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EFFECT OF FOLIAR AND SOIL APPLICATION DATES OF YEAST (*Saccharomyces Cerevisiae*) ON SUGAR BEET PRODUCTIVITY AND QUALITY

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ABSTRACT

This investigation was carried out at El-Manyal Village, Talkha District, Dakahlia Governorate, during 2012/2013 and 2013/2014 growing seasons to evaluate the role of three times of foliar and soil applications of yeast at 60, 75 and 90 days after sowing (DAS), compared to the control on productivity and quality of sugar beet "cv. Kawemira". The main results could be summarized as follows:

1- Spraying plants with yeast significantly increased the averages of all studied characters in both seasons compared with the control treatment (without yeast spraying), except root diameter and root juice apparent purity percentage.
2- Delaying spraying beet plants with yeast from 60 to 70 and 90 DAS resulted in gradual significant decreases in root fresh weight/plant, root length as well as root and sugar yields/fad., in both seasons. On the other side, the same treatment resulted in gradual significant increases in total soluble solids and sucrose percentages in both seasons.
3- Soil applications of yeast significantly increased the averages of root fresh weight/plant, root dimensions (length and diameter) as well as root and sugar yields/fad., in both seasons compared with the control (without yeast soil application) as well as total soluble solids percentage and root sucrose contents in the second season. On the other hand, the same treatment significantly decreased root juice apparent purity percentage in the second season.
4- Delaying soil applications of yeast from 60 to 90 DAS significantly decreased root fresh weight/plant, root length and diameter as well as root and sugar yields/fad., in both seasons and the percentages of root sucrose and root juice apparent purity in the second season. However, the same treatment significantly increased total soluble solids in the second season.
5- The interaction between times of foliar and soil applications of yeast had significantl effect on root and sugar yields/fad., in both seasons.

Generally, it could be concluded that adding yeast as a foliar and a soil applications for sugar beet plants at the age of 60 days is recommended to maximize its productivity and quality under the environmental conditions of Dakahlia Governorate.

Keywords: Sugar beet, *Beta vulgaris* L., yeast foliar application, yeast soil application, yield, quality.

INTRODUCTION

During last years, a great carefulness of procedures of some crops as wheat, corn and potatoes was done to use carbon dioxide to improve productivity and quality. Some of them burn weeds around their fields, others use yeast. Benefits of yeast include; A) Its contents of proteins, growth substances (growth regulators) and vitamins - and B) What it produce of carbon dioxide during respiration. How to use of yeast pushed researchers to investigate this subject from many sides. Concerning yeast composition and its effect on nutrients absorption, Warring and Phillips (1973) stated that

yeast application promote vegetative and fruit growth due to its richness in tryptophan which considered precursor of indole acetic acid (IAA). Also it plays a role in flower initiation due its effect on carbohydrates accumulation. Natio *et al.* (1981) showed that yeast treatments play a beneficial role in cell division and cell enlargement. Nagodawithana (1991) stated that yeast as a natural stimulator was characterized by its richness in protein (47%), carbohydrates (33%), nucleic acid (8%), as well as Na, Mg, K, P, S, Zn, Cu, Ni, Va and Li. In addition to thiamin, riboflavin pyridoxine, hormones and other growth regulation substances, and folic acid. Mok and Mok (2001) stated that the positive effect of yeast on yield and its components may be attributes to that, yeast was still alive and effective to provide the vines with synthetic endogenous cytokinins, minerals (macro and micro-elements) and 18 amino acids, vitamins (B1, B2, B3, B5 and B6), folic acid and bitin acting as cofactors for over 60 enzymes, which catalyze many biochemical pathways involving amino acids and removing amino groups from amino acids to be used for energy that involved in several bioactivities.

