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Effect of some Growth Substances on Growth, Chemical Compositions and Root Yield Productivity of Sugar Beet (*Beta vulgaris* L.) Plant

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ABSTRACT

Two field experiments were carried out at the experimental station of Sakha Agricultural Research, Agricultural Research Center, Egypt during the two growing successive seasons of 2011/2012 and 2012/2013 to study the effect of foliar application with humic acid at 15, 20 and 25 g/ L; mono potassium phosphate at 1, 1.5 and 2% and vigamax (amino acids) at 0.1, 0.2 and 0.4 ml/L on some morphological and physiological characteristics as well as root yield and quality of sugar beet (*Beta Vulgaris* L.) plant cv. "Ras poly". Results showed that all tested treatments statistically improved growth parameters i.e., Root length, diameter, size, number of leaves, root and leaves fresh weight , root and leaves dry weight, root yield parameters(i.e., root length, diameter, size, fresh and dry weights of root), root chemical compositions parameters, leaves bio constituents i.e., N, P, K, total sugars and chlorophylls contents as well as endogenous phytohormones (i.e., cytokinins, gibberellins, auxin (IAA) and abscisic acid (ABA)) of sugar beet plant compared with control.The treatments of vigamax (amino acids) at 0.4 ml/L and humic acid at 20 g/L followed by mono potassium phosphate at 2% were more effective comparing in this respect.

Conclusively, spraying sugar beet plant with vigamax (amino acids) at 0.4 ml/L treatment induced prospective effects on growth and root yield productivity.

Keywords: Sugar beet, vigamax, humic acid, mono potassium phosphate, Growth, Yield.

Introduction

Sugar beet (*Beta vulgaris* L.) family Chenopodiaceae is one of the most important sugar crops in the world. It is the second main source of sugar after sugar cane not only in Egypt but also in the world. Sugar beet grown area have been increased to 423,000 feddan in 2014. They have produced 53.1 % of the total amount of sugar production from the world production. This means that sugar beet has become the first source of sugar production (Egyptian Society Sugar Technologists and Sugar Crops Research Institute, 2014).

Recently, under Egyptian conditions a great attention is being devoted to search for untraditional natural and safe stimulating growth substances (chemical and biological technologies in agriculture) which have marked influence on plant growth parameters , that is reflect to increase plant productivity (Abd El-Aal and Abd El-Rahman , 2014).

So, the main aim of this study is to use some plant growth substances i, e. humic acid (HA), mono potassium phosphate (MKP) and vigamax (amino acids) for maximizing sugar beet growth and productivity to particularly reduce the gap between production and consumption of sugar in Egypt.

Humic acid (HA) treatment suggested to participate a beneficial role during this study 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). Kaya *et al.* (2005) mentioned that foliar application of common bean by humic acid significantly increased number of leaves/plant, fresh and dry weight/plant. Fathy *et al.* (2009) found that foliar application with humic of sugar beet increased photosynthetic pigments content of treated plant compared with control. El-Naggar and El-Ghamry, (2007) concluded that foliar spraying with humic acid increased Fe, Zn, Mn and Cu concentrations in wheat grains and straw. El-Bassiony *et al.* (2010) found that, foliar spray with humic acid increased phytohormones gibberellins and auxin, provide the plant with hormones such as auxin and cytokinins and inhibit IAA- oxidase, thus prevents destruction of this plant growth hormone of snap bean plants. Salwa and Eisa, (2011) revealed that foliar application with humic acid increased yield component of sugar beet i.e., sugar yield (ten/feddan).

