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Yield and quality response of some sugar beet (*Beta vulgaris* L.) varieties to humic acid and yeast application in newly reclaimed soil

Alice T. Thalooth, M.M. Tawfik, Elham A. Badre and Magda H. Mohamed

Field Crops Research Department, National Research Centre, 33 El-Buhouth St., (former El- Tahrir St.,) Dokki, Giza, Egypt. Postal Code: 12622.

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ABSTRACT

Field trials were conducted at Research and Production Station, National Research Centre, Alemam Malek village, Al Nubaria District, Al Behaira Governorate, Egypt in winter seasons of 2015 and 2016 to study the response of, yield and quality of three sugar beet (*Beta vulgaris* L.) cultivars to foliar application of humic acid and yeast and their combination under newly reclaimed sand soil .The obtained results show significant differences among tested cultivars in most studied character but cultivar Heba surpassed the other two cultivars. The results also indicate that either humic acid or yeast have promoting effect on all studied character but yeast application was more effective than humic acid. Maximum sugar yield and quality obtained by Haba variety foliar sprayed with combined application with humic acid and yeast.

***Keywords*: Sugar beet, Humic acid, Yeast, Yield, Quality**

Introduction

Sugar beet (*Beta vulgaris* L.) is a member of the family *Chenopodiaceae* is one of the most important sugar crops in the world. Sugar beet, grown as a feedstock for the production of pure sugar is one of the most important cash crops in the world. Sugar beet grown area in Egypt have been increased to 423.000 faddan in 2014. It is the second main source of sugar after sugar cane in Egypt. Now great attention is being devoted to search for advanced crop management techniques in agriculture and untraditional natural and safe stimulating growth substances to increase sugar beet productivity. Thus, possibilities of utilization of various biologically active matters such as humic acid and yeast for regulation of sugar beet growing process have been investigated.

Humic compounds occupy a key position because of their multifarious roles in maintaining improving soil fertility and positively affecting physiological functions (both of soil biota as well as plants). Plenty of information is available on the beneficial effect of organic matter and especially humic compounds in the soil-plant system (Arancon *et al.,* 2006; Khaled and Fawy, 2011) Moreover, the positive effects of humic acid on the growth and yield of sugar beet have been reported by Abd El-Aal and Abd El-Rahman, (2014) and Rassam *et al*. (2015).

The use of yeast as a bio-fertilizer in agriculture has received considerable attention because of their bioactivity and safety for human and the environment. Yeast is a natural bio- product rich in proteins, carbohydrates, minerals and vitamins, beside, hormones and other growth regulating substances (Nagodawithana, 1991). Yeasts represent an abundant and dependable source of bioactive and chemically novel compounds. A growing number of studies indicate that plant root growth may be directly or indirectly enhanced by yeasts (Boraste *et al.,* 2009).

Thus, the aim of this work is to study the effect of application of humic acid and yeast on yield and quality of sugar beet plants. In addition, there are significant differences among most sugar beet varieties.

So, it is preferable to evaluate them under these factors especially under newly reclaimed soils to select the best suited ones.

Material and Methods

Field experiment was carried out at the Agricultural Production and Research Station, National Research Centre, Nubaria Province, Behaira Governorate, Egypt, during the winter season of 2015/2016 to study the effect of foliar application of humic acid and yeast on yield of sugar beet

Corresponding Author: Alice T. Thalooth, Field Crops Research Department, National Research Centre, 33 El-Buhouth St., (former El- Tahrir St.,) Dokki, Giza, Egypt. Postal Code: 12622. E-mail: thaloothadel@yahoo.com

plants. The mechanical and chemical analysis of the soil was conducted according to the method described by Klute (1986) and is presented in Table (1).

