

Sugar loss to molasses (%) decreased by increasing disease severity (%) of cercospora leaf spot disease incidence. Beets with low sugar levels do not store well and loss in storage results form increased storage decay.

T2

T3

Profitable fields are additionally reduced due to greater levels of impurities in roots and decreased sugar loss to molasses during processing (Harvson, 2007).

In general, utilization of leaf spot-tolerant cultivars can significantly reduce disease severity and yield losses. Many new varieties are continually being developed that also adapted and contain multiple disease resistance. Resistant cultivars allow disease progress to develop more slowly even under favorable conditions. Some of the susceptible cultivars may have high yield potential in absence of leaf spot, but fungicidal applications will be necessary for satisfactory yields when disease becomes severe, but this can affect the air and soil. So, the safe option in this case to try plant extract for controlling this disease in sugar beet plantations

All quality characters including invertase enzyme were affected by high disease incidence of cercospora.

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بعض صفات الجودة ونشاط إنزيم الانفرتيز وعلاقته بمقاومة مرض تبقع الأوراق السركسبورى فى بنجر السكر

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أجرى هذا البحث بالصوبة السلكية بمحطة بحوث سخا الزراعية - محافظة كفرالشيخ خلال موسم ٢٠٠٨/٢٠٠٧م وذلك لدراسة العلاقة بين الإصابة بمرض تبقع الأوراق السركسبورى والمعاملة بمبيد التوبسين م ٧٠ بمعدل ١جم/لتر ومستخلص نبات الخلة بمعدل ٤٠٠٠ جزء فى المليون على الصفات المحصولية والتكنولوجية وكذا نشاط إنزيم الانفرتير فى بنجر السكر تم استخدام صنفي بنجر هما راس بولى وفريده وقد تم رش مبيد التوبسين م ٧٠ بمعدل ١ جم/لتر ومستخلص الخلة بمعدل ٤٠٠٠ جزء فى المليون قبل العدوى بثلاثة أيام وترك معاملة للعدوى الصناعية. وتم تنفيذ التجربة باستخدم تصميم القطع المنشقة مرة واحدة فى ثلاث مكررات وتمت العدوى الصناعية باستخدام الجراثيم الكونيدية لفطر السركسبورا *Cercopora beticola* بمعدل ٥٠ × ٣١٠ جرثومة/مل وذلك بعد ٩٠ يوم من الزراعة وتم أخذ أول عينة للتحليل قبل الرش بالمبيد و المستخلص وقبل العدوى الصناعية وتم أخذ أول قراءة للشدة المرضية لفطر تبقع الأوراق السركوسبوري بعد ١٥ يوم من العدوى الصناعية. وقد تم أخذ ٧عينات آخرى للتحليل ملازمة للقراءات بفاصل زمنى قدره ١٥ يوم.

وأوضحت النتائج أن الشدة المرضية لفطر السركسبورا تزداد تدريجيا خاصة للصنف راس بولى عن الصنف فريده وقلت الإصابة تحت معاملات المبيد والمستخلص النباتى وتأثرت بذلك صفات مثل وزن الجذر والنسبة المئوية الكلية للمواد الصلبة الذائبة والسكر ونقاوة العصير وكذا الكلوروفيل ونسبة العناصر مثل الصوديوم والبوتاسيوم وكذا الفا أمينو نيتروجين ونسبة الفقد فى كل من وزن الجذر والسكر وباقى الصفات.

وكان التأثير واضحا على نشاط إنزيم الانفرتيز وكانت أكثر تأثرا تحت ظروف العدوى وأقل تأثرا تحت ظروف استخدام المبيد أو المستخلص النباتى.

ويشير هذا البحث إلى أنه يمكن مقاومة مرض تبقع الأورق السركسبورى وذلك باستخدام مبيد التوبسين م ٧٠ أو مستخلص الخلة والذى يؤدى إلى خفض الشدة المرضية وبالتالى خفض نشاط إنزيم الانفرتيز الذى تؤدى زيادة نشاطه إلى منع بلورة السكروز وتحويله إلى سكريات أحادية وهى الفركتوز والجلوكوز مما يكون له تأثير سلبى على الناتج النهائى لمحصول السكر.

