

YIELD, QUALITY AND STABILITY EVALUATION OF THE EFFECT OF BIO FERTILIZER APPLICATION ON SUGAR BEET UNDER IRRIGATION SYSTEMS IN NEWLY RECLAIMED SANDY SOILS.

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ABSTRACT

Field experiment was carried out at the experimental farm of the Agricultural Research Station, National Research Centre El-Nubaria district, Egypt during the winter season of 2016/2017 to evaluate the effect of foliar application of humic acid and yeast as bio fertilizer on yield and quality of sugar beet under two method of water irrigation (Surface and subsurface).Results showed that subsurface irrigation was more efficient than surface irrigation. The results also indicate that dual application of humic acid and yeast have promoting effect than single one and such effect was more pronounced under subsurface irrigation.

Keywords: Sugar beet, Yield, quality, Surface, Subsurface irrigation, Humic acid, Yeast

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 has a crucial importance in human nutrition and raw material of sugar . Sugar beet, grown as a feedstock for the production of pure sugar is one of the most important cash crops in the world. 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. Water demand of sugar beet also has the most critical point to get a uniform yield. Pejic *et al.*, (2011) reported that sugar beet cannot meet water requirement to provide its uniform development so that irrigation is a necessity in the development period and water demand of sugar beet .

Bio-fertilizers are formulations of beneficial microorganisms, which upon application can increase the availability of nutrients by their biological activity and help to improve the soil

health. Microorganisms secrete various plant growth and health promoting substances Pandya and Saraf,(2010). Bio-fertilizers are considered as a low cost, effective and renewable source of plant nutrients to supplement chemical fertilizers Boraste *et al.*, (2009).Humic acid and yeast are considered bio-stimulants to enhance the yield and quality of sugar beet and they become positive factors that minimize utilization of inorganic and chemical fertilizers. They are safe for human and environment and using them was accompanied with reducing the great pollution occurred in our environment. Humic compounds occupy a key position because of their multifarious roles in maintaining improving soil fertility and positively affecting physiological functions of plant. 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).

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. Boraste *et al.*,(2009) mentioned that yeasts synthesize antimicrobial and other useful substances required for plant growth from amino acids and sugars secreted by bacteria, organic matter and plant roots A growing number of studies indicate that plant root growth may be directly or indirectly enhanced by yeasts Boraste *et al.*,(2009).

The performance of sugar beet plants depends not only on its genetic characteristics and nutrition but also on the surrounding environmental conditions particularly methods of irrigation and water supply. There are specific problems in the management of sandy soils including their excessive permeability, low water and nutrient holding capacities Suganya and Sivasamy,(2006). Therefore, managing the use of irrigation water and plant nutrients is a major challenge of sandy soil amelioration efforts. Recently, growers have to adopt modern techniques of cultivation, and improve water use efficiency (WUE) by systems irrigation of surface and subsurface..However, subsurface drip irrigation is considered to be the most modern irrigation system with efficient water delivery that can contribute immensely on improving crop water use efficiency and conserving water Hanson and May, (2004).

Therefore, the aim of this work is to study the effect of humic acid and yeast on the yield of sugar beet under surface and subsurface irrigation.

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 2016/2017 to study the effect of foliar application of humic acid and yeast on yield of sugar beet plants under two method of water application. The study included six treatments which were the combination of two irrigation systems (surface and subsurface irrigation) and three biofertilizer

application (Humic acid, yeast and combined application of humic and yeast). The experimental design was split block design with three replicates where the main plots allocated to method of system irrigation. Two drip irrigation systems (surface and subsurface) were constructed and tested before used in the experimental location. Laterals (16 mm diameter, P.E.) and the emitters were built-in with an average discharge 4.0 L/h and 0.3 m emitter spacing. The subsurface drip irrigation system was installed before the crop seeding, where its laterals (16 mm drip-lines) were buried 0.6 m apart at 15cm below soil surface so that they are not affected by the cultivation practices during the current growing season. The surface soil sample (0-30 depth) of the experimental area was subjected to laboratory analysis to determine some of its physical and chemical properties according to the method described by Chapman and Pratt (1982) in Table (1).

