EFFECT OF MINERAL, BIO FERTILIZATION, HUMIC ACID AND THEIR INTERACTIONS ON SUGAR BEET

Ali Abdallah Ali Mekdad
Agronomy Department, Faculty of Agriculture, Fayoum University, El -Fayoum, Egypt

ABSTRACT

Two field experiments were conducted during 2014/15 and 2015/16 seasons to study the effect of three mineral nitrogen fertilizer levels *i.e.*, 60, 90 and 120 kg N/fed and four biofertilization (without biofertilization, rhizobactrein, phosphorein and dual inoculation) and three foliar spraying levels with humic acid (water as a control, 12 and 24 g/l) on yield and its attributes of sugar beet variety Kawemira. The experimental design was a split-split plot in RCBD with three replications where mineral nitrogen fertilizer, biofertilization and foliar spraying with humic acid were allocated in the main, sub and sub-sub plots, respectively.

Results indicated that mineral nitrogen fertilizer and biofertilization with foliar spraying with humic acid had significant positive effect on yield, yield components and quality traits. The heaviest root fresh weight (2.17 kg/plant), root yield (39.77 t/fed) and gross sugar yield (7.13 t/fed) (fed= feddan= 4200 m^2) were obtained by the highest level of mineral nitrogen fertilizer (120 kg N/fed), with application the mixture of rhizobactrein+ phosphorein as biofertilization with the highest concentration of foliar sprayed with humic acid (24 g/l).

The results of regression analysis of yield and its attributes clarified that, there were four traits *i.e.* sucrose %, root yield, root length and root fresh weight in the first season, while in the second season, the same traits except root length were significantly ($P \leq 0.001$) contributed to variation in gross sugar yield.

Keywords: Sugar beet, mineral fertilizer, biofertilization, humic acid, regression, yield and quality.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) crop has been an important position in Egyptian crop rotation as a winter crop either in fertile soils or poor ones. It is highly adapted to grow in the new reclaimed soils as economic crop, in addition to its limited water requirements. Compared with sugar cane, sugar beet requires lesser water quantity, where a kilogram of sugar requires about 1.4 m^3 and 4.0 m^3 water to be produced by sugar beet and sugar cane, respectively **(Ouda, 2001)**. Approximately 77 % of our local needs are produced locally, while the rest (23 %) is imported from foreign countries. Increasing cultivated area and sugar production from unit area and water unit is one of the important national targets to minimize gap between sugar consumption and production. Improving sugar beet production can be achieved through application of traditional and nontraditional methods **(Hozayn *et al.*, 2013)**.

Nitrogen fertilizer has a pronounced effect on the growth and chemical characteristics of the yield and quality of sugar beet. The economic yield of sugar beet, is thus closely relates to the sugar accumulation process. The filling process also depends on the photosynthetic efficacy of leaves, which is not only controlled by light intensity and temperature but also by mineral nutrition. So, nitrogen fertilization should be managed to produce high root yield with high sucrose percentage and purity levels. In this respect, **Seadh, *et al*. 2007; Gobarah, *et al*. 2010; Nemeata Alla, *et al*. 2014; Mekdad, 2015 and Mekdad and Rady, 2016** reported that increasing nitrogen application as soil fertilizer recorded significantly increases in length, diameter and weight of roots as well as root, top and sugar yield t fad^{-1} of sugar beet. On the other side, root quality traits of beet *i.e*. sucrose %, juice purity and recoverable sugar percentages were significantly decreased by increasing nitrogen rates **(Lauer, 1995; Seadh, *et al*. 2007; Gobarah, *et al*. 2010; Nemeata Alla, *et al*. 2014; Mekdad, 2015 and Mekdad and Rady, 2016)**. Moreover, impurities in terms of potassium, sodium and α-amino nitrogen as well as sugar loss in molasses were significantly increased by increasing nitrogen levels **(Seadh, *et al*. 2007; Mekdad, 2015 and Mekdad and Rady, 2016).**

Biological fertilization of non-legume crops by N_2-fixing bacteria had a great importance in recent years. The effect of inoculation had marked positive influence on the growth of plant, which reflects in yield increase. This increase might be due to the effect of N which was produced by bacteria species, in addition of some growth regulators like IAA and GA3 which stimulated growth. Many investigators applied biofertilizers to minimize the environmental pollution resulted from mineral fertilizers and also to reduce its coasts **(Cakmakci, *et al*. 2001).**

More recently, a real challenge faces the researchers to stop usage the high rates of agro-chemicals which negatively affect human health and environment by using nitrogen fixing bacteria and phosphate dissolving bacteria, which are important in plant nutrition by increasing N and P uptake by the plants, and playing a significant role as plant growth-promoting rhizobacteria in the biofertilization of crops **(Sahin, *et al*. 2004).** They added that, phosphorus biofertilizers could be help via increase the availability of accumulated phosphates for plant growth by solubilization, enhancing plant growth by the increasing the efficiency of biological nitrogen fixation and the availability of Fe, Zn through production of plant growth promoting substances. In this regard, **Kandil, *et al*. (2002)** found that inoculation of sugar beet seeds with bio-fertilizer and 80 kg N/fed produced the highest weights of root and top yields. **Badr (2006)** showed that, inoculation seeds of sugar beet with bio-fertilizer in different combination with mineral fertilizer increased root dimensions, yields of root, top and sugar t/fed. On the other hand, the root quality (Sucrose and purity %) were decreased by increasing nitrogen levels in combination with bio-fertilizer. **Aboshady *et al*. (2009)** mentioned that, microbial inoculation with

"Azotobacter chroococcum+Bacillus megatherium" significantly increased top and root yields and root fresh weight.