وأيضا يشير هذا البحث إلى أنه يمكن استبدال المبيد الفطرى بالمستخلص النباتى وذلك لتقليل التلوث البيئى باستخدام المبيدات وإلى خفض التكاليف فى مقاومة الأمراض.

Table (1):Effect of Cercospora leaf spot disease severity (%) on root weight (kg), TSS (%), sucrose (%), purity (%) and losses (%) on two sugar beet under artificial inoculation, Topsin M70 and Khella extract during 2007/2008 seasons.

Cultivar (V)	*Scoring (reading) (R)	** Disease severity (%)			Root weight (kg/plant)			TSS (%)			Sucrose (%)			Purity (%)			Reduction (Loss) (%) of			
																	Root weight		Sucrose	
		Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Topsin M 70	Khella	Topsin M 70	Khella
Ras poly	1	0	0	0	0.573	0.585	0.590	8.5	8.8	8.6	5.5	5.5	5.6	64.7	62.5	65.1	2.1	2.9	0	1.8
	2	0.5	0	0	0.650	0.671	0.677	11.4	11.5	11.8	7.9	8.1	8.2	69.3	70.4	69.5	3.1	3.9	2.5	3.7
	3	1.8	0	0	0.698	0.725	0.730	12.3	14.2	14.5	8.3	9.9	10.0	67.5	69.7	68.9	3.7	4.3	16.2	17.0
	4	5.9	0	0.5	0.860	1.150	1.143	14.6	16.4	16.2	11.2	13.7	13.6	76.7	83.5	83.9	25.2	24.8	18.2	17.6
	5	16.4	0.4	1.6	1.210	1.410	1.540	19.0	21.5	21.0	14.8	17.6	17.1	77.9	81.8	81.4	14.2	21.4	15.9	13.5
	6	31.6	0.9	5.8	1.451	1.750	1.639	17.1	24.1	23.0	13.5	20.4	19.6	78.9	84.6	85.2	17.1	11.5	33.8	31.1
	7	59.3	1.5	13.5	0.945	1.849	1.776	13.8	25.4	23.8	9.6	21.3	19.2	69.5	83.8	80.7	48.9	46.8	54.9	50.0
	8	86.8	2.3	26.4	0.635	2.110	1.805	9.0	25.1	21.5	5.8	21.0	17.8	64.4	83.6	82.7	69.9	64.8	72.4	67.4
Fareida	1	0	0	0	0.430	0.485	0.480	7.8	7.7	7.8	4.9	4.9	4.9	62.8	63.6	62.8	11.3	10.4	0	0
	2	0	0	0	0.590	0.595	0.600	10.3	10.3	10.5	7.6	7.6	7.6	73.8	73.8	72.4	0.8	1.7	0	0
	3	0.4	0	0	0.641	0.657	0.653	13.5	13.5	13.6	10.3	10.7	10.3	76.3	79.3	75.7	2.4	1.8	3.7	0
	4	1.3	0	0	0.766	0.801	0.811	15.6	15.5	15.5	12.8	13.2	13.1	82.1	85.2	84.5	4.3	5.5	3.0	2.3
	5	8.5	0	0.6	1.100	1.121	1.125	19.8	21.8	21.3	16.2	18.9	17.9	81.8	86.7	84.0	1.8	2.2	14.3	9.5
	6	15.6	0.2	4.3	1.384	1.430	1.490	18.4	25.0	25.2	15.6	21.4	21.0	84.8	85.6	83.3	3.2	7.1	27.1	25.7
	7	25.9	0.7	4.4	1.415	1.710	1.681	17.0	25.2	24.6	13.2	21.3	20.4	77.6	84.5	82.9	17.3	15.8	38.0	35.3
	8	38.7	1.5	10.8	1.450	1.915	1.840	15.4	25.3	23.3	11.3	21.1	19.2	73.4	83.4	82.4	24.3	21.2	46.4	41.1
L.S.D. 0.05 a		2.22			0.160			2.16			1.90			2.11			1.96		2.13	
L.S.D. 0.05 b		1.55			1.09			1.46			1.82			1.87			1.81		1.98	

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

** Caused by *Cercospora beticola*

a 2 varieties at each of treatments

b 3 treatments at each of V x R

Table (2):Effect of Cercospora disease severity (%) on chlorophyll content, enzyme activity, Na^+, K^+ and α-amino-N in leaves of two sugar beet cultivars under artificial inoculation, Topsin M70 and Khella extract during 2007/2008 seasons.