Some researchers studied the effect of the foliar application of yeast as; El-Tarabily (2004) who stated that yeast application significantly increased fresh weight of root and foliage of sugar beet. This effect may be due to the role of yeast as a natural source of cytokinins which has stimulated effects on cell division and enlargement as well as synthesis of protein nucleic acid and chlorophyll. These effects are very important for top, root and sugar yields of sugar beet. Shahin *et al.* (2004) reported that foliar application of yeast extract on sugar beet plants caused significant increases in top, root and sugar yields, as well as the highest values of TSS%, sucrose% and apparent purity%. Shalaby and El-Nady (2008) found that yeast treatment as a foliar and a soil applications increased root length, root diameter, root fresh weight, TSS%, sucrose%, root and sugar yields/fad., in both seasons. Essam *et al.* (2012) studied the effect of yeast at the rate of 5 g/liter as a soil application and a foliar spraying on sugar beet. They found that these treatments increased root yield components as well as root and gross sugar yields/fad., in both seasons. Mohamed (2012) found that different yeast treatments surpassed nitrogen and micro-nutrients for root and foliage fresh weights and root length and diameter. The highest values of these characters were recorded for plants received the yeast treatment. Aly *et al.* (2014) found that yeast foliar application increased all studied characters compared with the control treatment (without yeast application). Awad and Moustfa (2014) found that spraying sugar beet plants with yeast significantly increased the percentages of sugar recovery and root juice purity and recoverable sugar yield (t/fad) in both seasons.

Concerning the effect of soil application of yeast, Stemwedel (2009) found that soil application of yeast showed improvement in humus and organic carbon contents, and significantly lower specific gravity as compared to the soil treated with chemical fertilizer. He also added that the favourable effect of yeast might be due to that yeast work on development of soil properties and encourage increase in the absorption of K and P elements from soil by beet roots. With soil application of yeast, sugar beets absorb

nutrients from soil faster than almost any other crops and, as a result, yeast is exceptionally rich in Mg, Na, Cu, Mn, Fe, Zn and other natural factors to yeast. Ferweez *et al.* (2011) stated that significant differences in root length and diameter, pol (%), alpha amino-N, Na and K contents and sugar recovery (%) of sugar beet as well as root and recoverable sugar yields (t/fad) of sugar beet were found between the studied treatments of yeast soil applications (0, 2.0 and 4.0 kg/fad.,). The highest values of root length, root diameter as well as root and recoverable sugar yields/fad., were recorded with soil application of yeast at the rate of 2 kg/fad. Abd El-Azez (2014) stated that soil application of yeast increased root yield components, root sucrose percentage, root and sugar yields/fad., in both seasons.

Concerning time of yeast spraying on sugar beet, Awad and Moustfa (2014) found that time of spraying beet plants with yeast had no significant effect on all studied characters.

So, this investigation aimed to investigate the effect of both foliar and soil application dates of yeast on productivity and quality of sugar beet "cv. Kawemira".

MATERIALS AND METHODS

The present investigation was carried out at El-Manyal Village, Talkha District, Dakahlia Governorate during the two successive winter seasons of 2012/2013 and 2013/2014, to study the effect of foliar and soil applications of yeast and time of its applications on productivity and quality of sugar beet "cv. Kawemira".

A split plot experiment in a randomized complete block design with three replicates was used. The main plots were occupied with the times of yeast foliar application (without, at 60, 75 and 90 days after sowing). While, the sub-plots were devoted to the dates of yeast soil applications (without, at 60, 75 and 90 days after sowing). Trade cold maceraled yeast were used after preparation (rubbing 2 kg of yeast in about 20-30 liters of worm water and mixed with 4 kg treacle). After 20-30 minutes, water was added to complete the solution to be 200 liters/fad.

The experimental basic unit included five ridges, each of 60 cm width and 3.5 m long, comprising an area of 10.5 m^2 (1/400 fad). The previous crop was maize (*Zea mays* L.) in both seasons. Soil samples were taken at random from the experimental field area at a depth of 0.0-30 cm from soil surface and prepared for both mechanical (physical) and chemical analyses. The mechanical and chemical properties of the experimental soil are presented in Table 1.

The experimental field area was well prepared through three ploughings, leveling, compaction and then divided into the experimental units. Both, calcium superphosphate (15.5% P_2O_5) at the rate of 31 kg P_2O_5/fad. and potassium sulphate (48.0% K_2O) at the rate of 24 kg K_2O/fad., were added before the last ploughing, then ridging and division were done.