Table 1: Mechanical and chemical analysis of experimental soil.

Mechanical analysis		Chemical analysis	
Sand %	91.2	Organic matter%	0.3
Slit %	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

Sugar beet variety *Chenopodiaceae* c.v (Sirana) was sown In the first week of November 2016. 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 ,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 and ton per fad) was also estimated. Three roots were chosen randomly from each sub plot 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 $= \{(K + Na) \times 0.0343\} + (\alpha \text{ amino} - N \times 0.094) + 0.29$ 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

A. Yield and yield components:

1. Effect of methods of water irrigation:

Data presented in Table (2) clearly show that root length(cm),root diameter(cm),fresh weight of root and top(gm), root, top and sugar yield(ton/fed)and white sugar yield (ton/fed) all studied characters slightly affected by method of water irrigation, however little increase recorded by subsurface drip irrigation than surface drip irrigation . The ability of subsurface drip irrigation to improve roots yield could be attributed to the less water lost from soil surface through evaporation, which resulted in optimum crop yield. Moreover, subsurface drip irrigation allows maintenance of optimum soil moisture content in the root zone, which improved the efficiency of water and fertilizers use .These results were in agreement with those obtained by Sakellariou-Makrantonaki *et al* (2002a+b), Kassab *et al* (2005),Abo EL-Soud(2009), Hassanli *et al.* (2009) , Selim *et al* (2009) and El-Noemani *et al* (2015) who reported that using of subsurface irrigation systems achieved the longest roots. Such effect results from enhancing cell division and enlargement which need more water supplies

2. Effect of foliar application:

The data presented in Table (2) clearly indicate that Irrespective effect of method of water irrigation, root parameters such as length, diameter and fresh weight of root and top significantly enhanced by yeast application as compared with humic acid. These results were in the same line with the findings of Shalaby and El-Nady (2008) and Nemeat Alla (2016). The obvious effect of yeast on root parameters may be attributed to the effect of yeast cytokinins that result in enhancing the accumulation of soluble metabolites Muller and Leopold,(1966). Such promoting effect of yeast resulted from the active biological substance produced by yeast such as auxins, gibberellins, cytokinins, amino acids and vitamins Bahr and Gomaa, (2002).These results confirmed by the record obtained by of Mekki and Ahmed (2005) and Agamy *et al.* (2013).The

same table also show that dual application of humic acid and yeast surpass the single effect of either yeast or humic acid . Such obvious effect of combined application of humic acid and yeast may be resulted from the collective effect of both of them. In this respect, Shehata *et al.* (2012), mentioned that yeast as a natural bio-substance has stimulating, nutritional and protective functions resulting from its enriched content with the sources of phyto-hormones especially cytokinins, vitamins, enzymes, amino acids and minerals. The enhancing effect of humic acid resulted from its promoting effect in increasing nutrient uptake of plants 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 positive effect of dual application supported by the results gained by Dina *et al.*, (2013) and Fatma *et al.* (2015) who reported that application of yeast extract plus humic acid increased vegetative growth parameters. In the same table (2) show that yeast resulted in clear increment of sugar yield (root ,top, sugar and white sugar yield(ton/fed)) as compared by humic application. These results obviously show that yeast records exceed that of humic acid effect. The positive effects of humic acid supported by El-Bassiouny *et al* (2014) and Oliver and Nelsan(2013) who reported that humic acid induce translocation of trace elements directly to metabolic sites in plant cell and thus maximizing the plants productive capacity.

Table 2: Effect of method of water irrigation and foliar application on root characters and yield components of sugar beet plants

Treatment	Root characters		Fresh weight /plant		Sugar yield (ton/fed)			
	Root Length (cm)	Root Diameter (cm)	Root (gm)	Top (gm)	Root yield (ton/fed)	Top yield (ton/fed)	Sugar Yield (ton/fed)	White Sugar (ton/fed)
Water irrigation								
Surface	36.11	7.89	1014.44	265.56	16.21	5.51	1.96	2.43
Subsurface	36.44	8.22	1124.44	275.56	20.12	7.06	2.57	3.20
LSD 5%	0.83	0.31	79.76	25.33	1.33	0.33	0.21	0.11
Foliar application								
Humic acid	32.33	7.17	923.33	190.83	13.21	5.96	1.61	2.06
Yeast	37.33	7.17	1093.33	290.00	19.57	6.20	2.40	2.97
Humic +yeast	39.17	9.83	1191.67	330.83	21.71	6.70	2.79	3.42
LSD5%	3.15	0.80	89.01	33.19	1.24	0.56	0.19	0.23