Table 1: Mechanical and chemical analyses of the

Mechanical	Analysis	Chemical analysis	
Sand %	91.2	Organic matter%	0.3
Silt %	4.0	E.C mmhos/cm^3	0.3
Clay %	4.8	pH	7.4
$CaCO_3$ %	1.3	Soluble N ppm	7.7
Soil texture	Sandy	Available P ppm	2.9
		Exchange K ppm	19.8

Three sugar beet varieties were evaluated under soil application with either humic acid) or yeast and both of them. The experimental design was split block design with three replicates where the main plots allocated to the three sugar beet varieties. On 17th November 2015 sugar beet varieties *Chenopodiaceae* c.v (Heba, Sirana and Peti) was sown on sand soil. Each plot were divided to three sub plots and subjected to the following. treatment: (1) plants treated with Humic acid at level of (2 gm/ liter) (2) plants treated with Yeast at level of (32 gm/ liter) and (3) plants treated with both Humic acid at level of (1 gm/ litre) and Yeast at level of (16 gm/ litre). Treatments carried out after one month of sowing at volume of 200 liter per feddan. The normal agriculture practices of growing sugar beet were practiced till harvest as recommended.

At harvest time (201) days from sowing) one square meter was taken at random from the three replicates from each sub plot to determine root characters (length and diameter) (cm) and fresh weight of top ,root and total weight of top and roots (gm / plant) .Yield of top , root and total weight of top and roots (Kg/m^2 and ton per Faddan) was also estimated.

Three roots were chosen randomly from each sub blot to determine sucrose percentage as described by Le- Docte (1927). Sugar yield was obtained by multiplying sugar % by root yield. Potassium and Sodium were measured in the root dry weight at harvest time, by using the Flame photometer. α Amino nitrogen was also calculated by double beam filter photometry using the blue number method Sheikh_Aleslami (1997) . Juice purity percentage (QZ) was calculated as following QZ= ZB/ Pol .Impurities percentage %calculated as the formula = {(K + Na) x 0.0343) + (alpha amino – N x 0.094) + 0.29} as described by Carruthers et al.(1962) . White sugar contents were calculated using the formula of Reinefeld *et al.* (1974): WSC = SC– MS– SFL. White sugar yield (WSY) = root yield (RY) * WSC.

The results were submitted to analysis of variance according to Snedecor and Cochran (1982). Differences among treatment means were determined using the LSD test at a significance level of 0.05.

Results and Discussion

1- Varietal differences

1.1. Effect on root characters:

Statistical analyses of data in Table (2) indicated significant differences in length and diameter per plant among sugar beet varieties. Heba variety recorded the highest values (40.11 and 8.89 cm respectively). While Sirana variety was ranked the second. Similar results obtained with other sugar beet obtained by Aly (2006), El-Bakary (2006) and Ismail *et al.* (2006). Varieties differences in root parameters were also recorded by Ahmed *et al.* (2012). The variations among the tested sugar beet varieties in these traits might be due to the gene make-up action, which plays an important role in plant structure and morphology.

1.2. Effect on fresh weight per plant:

Results illustrated in Table (2) also revealed that fresh weight of root, top and total weight of plant was significantly differed by varieties. Heba variety also occurred a significant superiority over the other varieties in root and total weight of sugar beet. Similar results obtained by Aly (2006), El-

Bakary (2006) and Ismail *et al.* (2006). In this respect, Shalaby *et al.* (2011) and Hozayn (2013) reported that there are high significant differences among cultivars in root weight of sugar beet.

1.3. Effect on sugar beet yield:

Data presented in Table (2) clearly show that there is a significant difference among sugar beet cultivars for top yield, root yield as well as total sugar beet yield (Kg/m^2 or ton/ faddan).However , Hepa cultivar surpassed all other cultivars on all above mentioned characters. Hepa cultivar gained 1.68, 5.00, 6.68 Kg/ m2 and 7.05, 1.01, 28.06 ton /faddan for top yield, root yield as well as total sugar beet yield respectively. The data also show that such increase in root yield was strongly related to root performance, i.e. root length, diameter and fresh weight. Thus, The increase in sugar beet yield may be due to that Heba variety was superior in root characters (length and diameter) and fresh weight of root. Such effect of variety on sugar yield supported by many researchers (Abd El-Aal, and Amal 2005, Ismail *et al.*, 2006, Shalaby *et al.,* 2011 and Hozayn, 2013). In this respect, Ebrahimian *et al.* (2009) stated that there is a significant difference among sugar beet cultivars for different parameters tested.