Cultivar (V)	*Scoring (reading) (R)	** Disease severity (%)			Chlorophyll content (mg/gm)			Enzyme activity (unit/100 g/hour)			Na^+			K^+			α-amino N		
		Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella
Ras poly	1	0	0	0	39.3	35.8	38.4	1.25	1.04	1.21	1.82	1.82	1.82	2.83	2.41	2.74	2.13	2.13	2.13
	2	0.5	0	0	47.9	48.3	47.1	1.52	1.09	1.25	1.88	1.76	1.76	2.80	2.39	2.63	2.21	2.17	2.17
	3	1.8	0	0.5	71.2	73.2	75.6	2.01	1.14	1.32	1.92	1.73	1.71	2.74	2.34	256	2.26	2.21	2.26
	4	5.9	0	0.5	83.4	89.6	87.5	2.68	1.19	1.72	2.00	1.71	1.65	2.69	2.28	2.49	2.33	2.26	2.32
	5	16.4	0.4	1.6	76.5	88.2	84.4	4.23	1.33	2.22	2.12	1.68	1.59	2.66	2.21	2.45	2.38	2.32	2.38
	6	31.6	0.9	5.8	56.7	80.9	75.3	4.87	1.71	3.28	2.18	1.62	1.53	2.61	2.18	2.38	2.49	2.37	2.46
	7	59.3	1.5	13.5	38.9	79.5	64.7	6.69	1.88	3.94	2.27	1.58	1.50	2.55	2.12	2.32	2.55	2.43	2.51
	8	86.8	2.3	26.4	18.5	75.2	59.2	9.03	1.97	4.61	2.37	1.50	1.42	2.49	2.08	2.29	2.61	2.48	2.56
Fareida	1	0	0	0	35.8	36.1	35.4	1.71	1.23	1.23	1.62	1.62	1.62	2.74	2.49	2.59	2.15	2.15	2.15
	2	0	0	0	42.2	43.4	41.8	1.79	1.28	1.29	1.78	1.56	1.56	2.70	2.46	2.52	2.19	2.17	2.17
	3	0.4	0	0	68.5	69.4	71.5	1.99	1.38	1.38	1.94	1.48	1.48	2.67	2.42	2.46	2.24	2.19	2.19
	4	1.3	0	0	75.9	85.3	87.1	2.34	1.52	1.59	2.01	1.45	1.42	2.61	2.38	2.40	2.37	2.27	2.24
	5	8.5	0	0.6	68.8	83.6	81.9	2.77	1.74	1.85	2.12	1.40	1.37	2.57	2.32	2.36	2.43	2.30	2.34
	6	15.6	0.2	4.3	62.2	79.5	72.4	4.13	1.83	2.12	2.21	1.38	1.31	2.50	2.28	2.18	2.49	2.34	2.42
	7	25.9	0.7	4.4	58.9	77.1	68.5	5.16	2.02	2.58	2.31	1.33	1.24	2.46	2.20	2.22	2.54	2.38	2.48
	8	38.7	1.5	10.8	51.4	75.6	65.3	5.98	2.35	2.83	2.80	1.29	1.17	2.40	2.11	2.17	2.62	2.50	2.54
L.S.D. 0.05 a		2.22			1.43			1.03			0.146			0.045			0.137		
L.S.D. 0.05 b		1.55			1.25			0.93			0.138			0.035			0.126		

* Started at 90 days from sowing until harvest with 15-days intervals.
** Caused by *Cercospora beticola*
a 2 varieties at each of treatments
b 3 treatments at each of V x R

Table (3):Effect of Cercospora disease severity (%) on enzyme activity, Na+, K+ , α-amino-N and some other quality characters in root of two sugar beet cultivars under artificial inoculation, Topsin M70 and Khella extract during 2007/2008 seasons.