B. Interaction effect of method of water irrigation and foliar application on root characters and yield components of sugar beet plants

The present study showed that either root length or diameter significantly response to method of water irrigation and foliar application treatment. However, the highest root length and diameter (39.33 and 10 cm) respectively obtained by sugar beet plants foliar sprayed with both yeast and humic acid under subsurface irrigation (Table 3). Also showed that root and top fresh weight similarly affected by the interaction effect of water irrigation and foliar application with yeast and humic acid. It is clearly also observed that the highest record of top and root (336.67 and 1256.67 gm) respectively resulted by combined application of yeast and humic under subsurface irrigation. According to the data presented in Table (3), it is clearly indicated that the interaction effect of dual application with humic and yeast under subsurface irrigation surpassed the other interactions. Subsurface irrigation was associated with higher yield quantity than surface drip irrigation. Such effect resulted in more pronounced values for root, top and total sugar yield (7.87, 24.39 and 32.26 ton/ fad) respectively. The enhanced effect of combined application of humic acid and yeast under subsurface irrigation supported by the results of Selim *et al* (2009) and Qin *et al* (2019). These results could be attributed to the improvement of the moisture retention and nutrient supply potentials of sandy soils after humic substances application.

In the same table is clearly indicated that dual application of yeast and humic acid under subsurface irrigation has promoting effect on sugar yield as well as white sugar yield (ton/ fad). The examined data obviously show strong correlation between sugar yield and white sugar yield with all important sugar beet parameters. These results were in line with those obtained by Sadeghi-Shoae *et al.* (2013). The same table also show that the highest sugar yield as well as white sugar yield gained by sugar beet plants foliar sprayed by both yeast and humic under subsurface irrigation (3.93 and 3.19 ton/fad) respectively.

Table 3: Interaction effect of method of water irrigation and foliar application on root characters and yield components of sugar beet plants

Treatment	Treatment	Root characters		Fresh weight /plant		Sugar yield (ton/fed)			
		Root Length (cm)	Root Diameter (cm)	Root (gm)	Top (gm)	Root yield (ton/fed)	Top yield (ton/fed)	Sugar Yield (ton/fed)	White Sugar (ton/fed)
Water irrigation	Foliar application								

Surface	Humic acid	32.33	7.00	843.33	188.33	12.20	5.50	1.89	1.48
	Yeast	37.00	7.00	1073.33	283.33	17.39	5.50	2.49	2.02
	Humic +yeast	39.00	9.67	1126.67	325.00	19.03	5.53	2.91	2.39
Subsurface	Humic acid	32.33	7.33	1003.33	193.33	14.22	6.41	2.23	1.74
	Yeast	37.67	7.33	1113.33	296.67	21.75	6.90	3.45	2.79
	Humic +yeast	39.33	10.00	1256.67	336.67	24.39	7.87	3.93	3.13
LSD5%		4.46	0.33	125.88	46.94	1.75	0.79	0.27	0.16

C. Quality traits:

It is interestingly known that sugar beet quality determined by both sugar concentration and other constituents that impair white sugar recovery such as potassium, sodium, amino acids and other nitrogenous compounds. According to the data presented in Fig(1,2) it is clearly show that there was few difference among treatments on purity and impurity percentage except slight increase in impurity under humic acid . These results confirmed by the results obtained by Sharaf (2012), Gobarah and Mekki (2005), Ahmed *et al.* (2012),Hozayn *et al* (2013) and Alice *et al.*,(2019).

The data presented in Table (4) show that dual application of yeast and humic under subsurface irrigation resulted on slight positive effect on purity 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 high record of purity with combined application of yeast and humic under subsurface irrigation may be probably due to it contains fewer values in the most of impurity parameters. In this respect Fortun *et al* (2006) reported that comparing with surface drip irrigation, subsurface drip irrigation improved the studied quality indicators.