1.4. Effect on sugar yield and white sugar yield:

Regarding sugar yield (Ton/ faddan) and white sugar yield, a significant difference was found among varieties (Table 3). A maximum sugar yield was observed in Hepa variety (3.12 ton/faddan) followed by Sirana (2.44 ton/faddan), while minimum in Peti (2.12 ton /faddan).The same trend also observed for white sugar yield. The recorded data were 2.94, 1.95 and 1.62 for the varieties Heba , Sirana and Peti respectively. From the obtained results in Table (2) it is clear that sugar yield as a final product positively correlated with root characters as well as root weight. It means that more is root yield of beets the highest will be the sugar yield. Thus, the increase in sugar yield of Heba variety may be due to the superiority records of root characters and yield. Similar results obtained by,Abd El-Aal and Amal (2005), Ahmed (2008) and Ebrahimian *et al.* (2009). Varieties differences in sugar yield was also recorded by Ahmed *et al.* (2012), Ahmad and Rasool (2011) and Hozayen (2013).

2. Effect of f humic acid and yeast application:

2.1. Effect on root characters:

Regarding root parameters, their length, diameter and fresh weight as presented in Table (2) significantly enhanced by yeast application as compared with humic acid. These results were in agreement with those obtained by Shalaby and El-Nady (2008) and Nemeat Alla *et al.* (2016) who reported that addition yeast to sugar beet plants at the rate of 15 g / l produced the biggest roots dimension (length and diameter).Such enhancing effect of yeast application might be due to yeast cytokinins enhancing the accumulation of soluble metabolites (Muller and Leopold, 1966).

The same table also show that combined application of yeast and humic acid has enhancing effect on root characters, length and diameter than single application of either yeast or humic acid. Such effect may be attributed to the combined effect of humic acid and yeast together. In this respect, Rassam *et al.* (2015) and EL-gamal *et al.* (2016) indicated that application of humic acid significantly increased root length and root diameter compare with untreated plants. This may be due to promoted nutrient uptake of plants by addition of humic substances which affect membrane permeability (Zientara, 1983). Nardi *et al.* (2002) and Eyheraguibel *et al.* (2008) also reported that humic acid may have various biochemical effects either at cell wall, membrane level or in the cytoplasm. The effect of yeast recorded by Shalaby *et al.* (2008) and Agamy *et al.* (2013). In this regard, Shehata *et al.* (2012), mentioned that yeast as a natural bio-substance has stimulating, nutritional and protective functions. Its protective and stimulatory effects might be attributed to its content that enriched with the sources of phyto-hormones especially cytokinins, vitamins, enzymes, amino acids and minerals.

2.1. Effect on fresh weight per plant:

The data presented in Table (2) clearly indicate that enhancing effect of yeast supported on fresh weight of top and root as well as total fresh weight of sugar beet as compared with humic acid treatment. The positive effect of yeast is supported also by the findings of Mekki and Ahmed (2005) and Agamy *et al.* (2013). The promoting effect of yeasts could be due to the biologically active substance produced by these biofertilizers such as auxins, gibberellins, cytokinins, amino acids and vitamins (Bahr and Gomaa, 2002). The effect of yeast clearly reflected when combined with humic acid application. Our results showed that all growth parameters of sugar beet plants were significantly enhanced as the result of the dual application of both of yeasts and humuc acid. Such stimulating effect of the dual application may be due to the promoting effect of both humic acid and yeast. The positive effects of humic acid on the growth and production of plants may be attributed to the hormone-like activity through its involvement in cell respiration, photosynthesis, protein synthesis, various enzymatic reactions and antioxidant effect (Zhang and Schmidt, 1999). The enhancing effect of yeast on fresh weight of sugar beet was strongly supported by Entian and Fröhlich (1984). They stated that this effect resulted from increased enzyme activity regulating catabolic productions in eukaryotic cells .It is worthy to note that increasing of root diameter accompanied with increasing of fresh weight means that applied dual treatment lead to vigorous growth. These results are in agreement with those reported by Dina *et al.,* (2013) and Fatma *et al.* (2015) who reported that application of yeast extract plus humic acid increased vegetative growth parameters.