Sowing of dry sugar beet balls took place in the dry soil during the first week of September in both seasons. The experimental field area was

immediately irrigated after sowing. Nitrogen in the form of urea (46.5% N) at the rate of 80 kg N/fad., was added in two equal doses at the first and second irrigations after thinning. Plants were kept free from weeds by hand hoeing for three times. All normal agricultural practices with the exception of the studied factors were conducted as usually done for growing sugar beet according to the recommendations of Ministry of Agriculture and Land Reclamation.

Table 1: Mechanical and chemical soil properties of the experimental site during the two growing seasons of 2012/2013 (I) and 2013/2014 (II).

Soil analysis	I	II
A: Mechanical properties:		
Fine sand (%)	9.60	10.20
Coarse sand (%)	5.30	4.90
Silt (%)	32.10	30.80
Clay (%)	52.90	54.00
Texture	Clayey	Clayey
B: Chemical analysis		
Soil reaction pH	7.60	7.70
Available N (ppm)	48.40	49.30
Available P (ppm)	11.50	12.00
Exchangeable K (ppm)	140.00	130.00

Studied Characters:

A- Root attributes and quality parameters:

At harvest time (210 days after sowing), ten plants were randomly chosen from the three inner ridges of each plot to estimate root yield attributes and quality parameters as follows:

1. Root fresh weight (g/plant).
2. Root length (cm).
3. Root diameter (cm).
4. Total soluble solids percentage (TSS %) in roots, which was measured in juice of fresh roots by using Hand Refractometer.
5. Sucrose percentage, which was determined Polarimetrically in a lead acetate extract of fresh macerated roots according to the method of Carruthers and OldField (1960).
6. Apparent purity percentage. It was determined as a ratio between sucrose % and TSS % of roots according to Carruthers and OldField (1960).

B- Root and sugar yields:

At harvest, all plants that produced from the three inner ridges of each plot were collected and cleaned. Roots and tops were separated and weighed in kilograms, then converted to estimate:

1. Root yield (t/fad).
2. Sugar yield (t/fad), that it was calculated by multiplying root yield by sucrose percentage.

All obtained data were statistically analyzed according to the technique of analyses of variance (AOV) for the split plot in a randomized

complete block design as outlined by Gomez and Gomez (1984) by using means of "MSTAT-C" computer software package. Least Significant of Differences (LSD) method was used to test the differences between treatment means at 5% level of probability as described by Waller and Duncan (1969).

RESULTS AND DISCUSSION

1- Effect of yeast application:

1-A. Effect of yeast foliar application:

Results in Table 2 show that spraying sugar beet plants with yeast resulted in significant increases in the averages of all studied characters, except root diameter and root juice apparent purity percentage compared with the control over both seasons. These obtained results may be due to; A) The fact that, yeast continually produce carbon dioxide as a result of its respiration. Carbon dioxide increases as a percentage of the air around beet plants that make use of it through its respiration producing more sugars or carbohydrates – and B) Yeast contents of proteins, growth substances and vitamins as it were mentioned by Warring and Phillips (1973), Natio *et al.* (1981), Nagodawithana (1991) and Mok and Mok (2001). Similar results were obtained by El-Tarabily (2004), Shalaby and El-Nady (2008) and Aly *et al.* (2014).

1-B. Effect of yeast soil application:

Results presented in Table 2 indicate that soil application of yeast significantly increased the averages of root fresh weight/plant, root length and diameter as well as root and sugar yields/fad., in both seasons and the percentage of total soluble solids (TSS %) in the second season compared to the control. While, the same treatment significantly decreased the percentages of root sucrose and root juice apparent purity in the second season. The obtained increases in the previous mentioned characters may be due to the facts that; A) Increasing carbon dioxide in the soil air led to decrease the soil pH (or increasing soil acidity) as a result to its reaction with the soil water giving carbonic acid according to the following equation;

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

Carbonic acid led to solve some of soil phosphatic compounds and so it increases the phosphorus compounds in soil solution. Moreover, decreasing the soil pH (or increasing the soil acidity) led to increase the availability of nutritive elements to absorption by plants. – and B) Yeast contents of proteins, growth substances (growth regulators) and vitamins as it were mentioned by Warring and Phillips (1973), Natio *et al.* (1981), Nagodawithana (1991) and Mok and Mok (2001). Similar results were stated by Stemwedel (2009), Ferweez *et al.* (2011) and Abd El-Azez (2014).