Humic acid treatment suggested to participate a beneficial role due to it is one of the natural antioxidants, the absorption of humic substances into the plant tissue resulting in various biochemical effects through elevate nutrient uptake and maintaining vitamins and amino acid level in plant tissues. Humic acid is used widely across the globe by agriculturists due to their several benefits *i.e.*, stimulates the respiration rates, increase root and shoot growth on a fresh and dry weight basis on enhancement of plant root uptake of P, K, Fe, Cu, Zn and Ca, stimulates plant enzymes and hormones- suppresses diseases, heat stress and frost damage by promoting antioxidants activity **(Seydabadi and Armin 2014**) they added that the mixture chloridazon + phenmedipham with humic acid produced highest root and sugar yields.

Shaban, *et al*. (2014) reported that, application of humic acid significantly increased on root yield by (22.80 % and 28.38 %), sugar yield by (26.56and 32.44%) and sucrose % by (0.41 and 0.61%), respectively in the 1st and 2nd seasons compared with untreated one. **Rassam, *et al*. (2015)** found that humic acid increased sucrose, root and sugar yield of sugar beet compared with control. **EL-gamal, *et al*. (2016)** reported that, foliar spraying with humic acid at 20 g/L improved length, diameter and fresh weight of root as well as, sucrose %, purity %, root and sugar yields of sugar beet compared with control.

The main goal of the current trial was looking for the effect of mineral nitrogen fertilization and biofertilizers under foliar application with humic acid applied to sugar beet crop to get a high yield with a good quality in newly reclaimed soil, in addition to keep our environment clean and safe to live in.

MATERIALS AND METHODS

Two field experiments were conducted at the farm of the Faculty of Agriculture, Demo (29°17` N; 30°53` E), Fayoum University, Egypt, during the two successive seasons of 2014/2015 and 2015/2016. The experimental soil was sandy loam with organic matter of 0.89%, electical conductivity of 5.42 dS/m and pH of 7.96.The objective of this investigation was to study the effect of nitrogen fertilizer levels, inoculation of sugar beet seeds (*Beta vulgaris* L.) variety Kawemira with rhizobactrein and phosphorein singly or in combination under different levels of humic acid on yield, yield components and root quality. The recommended agricultural practices for growing sugar beet were followed except the factors under study which arranged in split-split plot in randomized complete block design with three replications. Ammonium nitrate (33.5% N) at three levels of nitrogen fertilizers (60, 90 and 120 kg N/fed) were arranged in the main plots, it was applied in three equal doses (at 4–6 leaf stage, before the 2nd irrigation, and before the 3rd irrigation). While four bio-fertilizer treatments. (without inoculation, rhizobactrein, phosphorein and dual inoculation) were randomly distributed in the sub plots. The sub-sub plots were occupied with three humic acid as foliar spraying (tap water, 12 and 24 g/l), were sprayed with different used concentrations at 45, 75 and 105 days after planting date. Both rhizobactrein and phosphorein were produced by bio-fertilizers unit, General Organization of Agriculture Equalization Fund (G.O.A.E.F.), Agriculture Research Centre, Ministry of Agriculture, Giza Egypt. Humic acid: made in Spanish, (humic acid 85%; fulvic acid 8%; K_2O 8%; N 0,7%; P_2O_5 0.06%; Ca 3.89%; Mg 0.29%; Fe 1.89%; Mn 0.043%; Zn 0.013; Cu 0.056%; B 0.048 and soluble matter 95%).

Each experimental basic unit included 5 ridges, 60 cm apart and 3.5 m long, comprising an area of 10.5 m^2 (1/400fed). The preceding summer crop was corn (*Zea mays* L.) in both seasons. Experiments were sown on September 21th and 27th in the first and second seasons, respectively. Sugar beet was hand sown 3-5 balls/hill using dry sowing method on one side of the ridge in hills 20 cm apart. Plants were thinned to one plant/hill (35000 plants/fed) at the age of 35 days. Potassium fertilization was applied at the rate of 48 kg K_2O/ fed. as potassium sulphate (48 % K_2O) in two equal doses the first after thinning and the second 21 days later.

At harvest, (after 210 days from sowing) a random sample of five guarded plants in each sub-sub plot was taken. Samples were carried immediately to laboratory where roots washed to remove the soil particles. Plants were separated into tops and roots. Root length (cm), root diameter (cm) and root fresh weight (kg/plant) were determined at harvest.

At harvest also, plants of all ridges from each sub-sub plot were harvested, cleaned, topped and weighed plus weight of five plant sample and then converted to estimate: Root yield (t/fed), top yield (t/fed) and biological yield (t/fed). It was calculated by adding root yield together with top yield (t/fed).