2.2. Effect on yield:

Top, root and total yield of sugar beet (Kg/m^2 as well as ton/ Faddan) as affect by application of yeast, humic acid and their combination are presented in Table (2). The obtained results show that yeast effect followed the same pattern as fresh weight parameters i.e that yeast records exceed that of humic acid effect. These results are in line with results of Shalaby and El- Nady (2008), Sharaf, (2012), Agamay *et al.* (2013) and Oliver *et al.* (2013). Recently, Nemeata Alla (2016) reported that the highest yields results from increasing rate of yeast to 15 g yeast per liter. These progressive may be due to the role of yeast and its containing from growth regulators as well as vitamins and other useful materials to sugar beet.

Our results also show that the combined action of foliar application of yeast and humic acid over exceed their effect lonely. Such stimulating effect reflect on all yield parameters. The effect of yeast on yield components may be attributed to the role of yeast in making available nutrient elements for plants. In addition, yeast content of macro and micronutrients, growth regulators and vitamins stimulate the plant to build up dry matters (Hesham and Mohamed, 2011). The positive effects of humic acid on yield of sugar beet have been reported by El-Bassiouny et al (2014) and Rassam et al, (2015) and could be attributed to the effect of humic acid on translocation of trace elements directly to metabolic sites in plant cell and thus maximizing the plants productive capacity. Such combined effect confirmed by the results obtained by Fatma *et al.* (2016) who reported that application of yeast extract plus L humic acid gave the best effect on yield and increased vegetative growth parameters, total leaf chlorophyll content and leaf mineral content (N, P, K and Mg).

2.3. Effect on sugar yield and white sugar yield:

The data presented in Table (3) and revealed that application of yeast resulted in clear increment of sugar yield as well as white sugar yield as compared by humic application (ton/ faddan).The same table also supported the enhanced effect of the combined application of humic acid and yeast. Such stimulating effect of this dual application may be resulted from the combined action of both yeast and humic acid on sugar yield and white sugar yield. The enhancing effect of humic acid on sugar yield and white sugar reported by Sadeghi-Shoae *et al.* (2013) and Rassam *et al.* (2015). In this concern, Mehdi *et al.* (2013), reported that these results may be due to effect of humic acid in enhancing the uptake of some nutrients, reduce the uptake of toxic elements, and improve the plant growth which was reflected on positive effect on the final production of sugar yield. The promoting effect of yeast reported also by Sherif *et al.* (2012) and Neseim *et al.* (2014). The increase in sugar yield because of yeast treatment is mainly attributed to the effect of yeast, which can play a very significant role in making available nutrient elements for sugar beet growth, hence sugar yield production (Hesham and Mohamed, 2011).

3. Interaction effect of variety and foliar application of humic acid and yeast:

3.1. Effect on root characters:

Root characters as presented in table 4 indicate that root length and diameter significantly affected by variety and treatment application. The data show that the highest record of root length and

Table 2: Effect of variety and humic acid and yeast application on root characters and yield components of sugar beet plants grown in newly reclaimed soil