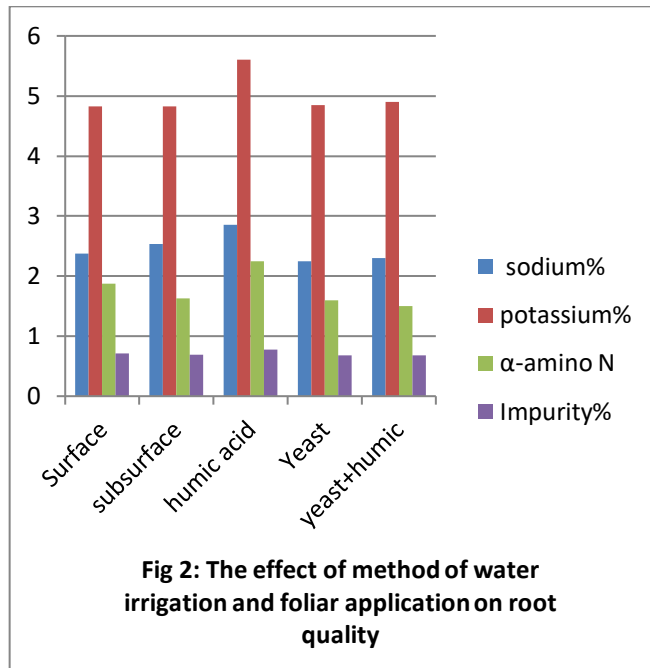
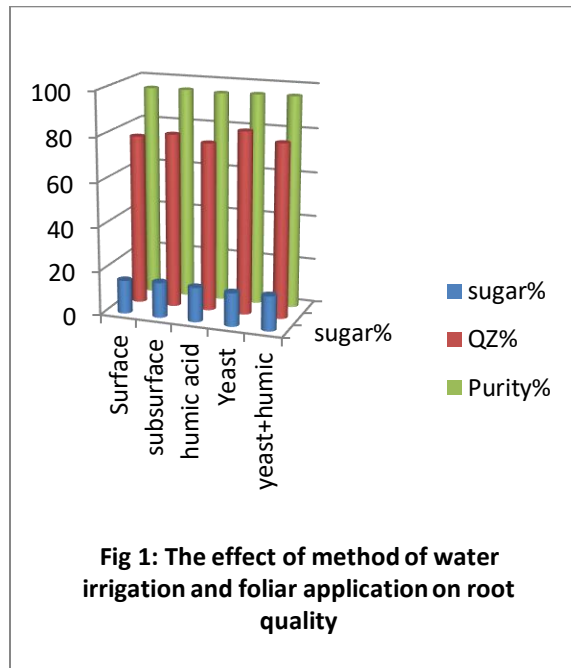


Table 4: Interaction effect of method of water irrigation and foliar application on root quality

Water irrigation	Foliar application	Sugar %	Sodium %	Potassium %	α-amino N %	QZ%	Impurty %	Purity %
Surface	Humic acid	15.5	2.6	5.6	2.6	72.68	0.82	94.74
	yeast	14.3	2.1	4.5	1.5	82.89	0.66	95.40
	Yeast+humic	15.3	2.4	4.4	1.5	73.68	0.66	95.66
Subsurface	Humic acid	15.66	3.10	5.60	1.90	78.93	0.75	95.19
	yeast	15.86	2.40	5.20	1.70	81.69	0.71	95.52
	Yeast+humic	16.11	2.20	5.40	1.50	83.01	0.69	95.71
L.S.D 5%								

CONCLUSION

Based on the obtained results of root yield, top yield, sugar yield and white sugar yield significantly affected with irrigation techniques. It can be concluded that subsurface drip irrigation was more efficient than surface drip irrigation on enhancing quantitative and

qualitative yield parameters of sugar beet. In addition, dual application of humic acid and yeast had significant effect on improving sugar beet yield as well as quality. Our findings also revealed that subsurface drip irrigation design in combination with dual application of humic acid and yeast is the most advantageous for sugar beet yield and quality in sand soil areas.

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