Gross sugar yield (t/fed), was estimated by multiplying root yield by gross sugar percentage. White sugar yield (t/fed), was estimated by multiplying root yield by white sugar percentage. Losses sugar yield (t/fed), was estimated by multiplying root yield by loss sugar percentage.

All traits were determined in Delta Sugar Company Limited Laboratories at El-Hamoul, Kafr El-Sheikh Governorate according to the method of **McGinnus (1971)**.

The traits of quality included: Gross sugar %: Juice sugar content was determined according to **McGinnus (1971)**. White sugar %: Extractable sugar content (white sugar) of beets was calculated according to **Harvey and Dotton (1993)** as follows:

$$ZB = pol-[0.343(K+NA) + 0.094\ AmN + 0.29]$$

Where: ZB = extractable sugar content (% per beet) or white sugar. Pol = gross sugar %. AmN = α-amino-N determined by the “blue number method”

Loss sugar %: Loss sugar % = gross sugar % - white sugar %

Juice purity percentage: Juice purity % (Qz) = ZB/ Pol x100.

The soluble non-sugars (potassium, sodium and alpha-amino nitrogen in meq/100 g of beet) in roots were determined by an Automatic Sugar Polarimetric.

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split-split plot design as published by **Gomez and Gomez (1984)**, using MSTAT-C (Michogen, USA), and LSD at 5% levels of probability was used to test the differences between treatment means.

RESULTS AND DISCUSSION

A- Effect of nitrogen fertilizer levels:

Data in table (1) reveal that nitrogen fertilizer levels exerted significant effects on sugar beet root length and diameter as well as root fresh weight in 1st and 2nd seasons of the study. The highest nitrogen level (120 kg N/fed) exhibited higher values for such traits reached 45.49 & 40.97 % on root length, 26.75 & 62.35 % on root diameter, and 50.41 & 84.16 % on root fresh weight in 1st and 2nd seasons, respectively, comparable with 60 kg N/fed nitrogen level. **Amin, *et al*. (2013); Nemeata Alla, *et al*. (2014); Mekdad (2015) and Mekdad and Rady (2016)** recorded similar tendency.

Nitrogen fertilizer levels caused significant effects on all yield characters *i.e.* root, top, biological and loss sugar yield in the two growing seasons, and gross sugar yield in the second one (Table 1 and 3). The highest values of root yield (33.41 and 35.05 t/fed), top yield (12.33 and 13.97 t/fed), biological yield (45.74 and 49.01 t/fed), loss sugar yield (1.08 and 2.13 t/fed) in the first and second season, respectively, but gross sugar yield (6.47 t/fed) in the 2nd season were produced from fertilizing

Table (1): Effect of mineral nitrogen, biofertilizer, humic acid and their interactions on root length, root diameter. root fresh weight, root yield, top yield and biological yield of sugar beet during 2014/15 and 2015/16 seasons.

Treatments	Root length cm		Root diameter cm		Root fresh weight kg/p		Root yield t/fed		Top yield t/fed		Biological yield t/fed	
	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16
	A- Nitrogen											
60 kg N/fed	26.36	27.19	11.55	10.20	1.21	1.01	26.66	21.76	8.38	7.53	35.04	29.29
90 kg N/fed	29.13	32.55	12.94	13.77	1.45	1.46	29.03	25.59	9.34	11.01	38.37	36.61
120 kg N/fed	38.35	38.33	14.64	16.56	1.82	1.86	33.41	35.05	12.33	13.97	45.74	49.01
LSD (5%)	0.15	0.83	0.08	0.36	0.01	0.22	0.22	2.27	0.09	0.86	0.30	2.80
	B- Biofertilizer											
Without	28.99	31.04	11.53	12.49	1.08	1.33	25.21	25.65	8.62	10.03	33.83	35.68
Rhizobacterin	31.17	32.76	13.81	13.69	1.61	1.45	30.43	27.45	10.53	10.86	40.96	38.31
Phosphorin	30.49	32.13	12.27	13.24	1.51	1.38	29.53	27.05	9.35	10.58	38.89	37.63
Rhizobacterin+ Phosphorin	34.46	34.83	14.56	14.61	1.77	1.61	33.62	29.73	11.56	11.88	45.18	41.61
LSD (5%)	0.21	0.24	0.10	0.09	0.01	0.04	0.18	0.56	0.10	0.19	0.25	0.67
	C- Humic acid											
0	30.29	32.05	12.45	13.15	1.30	1.40	28.49	26.96	9.28	10.57	37.76	37.53
12 g/l	31.33	32.67	13.14	13.51	1.54	1.45	29.68	27.41	10.15	10.84	39.83	38.25
24 g/l	32.22	33.35	13.53	13.87	1.63	1.48	30.93	28.03	10.62	11.10	41.55	39.13
LSD (5%)	0.11	0.11	0.03	0.05	0.01	0.01	0.09	0.13	0.11	0.03	0.09	0.13
	D- Interactions											
LSD (5%)AB	0.36	ns	ns	0.11	0.01	0.06	ns	0.97	ns	ns	ns	1.16
AC	ns	0.19	ns	ns	0.01	ns	ns	0.23	ns	0.05	ns	0.23
BC	0.22	0.22	0.06	0.10	0.01	ns	0.17	0.26	0.05	0.05	0.19	0.26
ABC	0.39	0.38	ns	0.17	0.02	ns	ns	0.46	ns	ns	ns	0.45

ns – non-significant

Table (2): Effect of mineral nitrogen, biofertilizer, humic acid and their interactions on percentage of sucrose, sodium, potassium, alpha amino nitrogen, extractable sugar and purity of sugar beet during 2014/15 and 2015/16 seasons.