Treatment	Root characters		Fresh weight/ plant			Sugar beet Yield			Sugar yield	
	Root length (cm)	Root diam. (cm)	Top (g)	Root (g)	Total (g)	top Ton/ Fad.	Root Ton/ Fad.	Total Ton/ Fad.	Sugar yield Ton/ Fad.	White S. yield Ton/ Fad.
Variety										
Heba	40.11	8.89	333.3	1210.3	1543.7	7.05	21.01	28.06	3.15	2.74
Sirana	36.11	7.89	265.6	1014.4	1280	6.58	16.21	22.79	2.44	1.95
Peti	35.78	6.89	239.4	974.4	1213.9	4.33	15.74	19.99	2.12	1.62
LSD.05%	**4.49**	**0.93**	**20.1**	**196.9**	**200.2**	**0.56**	**2.14**	**2.12**	**0.3**	**0.23**
Treatment										
Humic acid	32.78	6.89	187.2	925.5	1112.8	4.87	13.92	18.71	2.05	1.64
Yeast	38.44	7.44	300	1118.9	1418.9	5.15	18.44	23.58	2.63	2.14
Humic+ yeast	40.78	9.33	351.1	1154.8	1505.9	7.95	20.6	28.55	3.02	2.52
LSD.05%	**3.37**	**0.76**	**22.2**	**86.8**	**74.08**	**0.39**	**0.97**	**1.02**	**0.14**	**0.11**

Table 3: Effect of interaction between variety and humic acid and yeast application on root characters and yield components of sugar beet grown in newly reclaimed soil.

Variety	Treatment	Root characters		Fresh weight/plant			Sugar beet yield			Sugar yield	
		Root length (cm)	Root diam. (cm)	Top (g)	Root (g)	Total (g)	Top Ton/ Fad.	Root Ton/ Fad.	Total Ton/ Fad.	Sugar yield Ton/ Fad.	W. S. yield Ton/ Fad.
Heba	**Humic acid**	33.67	7.33	190.00	1166.67	1356.67	5.58	18.29	23.87	2.84	2.45
	Yeast	42.00	8.33	393.33	1216.67	1610.00	6	20.51	26.51	3.02	2.61
	Humic + Yeast	44.67	11.00	416.67	1247.67	1664.33	9.58	24.23	33.81	3.59	3.14
Sirana	**Humic acid**	32.33	7.00	188.33	843.33	1031.67	5.5	12.2	17.7	1.94	1.42
	Yeast	37.00	7.00	283.33	1073.33	1356.67	5.53	17.39	22.92	2.47	2.03
	Humic+Yeast	39.00	9.67	325.00	1126.67	1451.67	8.73	19.03	27.76	2.91	2.39
Peti	**Humic acid**	32.33	6.33	183.33	766.67	950.00	3.53	11.27	14.56	1.39	1.04
	Yeast	36.33	7.00	223.33	1066.67	1290.00	3.92	17.41	21.33	2.4	1.77
	Humic+Yeast	38.67	7.33	311.67	1090.00	1401.67	5.55	18.53	24.08	2.56	2.03
LSD.05%		**5.83**	**1.32**	**38.52**	**150.46**	**128.31**	**0.68**	**1.68**	**1.77**	**0.25**	**0.2**

diameter was 44.67 and 11.00 cm respectively obtained by variety Heba treated with both humic acid and yeast followed by the variety Sirana under the same treatment .The least record obtained by variety Peti under humic acid application.

3.2. Effect on fresh weight per plant:

Data of fresh weight as indicated in Table (4) followed the same pattern of root characters i.e most varieties affected by the combined application of humic acid and yeast but greatly differed in their response. The data show that variety Heba is more affected by this treatment than other varieties .However, the highest fresh weight of top, root and total gained by Heba variety was 416.67,1247.67 and 1664.33 gm /plant respectively.

3.3. Effect on Sugar beet yield:

The obtained values of top, root and total yield per square meter as well as per faddan, in response to interaction between variety and treatment were higher for Heba varity treated (Table 3) with combined humic acid and yeast as compared with either Sirana or Peti variety. The highest values of the top, root and total yield parameters ton per faddan were(9.58,24.23 and 33.81) and the lowest ones were (5.55,18.53 and 24.08) obtained with the interactions between variety Peti under humic acid treatment , respectively.