2-

2- Effect of date of yeast application:

2-A. Effect of yeast foliar application date:

Results listed in Table 2 clear that, delaying spraying sugar beet plants with yeast from 60 up to 90 days after sowing (DAS) resulted in gradual significant decreases in root fresh weight (g/plant), root length as well as root and sugar yields/fad., over both seasons. On the other side, the same treatment resulted in gradual significant increases in the percentages of total soluble solids (TSS %) and root sucrose content in both seasons. The gradual deceases in root fresh weight/plant, root length, root and sugar yields/fad. and the increases in the percentages of TSS and root sucrose content associated with the gradual delay of yeast foliar application may be due to the fact that delaying spraying beet plants with yeast decreased the period of duration life that beet plants can grow well using of yeast respiration and its production of carbon dioxide, whereas beet plants tended to decrease its vegetative growth and storage its moreover photosynthetic in roots. Converse results were stated by Awad and Moustfa (2014).

2-B. Effect of yeast soil application date:

Results in Table 2 indicate that date of yeast soil application had significant effects on all studied characters in both seasons, except the percentages of TSS, root sucrose content and root juice apparent purity in the first season. Delaying dates of yeast soil application from 60 up to 90 DAS resulted in gradual decreases in root fresh weight (g/plant), root length and diameter (cm) as well as root and sugar yields/fad., in both seasons and also gradual decreases in the percentages of root sucrose content and root juice apparent purity in the second season. However, the same treatment gradually increased TSS % in the second season. These obtained results may be due to the fact that, delaying the soil application of yeast led to cut short the time that beet plants are able to absorb soil soluble nutrients, that were solved by the action of carbonic acid that was formed as previously mentioned from link (reaction) of carbon dioxide (produced as a result of yeast respiration) with soil water during the end of vegetative stage of beet plants and building strong canopy before maturity. During maturity stage, plants continue in absorption for nutrients (increasing impurities or TSS) producing small late leaves, that they are the reason of decreasing root sugar content and helping as an indirect cofactor to increase TSS%.

3. Effect of the interaction:

Results in Table 2 clear that all studied characters were not significantly affected by the interaction between times of soil and foliar of yeast applications, except root and sugar yields (t/fad) in both seasons.

Results in Table 3 show that both root and sugar yields (t/fad) were significantly affected by the interaction between times of soil and foliar applications of yeast in both seasons. Adding yeast as a foliar and a soil applications at the age of 60 days recorded the highest values of root yield (34.031 and 34.371 t/fad) and sugar yield (6.195 and 6.283 t/fad) in the first and second seasons, respectively. While spraying beet plants with yeast at 75 DAS and the soil addition at the age of 60 days came in the second rank with this respect, where this treatment yielded 33.769 tons of roots/fad., in the

second season and 6.177 and 6.237 tons of sugar/fad., in the first and second seasons, respectively. These obtained results may be due to the facts that, mechanism of yeast as a foliar application different from its mechanism as a soil application, while in the first case it depends on increasing (accumulation) of carbon dioxide around canopy. Plant make use of it through its photosynthesis, but in the second case it depends on increasing carbon dioxide among soil gases that reacts with soil water giving carbonic acid, that cause increase in soil acidity that encourage absorption of nutrients by sugar beet roots from the soil. Moreover, El-Tarabily (2004) stated that yeast application significantly increased fresh weight of root and foliage of sugar beet. This effect may be due to the role of yeast as a natural source of cytokinins which has stimulated effect on cell division and enlargement as well as synthesis of protein nucleic acid and chlorophyll. These effects are very important for top, root and sugar yields of sugar beet – and Stemwedel (2009) who stated that the favorable effect of yeast might be due to that yeast work in development of soil properties and encourage increase in the absorption of K and P elements from soil by beet roots. With soil application of yeast, sugar beets absorb nutrients from soil faster than almost any other crops and, as a result, yeast is exceptionally rich in Mg, Na, Cu, Mn, Fe, Zn and other natural factors to yeast.