Treatments	Sucrose %		Na %		K %		α-amino N %		Extractable sugar %		Purity %	
	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16
	A- Nitrogen											
60 kg N/fed	21.26	22.87	1.29	1.25	2.82	1.44	0.91	0.97	19.48	20.56	91.56	89.84
90 kg N/fed	21.06	20.88	2.72	1.87	3.82	2.51	1.32	1.48	18.40	16.93	87.00	80.90
120 kg N/fed	18.03	18.47	3.41	3.02	4.77	3.47	1.51	1.64	14.80	12.42	81.98	67.09
LSD (5%)	1.56	1.22	0.11	0.19	0.24	0.13	0.03	0.08	1.64	1.14	0.85	1.55
	B- Biofertilizer											
Without	20.83	21.59	2.27	1.81	3.51	2.17	1.18	1.25	18.45	18.02	88.32	82.70
Rhizobacterin	19.86	20.70	2.49	2.03	3.75	2.44	1.24	1.35	17.32	16.64	86.92	79.57
Phosphorin	21.04	20.88	2.46	1.98	3.68	2.41	1.22	1.34	18.53	16.91	87.37	80.14
Rhizobacterin+ Phosphorin	18.74	19.78	2.27	2.37	4.27	2.86	1.36	1.50	15.95	14.98	84.77	74.71
LSD (5%)	1.37	0.23	0.0	0.08	0.10	0.09	0.02	0.04	1.37	0.22	0.44	0.55
	C- Humic acid											
0	19.52	20.47	2.56	2.09	3.94	2.62	1.29	1.39	16.88	16.17	86.14	78.06
12 g/l	20.70	20.73	2.48	2.05	3.79	2.48	1.25	1.36	18.14	16.62	87.01	79.26
24 g/l	20.13	21.03	2.37	2.01	3.68	2.31	1.21	1.33	17.65	17.12	87.39	80.52
LSD (5%)	Ns	0.05	ns	0.01	0.03	0.05	0.01	0.02	ns	0.07	0.28	0.26
	D- Interactions											
LSD (5%)AB	ns	ns	n	0.14	0.18	0.16	0.03	0.06	ns	0.38	ns	0.96
AC	ns	ns	ns	0.02	ns	ns	0.01	Ns	ns	ns	ns	ns
BC	ns	ns	ns	ns	0.05	ns	0.01	Ns	ns	ns	ns	ns
ABC	ns	ns	ns	ns	ns	ns	0.02	Ns	ns	ns	ns	ns

ns – non-significant

Table (3): Effect of mineral nitrogen, biofertilizer, humic acid and their interactions on of loss sugar percentage, and yield of gross, extractable and loss sugar of sugar beet during 2014/15 and 2015/16 seasons.

Treatments	Loss sugar %		Gross sugar yield t/fed		Extractable sugar yield t/fed		Loss sugar yield t/fed	
	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16
	A- Nitrogen							
60 kg N/fed	1.78	2.31	5.65	4.97	5.17	4.47	0.48	0.51
90 kg N/fed	2.66	3.95	6.11	5.34	5.33	4.32	0.77	1.02
120 kg N/fed	3.23	6.05	6.01	6.47	4.92	4.34	1.08	2.13
LSD (5%)	0.08	0.20	ns	0.57	ns	ns	0.02	0.12
	B- Biofertilizer							
Without	2.38	3.57	5.22	5.45	4.60	4.47	0.61	0.98
Rhizobacterin	2.55	4.06	6.01	5.59	5..22	4.51	0.79	1.20
Phosphorin	2.51	3.98	6.18	5.56	5.43	4.39	0.76	1.16
Rhizobacterin+ Phosphorin	2.80	4.80	6.27	5.77	5.31	5.24	0.95	1.53
LSD (5%)	0.04	0.10	0.42	0.09	0.42	0.08	0.01	0.04
	C- Humic acid							
0	2.64	4.29	5.50	5.42	4.73	4.17	0.77	1.25
12 g/l	2.56	4.11	6.09	5.58	5.32	4.36	0.78	1.22
24 g/l	2.48	3.91	6.17	5.78	5.38	4.59	0.79	1.19
LSD (5%)	0.02	0.05	0.34	0.03	0.34	0.03	Ns	ns
	D- Interactions							
LSD (5%)AB	0.06	0.18	ns	0.16	ns	ns	0.02	0.07
AC	ns	ns	ns	0.05	ns	0.05	0.01	ns
BC	0.02	ns	ns	0.06	ns	0.06	0.01	ns
ABC	0.03	ns	ns	0.10	ns	ns	0.02	ns

ns – non-significant

Table (4): Correlation coefficient (r), coefficient of determination (R^2) and standard error of the estimates (SEE) for predicting gross sugar yield (t/fed) in 2014/15 and 2015/16 seasons.