3.4. Effect on sugar yield and white sugar yield:

The combined effect of humic and yeast on sugar yield as well as white yield (Ton / faddan) are presented in Table (3). The data show that it is evidenced that it has strong correlation between sugar yield as final product and white sugar with all important beet parameters as indicated in the same table. However, these parameters have attained high values by the dual combinations of humic acid and yeast and ultimately higher is the sugar yield and white sugar yield. Once again such effect resulted from the combined effect of both yeast and humic acid. In this concern, Sadeghi-Shoae *et al.* (2013) and Mehdi *et al.* (2013) reported 27% increase of refined sugar yield in the plots containing humic acid. This result mainly resulted also from the direct effect of foliar yeast application on enzyme activity which reflected positively on root yield itself and sugar yield too. This finding is in line with that found by Mok and Mok (2001).

Sugar beet quality as affected by variety and foliar application of humic acid and yeast

The beet quality is determined not only by sucrose concentration, but also by the concentrations of other constituents that impair white sugar recovery such as potassium, sodium, amino acids and other nitrogenous compounds . Regarding variety effect on purity and impurity the data presents in Table (4) indicate that the difference between varieties is slightly observed but, in general, the variety Heba recorded the highest purity and the least impurity percentage. Hence, impurities values are indicator for quality of sugar beet roots including (K, Na and α-N), the data collected in Table (4) indicate that the superiority of Heba cultivar in quality parameters may be probably due to it contains fewer values in the most of impurity parameters. The variations among the tested sugar beet varieties in these traits might be due to the gene make-up action. These results confirmed by the results obtained by Shehata *et al.* (2000), Gobarah and Mekki (2005), Ahmed *et al.* (2012) and Hozayn et al (2013). Regarding, humic acid and yeast effect on purity and impurity percentage the data indicate that few difference among treatments except slight increase in impurity under humic acid treatment.

Conclusion

Based on the obtained results, it could be concluded that Heba variety, proved to be the best promising cultivar with the highest root yield, sugar recovery and ultimate maximum sugar yield by application of combined humic acid and yeast. So, it can be cultivated as commercial crop in the newly reclaimed soils with the recommended treatment for maximizing sugar beet yield and its quality.

Table 4: Sucrose percentage and root quality of sugar beet as affected by variety and humic acid and yeast application in newly reclaimed soil

Variety	Treatments	Sucrose (%)	Sodium (%)	Potassium (%)	α-amino N (%)	QZ (%)	Impurity (%)	Purity 0.61
Heba	Humic acid	15.5	2.5	2.5	1.6	84.5	0.61	96.05
	Yeast	14.7	2.3	2.3	1.0	88.7	0.54	96.31
	Humic+Yeast	14.8	2.1	2.1	1.1	85.95	0.54	96.37
Sirana	Humic acid	15.9	2.6	5.6	2.6	72.68	0.82	94.87
	Yeast	14.3	2.1	4.5	1.5	82.89	0.66	95.4
	Humic+Yeast	15.3	2.4	4.4	1.5	73.68	0.66	95.66
Peti	Humic acid	12.3	2.3	5.4	1.4	83.97	0.69	94.43
	Yeast	13.8	3.1	6.3	1.4	83.4	0.74	94.61
	Humic + Yeast	13.8	2.4	4.8	2.2	76.61	0.74	94.61
Variety	Heba	15.0	2.3	2.3	1.23	86.38	0.56	96.24
	Sirana	15.17	2.37	4.83	1.87	76.42	0.71	95.31
	Peti	13.97	2.27	4.77	1.47	80.18	0.67	95.16
Treatment	Humic acid	14.57	2.47	4.5	1.87	80.38	0.71	95.12
	Yeast	14.27	2.5	4.37	1.3	85	0.65	95.44

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