Cultivar (V)	*Scoring (reading) (R)	** Diseases severity (%)			Enzyme activity (unit/100 g/hour)			Na^+			K^+			α-amino N			Reducing sugar (%)			Recoverable sugar (%)			Sugar loss to molasses (%)		
		Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella	Infected	Topsin M 70	Khella
Ras poly	1	0	0	0	2.18	2.09	2.09	0.36	0.36	0.36	8.92	6.94	6.94	1.31	1.31	1.31	0.10	0.10	0.10	1.91	2.59	2.69	2.99	2.31	2.31
	2	0.5	0	0	2.66	2.18	2.18	1.22	0.41	0.41	8.39	6.75	6.75	2.47	1.38	1.38	0.14	0.11	0.11	4.09	5.23	5.33	3.21	2.27	2.27
	3	1.8	0	0	3.13	2.22	2.26	1.24	0.58	0.70	7.82	5.67	6.22	2.55	1.45	1.72	0.25	0.13	0.14	4.67	7.33	7.18	3.03	1.97	2.22
	4	5.9	0	0.5	3.99	2.27	2.65	1.40	0.74	0.98	7.55	5.48	5.38	2.71	1.56	2.20	0.33	0.14	0.23	7.59	11.13	10.92	3.01	1.97	2.08
	5	16.4	0.4	1.6	6.46	2.42	2.99	1.85	0.82	1.12	7.23	4.53	5.20	2.82	1.72	2.57	0.41	0.16	0.26	11.14	15.32	14.41	3.06	1.68	2.09
	6	31.6	0.9	5.8	9.40	2.61	4.37	2.03	0.93	1.28	6.47	3.89	4.35	3.01	1.82	2.67	0.65	0.25	0.52	10.01	18.29	17.13	2.89	1.51	1.87
	7	59.3	1.5	13.5	10.30	2.75	4.56	2.52	1.04	1.38	3.44	3.63	3.97	3.32	2.28	2.80	0.94	0.50	0.90	6.96	19.19	16.82	2.04	1.51	1.78
	8	86.8	2.3	26.4	11.20	2.80	5.51	2.74	1.14	1.48	1.53	2.89	3.78	3.62	2.70	2.99	1.39	0.76	0.94	3.71	19.08	15.43	1.49	1.32	1.77
Fareida	1	0	0	0	2.28	1.99	1.99	0.10	0.10	0.10	7.55	5.56	5.56	1.09	1.09	1.09	0.10	0.10	0.10	1.89	2.57	2.57	2.41	1.73	1.73
	2	0	0	0	2.37	2.09	2.09	1.12	0.12	0.12	6.89	5.01	5.01	1.28	1.28	1.28	0.11	0.11	0.11	4..44	5.43	5.43	2.56	1.57	1.57
	3	0.4	0	0	2.60	2.18	2.18	1.19	0.23	0.23	6.52	4.70	4.70	2.03	1.35	1.35	0.14	0.12	0.12	7.18	8.59	8.19	2.52	1.51	1.51
	4	1.3	0	0	3.10	2.29	2.35	1.24	0.39	0.54	5.87	4.48	3.46	2.43	1.42	1.48	0.25	0.13	0.14	9.84	11.11	11.30	2.36	1.49	1.20
	5	8.5	0	0.6	3.71	2.35	2.42	1.36	0.57	0.86	5.64	4.26	3.37	2.71	1.48	2.03	0.38	0.14	0.25	13.26	16.81	15.97	2.34	1.49	1.33
	6	15.6	0.2	4.3	4.94	2.47	2.51	1.51	0.74	1.06	5.32	4.06	3.08	2.80	1.69	2.70	0.61	0.15	0.36	12.71	19.31	19.04	2.29	1.49	1.36
	7	25.9	0.7	4.4	6.83	2.66	3.61	1.62	0.91	1.22	3.15	3.88	2.68	3.08	2.01	2.80	0.70	0.23	0.62	10.98	19.18	18.51	1.62	1.52	1.29
	8	38.7	1.5	10.8	7.60	2.75	3.98	1.83	1.04	1.31	1.25	3.50	1.07	3.31	2.56	3.15	0.81	0.46	0.71	9.64	19.01	17.80	1.06	1.49	0.80
L.S.D. 0.05a		2.22			1.16			0.69			0.53			0.47			0.119			1.12			0.44		
L.S.D. 0.05b		1.55			0.94			0.56			0.77			0.31			0.113			1.07			0.29		

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

**** Caused by *Cercospora beticola***

a 2 varieties at each of treatments

b 3 treatments at each of V x R