Season	R	R^2	SEE	Sig.	Fitted equation
2014/15	0.998	0.996	0.073	***	Gross sugar yield = - 5.90 + 0.301 sucrose % + 0.196 root yield - 0.001 root length +0.117 root fresh weight
2015/16	0.996	0.993	0.069	***	Gross sugar yield = - 5.255 + 0.176 root yield+ 0.264 sucrose % + 0.367 root fresh weight

beet plants with 120 kg N/fed. The lowest values of former yield characteristics were obtained from (60 kg N/fed) in the two growing seasons. The increase in yield characters due to application of nitrogen fertilization can be explained through the fact that nitrogen has a vital role in building up metabolites, activating enzymes and enhanced root length, diameter as well as root fresh weight and finally root and sugar yields per unit area. **Seadh, *et al*. (2007); Shewate, *et al*. (2008); El-Sarag (2009); Zhang, *et al*. (2009); Attia, *et al*. (2011); Amin, *et al*. (2013); Nemeata Alla, *et al*., (2014); Mekdad (2015) and Mekdad and Rady (2016)** recorded similar tendency.

Significant differences on all root quality traits were obtained due to nitrogen fertilizer levels in both seasons (Table, 2). The highest sucrose (21.26 and 22.87 %), extractable sugar (19.48 and 20.56 %) and purity (91.56 and 89.84 %) were recorded by the minimum level of nitrogen 60 kg N/fed in both seasons. On the other side, the highest values of impurities in terms of Na, K and α-amino N as well as, loss sugar percentages were recorded by the maximum level of nitrogen (120 kg N/fed) in the both seasons. This result is consistent with the previous researchers of **(Seadh, *et al*. 2007; Stevens, *et al.* 2007; Gobarah, *et al*. 2010; Amin, *et al*. 2013; Nemeata Alla, *et al*. 2014; Mekdad, 2015 and Mekdad and Rady, 2016)**. These results may be due to the reason that high levels of nitrogen fertilizers application can be ascribed to its role in increasing root weight and diameter, tissue water content as well as increasing soluble non-sugar compounds in root juice and they interfere with sugar extraction which reflected by raising the percentage of sugar loss to molasses and consequently reducing sugar extractable %.

B- Effect of biofertilization treatments

Biofertilization treatments caused significant effects on root length and root diameter as well as root fresh weights as shown in table (1). Application the mixture of rhizobactrein+ phosphorein produced the highest values of yield attributes (root length, root diameter and root fresh weights) in both seasons. From obtained results under the environmental conditions of this research, it could be observed that using of rhizobacterin biofertilizer either alone or in the mixture with phosphorien surpassed control and phosphorien biofertilizer alone during both seasons. However, the lowest values of the former parameters were resulted from control treatment (without biofertilization) in both seasons. This increase in yield attributes as a result of application biofertilizers particularly rhizobacterin may be due to its role in nitrogen fixation via free living bacteria which reduce the soil pH especially in the rhizosphere which led to increase the availability of most essential macro and micro-nutrients as well as excretion some growth substances such as IAA and GA3 which play an important role in formation a large and active root system and, therefore, increasing nutrient uptake, which stimulate establishment and vegetative growth, hence increasing root parameters. Many investigators confirm this conclusion *i.e.* **Kandil, *et al*.**

(2002); Ramadan, ***et al*****. (2003); Badawi,** ***et al*****. (2004); Gobarah,** ***et al.*** **(2011) and Amin,** ***et al*****. (2013)**.

Data in Table (1 and 3) show that root, top, biological, gross sugar, extractable sugar and loss sugar yields/fed were significantly responded to biofertilization treatments in both seasons. Noteworthy, application the mixture of rhizobacterin + phosphorien biofertilizers yielded the highest values of root yield (33.62 and 29.73 t/fed), top yield (11.56 and 11.88 t/fed), biological yield (45.18 and 41.61 t/fed), gross sugar yield (6.27 and 5.77 t/fed), extractable sugar yield (5.31 and 4.24 t/fed) and loss sugar yield (0.95 and 1.53 t/fed) in the first and second seasons, respectively. Concerning application of rhizobacterin, it's ranked after aforementioned treatment, respectively with respecting their effect on former parameters in the two seasons. On the other hand, control treatment (without biofertilization) resulted in the lowest means of these yield traits. This effect of biofertilization treatments expressly rhizobacterin biofertilizer may be ascribed to its role in improving plant growth, vigor of plant and yields through fixing atmospheric nitrogen and mineralization and/or mineralizing organic compounds as well as release of certain growth regulators, stimulatory compounds and nutrients in soil by the introduced organisms. Similar results were in coincidence with the present ones as reported by **Badawi,** ***et al*****. (2004); Gobarah,** ***et al*****. (2011) and Amin,** ***et al*****. (2013).**

Data in Table (2 and 3) clear that application of biofertilization treatments were associated with negatively significant effect on sucrose, extractable sugar, purity, impurities in terms of (Na, K and α-amino N), as well as loss sugar in molasses percentages in both seasons. The decrease in quality parameters due to bio fertilizer can be ascribed to its role in increasing root weight as well as increasing non-sucrose substances such as proteins and alpha amino acid, and hence decreasing sucrose content in roots **(Sahin,** ***et al*****., 2004)**. These results are in good agreement with those reported by **Gobarah,** ***et al*****. (2011) and Amin,** ***et al*****. (2013).**