Table 3: Root and sugar yields/fad., as affected by the interaction between time of foliar and time of soil applications of yeast during 2012/2013 (I) and 2013/2014 (II) seasons.

Sugar yield (t/fad.,)		Root yield (t/fad.,)		Characters / Treatments	
II	I	II	I	Time of yeast soil application	Time of yeast foliar application
6.283	6.195	34.371	34.031	60 DAS	60 DAS
6.069	6.052	33.740	33.380	75 DAS	
5.885	5.951	32.883	33.061	90 DAS	
6.237	6.177	33.769	33.215	60 DAS	75 DAS
5.998	6.033	33.108	32.780	75 DAS	
5.929	5.908	32.745	32.451	90 DAS	
6.083	6.136	32.553	32.640	60 DAS	90 DAS
5.881	5.951	32.136	32.139	75 DAS	
5.806	5.797	31.683	31.677	90 DAS	
*	*	*	*	F. test	
0.456	0.443	2.379	1.980	LSD at 5 %	

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تأثير مواعيد الإضافات الورقية والأرضية للخميرة على إنتاجية وجودة بنجر السكر

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أقيمت تجربتان حقليتان بقرية المنيل – مركز طلخا – محافظة الدقهلية خلال موسمى الزراعة ٢٠١٢/٢٠١٣ و ٢٠١٣/٢٠١٤ م – بغرض دراسة تأثير ثلاثة مواعيد للرش الورقى عند عمر ٦٠ ، ٧٥ و٩٠ يوماً وكذلك ثلاثة مواعيد للإضافة الأرضية أيضاً عند عمر ٦٠ ، ٧٥ و٩٠ يوماً مقارنةً بمعاملة المقارنة (بدون إضافة ورقية أو أرضية) بالإضافة إلى التفاعل بينهما على إنتاجية وجودة بنجر السكر "صنف كواميرا -عديد الأجنة". نفذت التجارب بنظام القطع المنشقة كاملة العشوائية فى ثلاث مكررات. ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

١- أظهرت النتائج أن رش نباتات بنجر السكر بالخميرة سببت زيادة متوسطات قيم جميع الصفات المدروسة بالمقارنة بها للنباتات التى لم يتم رشها خلال الموسمين فيما عدا قطر الجذر ونقاوة عصير الجذور حيث أن تأثرهما لم يكن معنوياً.

٢- أدى تأخير رش نباتات بنجر السكر بالخميرة من عمر ٦٠ حتى ٩٠ يوماً إلى نقص معنوى تدريجى فى صفات الوزن الغض للجذور وطول الجذور وكذلك محصولى الجذور والسكر/فدان خلال الموسمين – وعلى النقيض من ذلك فقد أدت هذه المعاملة إلى زيادة معنوية تدريجية لكل من النسبة المئوية للمواد الصلبة الذائبة الكلية بالجذور ونقاوة العصير خلال الموسمين.

٣- أظهرت النتائج أن الإضافة الأرضية للخميرة أدت إلى زيادة معنوية فى متوسطات قيم صفات الوزن الغض للجذور وطول وقطر الجذر وكذلك محصولى الجذور والسكر بالطن/فدان خلال الموسمين وكذلك النسبة المئوية لكل من المواد الصلبة الذائبة الكلية بالجذور ومحتوى الجذور من السكروز فى الموسم الثانى وذلك بالمقارنة فى حالة عدم الإضافة الأرضية للخميرة – بينما أدت هذه المعاملة إلى نقص معنوى فى نقاوة عصير الجذور فى الموسم الثانى بالمقارنة بعدم الإضافة الأرضية للخميرة.