C- Effect of foliar spray with humic acid:

Results given in table (1) indicate that application of 24 g/l foliar spray with humic acid significantly increased root length by (6.37 % and 4.06 %), root diameter by (8.67% and 5.48%) and root fresh weight by (25.38 and 5.71%) in the 1^{st} and 2^{nd} seasons, respectively compare with untreated plants. This may be due to promoting growth and nutrient uptake of plants by addition of humic substances which affect membrane permeability **Zientara (1983) and Shaban,** ***et al*****. (2014).** A similar trend was found by **EL-gamal,** ***et al.*** (2016) who showed that root fresh weight of sugar beet was affected by the level of humic acid 25 g/L and the maximum value (1250 g/plant) was obtained from humic application and the lowest value (1017 g/plant) was observed when humic acid was not applied. **Türkmen** ***et al*****. (2005)** reported that humic acid application positively affected the parameters of plant grown in salinity condition.

Data in table (1 and 3) clear that a significant effect of foliar spray with humic acid was found for root, top, biological, gross sugar and extractable sugar yields t/fed. Application of 24 g/l humic acid was significantly increased effected on root yield by (8.56 and 3.97 %), top yield by (14.44 and 5.01%), biological yield by (10.04 and 4.26%), gross sugar yield by (12.19 and 6.63%) and extractable sugar yield by (13.74 and 10.07 %), respectively in the 1st and 2nd seasons compared with untreated one. These results may be due to that humic substances enhance the uptake of some nutrients, and improve the plant characteristics. This was reflected in the growth characteristics and occurred positive effect on the final production of sugar beet plants. In this respect, **Mehdi, *et al*. (2013)** and **Shaban, *et al*. (2014)** reported that, root and sugar yield were strongly affected by humic acid, where humic acid increased root and sugar yield compared with untreated plant.

Data in table (2) clear that a significant effect of foliar spray with humic acid was found for K, α-amino N, purity and loss sugar in molasses % in both seasons, and sucrose, extractable sugar and Na % only in the first season. Applying 24 g/ l of humic acid was accompanied by increased percentage of sucrose, extractable sugar and purity % compared with the control. On the other hand, Applying 24 g/ l of humic acid was accompanied by decreased impurities in terms of Na, K and α-amino N %, as well as loss sugar in molasses compared with the control. In this respect, **EL-gamal, *et al*. (2016)** reported that, sucrose and purity percentage of sugar beet were strongly increased by humic acid.

D- INTERACTION EFFECTS

D-1. Effect of the bilateral interaction between the three mineral nitrogen fertilizer and four biofertilization levels: Data illustrated in tables (1, 2 and 3) reveal that root fresh weight (kg/plant), K, α-amino N, loss sugar % and loss sugar yield (t/fed) were significantly affected by the interaction between application of three mineral nitrogen fertilizer and four biofertilization levels in both seasons, and root length in 1th season, but root diameter, root yield, biological yield, Na, extractable sugar, purity and gross sugar yield in the second one. The highest root length, diameter and fresh weight, yield in terms of root, biological and gross sugar were recorded in fertilized with level of 120 kg N/fed as mineral fertilizers and dual inoculation. These results are accomplished with those reported by **Kandil, *et al*. (2002); Ramadan, *et al*. (2003)** and **Gobarah, *et al*., (2011)** who stated that, this increment in yield characters were due to the interaction between bio-and mineral fertilizer.

D-2. Effect of the bilateral interaction between the three mineral nitrogen fertilizer levels and three foliar spray with humic acid: Results in tables (1, 2 and 3) indicat that root fresh weight (kg/plant), α-amino N% and loss sugar yield (t/fed) in the first season, and root length (cm), Na %, yield in terms of root, top, biological, gross and extractable sugar (t/fed) in the second season were significantly affected by the interaction between application of the three mineral nitrogen fertilizer levels and three foliar spray with humic acid. The highest root length and root fresh weight, as well as yields in terms of root, top, biological, gross and extractable sugar were recorded from the foliar sprayed application with humic acid 24 g/l and soil N fertilization by 120 kg N/fed. These results are in agreement with those obtained by **El-Hassanin, *et al*. (2016)**. They found that the highest top, root and sugar yields recorded from the foliar application with fulvic acid and the highest soil N fertilization. **Shaban, *et al*. (2014)** reported that the interaction effect between inorganic and organic nitrogen fertilization showed a significant effect on root and sugar yields and sucrose %, the highest values of all the previous traits were obtained by100 kg N/fed and 10 kg /fed humic acid.

D-3. Effect of the bilateral interaction between four biofertilization and three foliar spray with humic acd: Data illustrated in tables (1,2 and 3) reveal that the mean root length and diameter (cm) and yield in terms of root, top and biological (t/fed) in 2014/15 and 2015/16 seasons, besides root fresh weight (kg/plant), K, α-amino N, loss sugar in molasses % and loss sugar yield (t/fed) in the first season, in addition to, gross and extractable sugar yield (t/fed) in the second season were significantly affected by the interaction between application of four biofertilization and foliar spray with humic acid levels.

D-4. Effect of the trilateral interaction among the three levels of mineral nitrogen fertilizer, four levels of biofertilization and three levels of foliar spray with humic acid: The data presented in tables (1, 2 and 3) show the differences root length (cm) in 2014/15 and 2015/16 seasons, as well as root fresh weigh (kg/plant), α-amino N, loss sugar in molasses % and loss sugar yield (t/fed) in the first season,

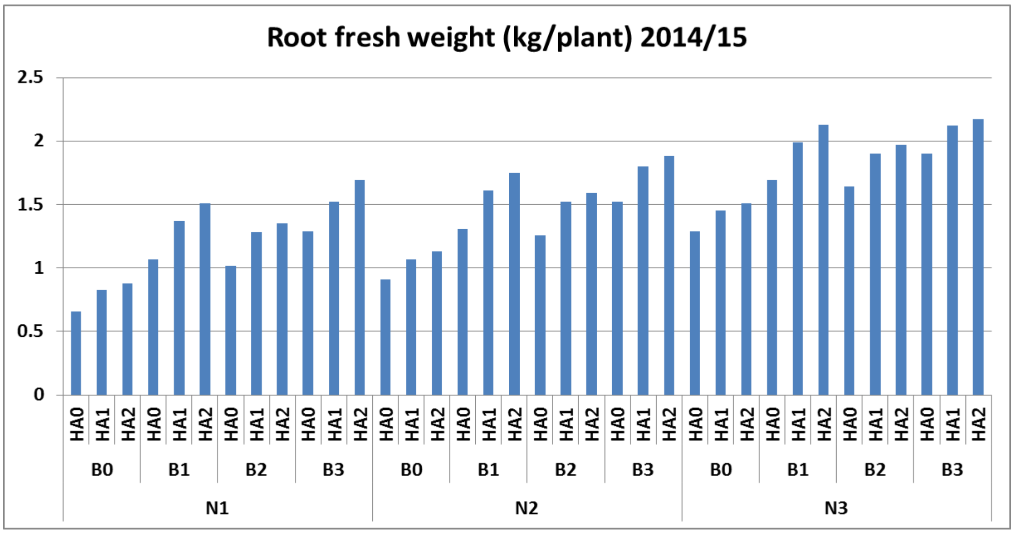

Fig. (1)

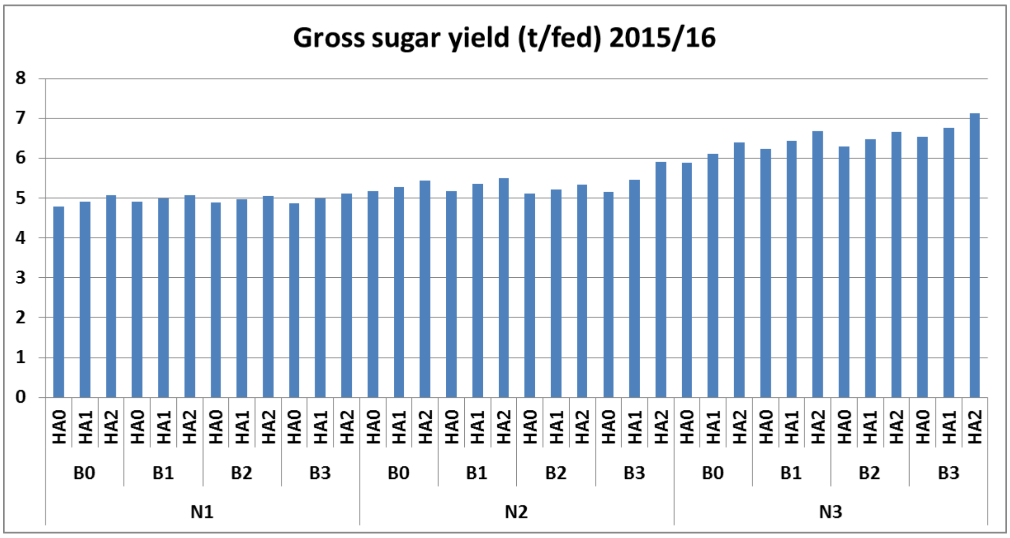

Fig. (2)