٤- أدى تأخير الإضافة الأرضية للخميرة من عمر ٦٠ حتى ٩٠ يوماً إلى نقص معنوى فى متوسطات صفات الوزن الغض للجذور وطول وقطر الجذر وكذلك محصولى الجذور والسكروز بالطن/فدان خلال الموسمين وكذلك النسبة المئوية لكل من محتوى الجذور من السكروز ونقاوة عصير الجذور فى الموسم الثانى – بينما أدت هذه المعاملة إلى زيادة معنوية تدريجية لصفة النسبة المئوية للمواد الصلبة الذائبة الكلية بالجذور فى الموسم الثانى.

٥- تأثرت صفتى محصولى الجذور والسكر بالطن/فدان خلال الموسمين بالتفاعل بين مواعيد الإضافتين الورقية والأرضية للخميرة وتم الحصول على أعلى القيم لهاتين الصفتين خلال الموسمين عند الإضافة الورقية والإضافة الأرضية عند عمر ٦٠ يوماً لمحصول بنجر السكر.

بصفة عامة توصى هذه الدراسة بضرورة الإضافتين الورقية والأرضية للخميرة عند عمر ٦٠ يوماً للحصول على أعلى إنتاجية وجودة لمحصول بنجر السكر تحت ظروف محافظة الدقهلية.

Table 2: Root fresh weight, root length and diameter, percentages of total soluble solids (TSS), sucrose and juice purity and root and sugar yields/fad., as affected by time of foliar and soil application of yeast and their interaction during 2012/2013 (I) and 2013/2014 (II) seasons.

Sugar yield (t/fad.,)		Root yield (t/fad.,)		Purity(%)		Sucrose (%)		TSS (%)		Root diameter (cm)		Root length (cm)		Root fresh weight (g/plant)		Characters
II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	Treatments
A- Time of foliar application of yeast:																
6.077	6.079	33.313	33.348	78.11	79.20	18.25	18.23	23.37	23.02	12.35	12.22	31.32	31.29	1030.0	1037.9	60 DAS
6.073	6.055	32.873	32.682	78.72	79.01	18.49	18.52	23.50	23.45	12.00	12.00	31.21	30.85	1018.7	1016.2	75 DAS
5.923	5.979	31.690	31.983	77.90	79.39	18.70	18.70	24.02	23.55	11.72	11.87	29.91	30.32	993.7	997.5	90 DAS
5.161	5.102	29.300	28.877	79.04	79.29	17.60	17.67	22.27	22.30	11.70	11.87	29.63	29.80	913.7	895.8	Without application
6.024	6.038	32.625	32.671	78.24	79.20	18.48	18.48	23.63	23.34	12.02	12.03	30.81	30.82	1014.1	1017.2	Means
*	*	*	*	NS	NS	*	*	*	*	NS	NS	*	*	*	*	F. test
0.132	0.118	0.926	0.990	-	-	0.34	0.41	0.28	0.36	-	-	0.98	0.81	31.7	23.3	LSD at 5 %
B- Time of soil application of yeast:																
6.012	5.946	32.776	32.382	78.94	79.43	18.35	18.35	23.25	23.10	12.60	12.60	31.38	31.32	1020.0	1007.0	60 DAS
5.791	5.801	32.108	31.878	76.76	78.48	18.03	18.18	23.50	23.17	12.05	12.05	30.75	30.84	997.5	991.2	75 DAS
5.689	5.671	31.621	31.447	76.06	77.88	17.98	18.02	23.65	23.15	11.65	11.77	30.21	30.33	982.5	977.9	90 DAS
5.741	5.797	30.670	31.182	82.00	81.10	18.68	18.57	22.77	22.90	11.48	11.55	29.74	29.77	956.2	971.2	Without application
5.808	5.804	31.794	31.722	78.44	79.22	18.26	18.28	23.29	23.08	11.95	11.99	30.52	30.57	989.1	986.8	Means
*	*	*	*	*	NS	*	NS	*	NS	*	*	*	*	*	*	F. test
0.128	0.121	0.789	0.690	0.97	-	0.48	-	0.31	-	0.63	0.71	0.91	0.70	33.6	27.2	LSD at 5 %
C- Interaction:																
*	*	*	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	A × B