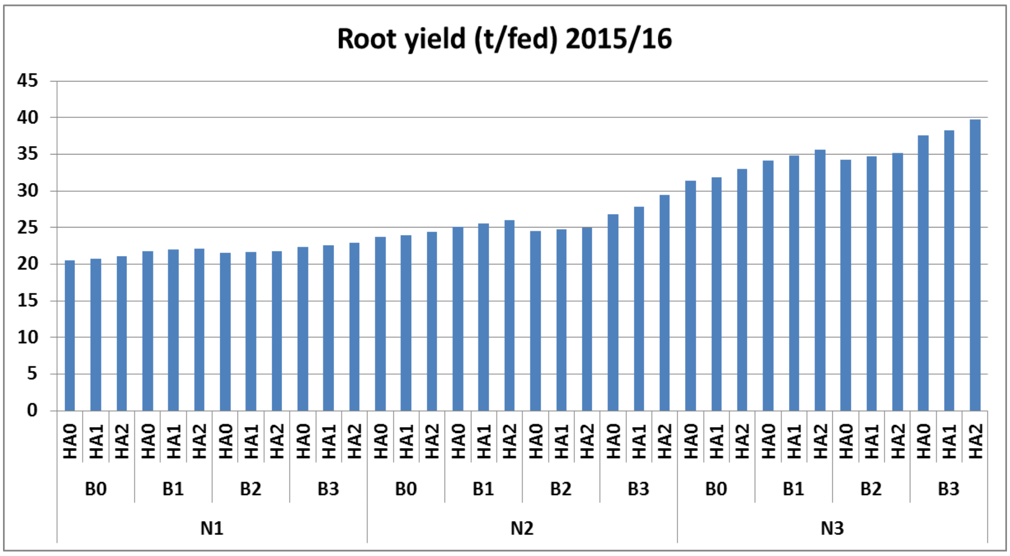

Fig. (3)

In figures (1, 2 and 3) where: N_1, N_2, N_3 is 60, 90 and 120 kg N/fed, B_0, B_1, B_2, B_3 is uninoculated, rhizobactrein, phosphorein and dual inoculation, HA_0, HA_1, HA_2 is 0, 12 and 24 g/l, respectively.

while the differences in root diameter (cm) and yield in terms of root, biological and gross sugar (t/fed) in the second season due to the interaction among the three factors were significant. The highest root fresh weight (2.17 kg/plant), root yield (39.77 t/fed) and gross sugar yield (7.13 t/fed) which are presented in Fig. (1, 2 and 3) were obtained by the higher level of mineral nitrogen fertilizer 120 kg N/fed with application the mixture of rhizobactrein+ phosphorein with the higher level of foliar sprayed with humic acid 24 g/l.

Regression analysis of yield and its attributes

The results obtained in Table (4) clarify that there are four traits *i.e.* sucrose %, root yield, root length and root fresh weight in the first season, while there are three traits *i.e.* root yield, sucrose and root fresh weight in the second one were significantly ($P \leq 0.001$) contributed to variation in gross sugar yield.

Generally, under the condition of this study, it could be recommended that fertilizing sugar beet with 120 kg N/fed as mineral nitrogen fertilizer and using mixture of rhizobactrein+ phosphorein as biofertilization and sprayed with 24 g/l humic acid, increased the productivity and quality of sugar beet plants.

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تأثير التسميد المعدنى والحيوي والرش الورقى بالهيومك والتفاعل بينهم على محصول بنجر السكر

على عبدالله على مقداد
قسم المحاصيل – كلية الزراعة - جامعة الفيوم

أجريت تجربتين حقليتين فى مزرعة كلية الزراعة بالفيوم بمنطة دمو- جامعة الفيوم- مصر خلال عام ١٥/٢٠١٤ و ١٦/٢٠١٥ لدراسة تأثير ثلاثة مستويات من التسميد النيتروجينى المعدنى (٦٠، ٩٠ و ١٢٠ كجم نيتروجين للفدان) و أربعة مستويات من التسميد الحيوى (بدون تلقيح ،التلقيح بإستخدام الرايزوبكترين ،التلقيح بإستخدام الفوسفورين و التلقيح المزدوج بينهما) وثلاثة مستويات من الرش الورقى بالهيومك (الرش بالماء، الرش بمستوى ١٢ جم/لتر والرش بمستوى ٢٤ جم/لتر) على المحصول ومكوناته لبنجر السكر. تم إستخدام القطع المنشقة مرتين فى تصميم القطاعات كاملة العشوائية بإستخدام ثلاثة مكررات فى الموسمين. وقد إحتلت معاملة التسميد المعدنى بالنيتروجين القطع الرئيسية ووزعت معدلات التسميد الحيوى فى القطع الشقية الأولى فى حين تم توزيع معدلات الرش الورقى بالهيومك فى القطع الشقية الثانية.

أظهرت النتائج المتحصل عليها أن معاملة كلا من التسميد المعدنى بالنيتروجين والحيوى وكذلك الرش الورقي بالهيومك كانت معنوية وذات تأثير إيجابي على صفات المحصول ومكوناته وكذلك صفات الجودة،.أظهرت النتائج المتحصل عليها أن أعلى محصول للجذور وللسكر كانت ٣٩.٧٧، ٧.١٣ طن/ فدان على الترتيب خلال الموسم الثانى، بينما كان أعلى وزن طازج للجذر (٢.١٧ كجم/ النبات) في الموسم الأول فقط ناتجة من إستخدام المعدل العالى من التسميد النيتروجينى (١٢٠ كجم/فدان) مع إستخدام التلقيح المزدوح للتسميد الحيوى (التلقيح بإستخدام الرايزوبكترين + الفوسفورين) و إستخدام معاملة المعدل الثالث من التسميد الورقى بإستخدام الهيومك (٢٤ جم/لتر). وأظهرت نتائج تحليل الإنحدار أن هناك علاقة عالية المعنوية بين محصول السكر الظاهرى مع كل من محصول الجذور والنسبة المئوية للسكر والوزن الطازج للجذر فى كلا الموسمين، بالإضافة إلى صفة طول الجذر خلال الموسم الأول فقط.