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As for Mono-potassium phosphate (MKP) is a cost effective and readily available fertilizers used in soil applications, MKP is the formulation with the lowest salt index and thus it considered the choice of foliar fertilizer for many crops (Ankorion, 1998). K is one of the macro elements required for plants, the main physiological functions of k are enzymes activation, protein synthesis, carbohydrate metabolism, osmoregulation, stomata movement, energy transfer, phloem transport, cation-anion balance and stress resistance, improves efficiency of plant water and sugar use for maintenance and normal growth functions. potassium with phosphorus stimulate and maintain rapid root growth of plants(Restrepo-Diaz *et al.,* 2008; Cook and Scott, 2006; Marschner, 2005; Wang *et al.,* 2013 and Salami and Saadat 2013. Attia, (2004) stated that foliar application with potassium of sugar beet increase the biosynthesis of photosynthates. El-gamal (2009) stated that foliar spray with potassium 1000 ppm increased chemical compounds of sugar beet i.e.,T.S.S, purity, sucrose, NPK uptake and total sugar. Fageria *et al.* (2009) studied that foliar application with potassium of crop plants increased phytohormones and amino acids content. Braunsch and Orlovius, (2002) stated that foliar application with potassium on sugar beet increased the yield level of sugar beet.

Regarding, phosphorus it is necessary for many plant physiological processes such as photosynthesis, synthesis and breakdown of carbohydrates and the transfer of energy within the plant. Phosphorus plays a significant role in sugar production, as well as being a nutrient essential for growth. Foliar sprays of phosphorus compounds can affect growth and sucrose percentage in beet roots, but concentration of spray and time of application are critical(John and Jim, 1980 and California Fertilizer Foundation, 2009). Fabrício *et al.,* (2012) reported that foliar application with phosphorus of common bean increased growth characteristics i.e., root dry weight, shoot dry weight, and root to shoot ratio and chemical compounds concentration of N, K, Mg, B, Cu, Mn and Fe in shoot tissues. Mauro *et al.* (2005) revealed that foliar application with phosphorus increased sugar beet photosynthesis (chlorophyll a, b and carotenoid). Fageria *et al.* (2009) studied that foliar application with phosphorus of crop plants increased phytohormones and amino acids content. Sims *et al.* (2010) found that foliar application with P of sugar beet increased yield components i.e., sugar content, root yield and yield quality.

As for Vigamax (amino acids) amino acids can directly or indirectly influence the physiological activities of the plant. Foliar nutrition in the form of protein hydrolysate (known as amino acids liquid) and foliar spray provide readymade building blocks for protein synthesis: Proteins have a structural function, metabolic function (enzymes), a transport function and a stock of amino acids function. Amino acids acts as antioxidants to tolerate environmental and water stresses, precursors or activitors of phytohormones, growth factors and many other important bioconstituents (Xing-Quan Liu and Kyu-Seung Lee, 2012). El-Desouky *et al.* (2011) and Abd El-Aal, (2012) showed that significant increase was existed in many growth aspects as stem length and diameter, number of formed branches and leaves/plant, fresh and dry weight of stems and leaves, total leaf area/plant and specific leaf weight as well with applied amino acids treatment. El-Tohamy *et al.* (2008) pointed out that, spraying with amino acid of snap bean increased chlorophyll and hormonal content. El-Badawy and Abd El-Aal, (2013) assumed that the highest leaf N, P, K, total carbohydrates percentage, total indols as well as the lowest value of total phenols content were registered by 150ppm tryptophan-sprayed plants. Dina *et al.* (2013) concluded that foliar application with amino acids increased yield component i.e., yield and quality, total sugar yield and root yield as ton/feddan, as well as its physical properties of sugar beet.

Materials and Methods

Two field experiments were conducted at Sakha Agricultural Research Station, Agricultural Research Center, Egypt, during two growing successive seasons 2011/2012 and 2012/2013. Sugar beet (*Beta vulgaris* L) is one of the sugar crops those known to be largely cultivated in Egypt in winter seasons, is taken as botanical material in this study .This experiment was performed to study the effect of foliar spray with humic acid (HA), mono potassium phosphate (MKP) and vigamax (amino acids) on some morphological and physiological characteristics as well as root yield and quality of sugar beet *(Beta vulgaris L.*) plant and their relationship to cercospora leaf spot disease in "*Ras poly*" cultivar.

Seeds of sugar beet (Beta vulgaris) CV. Ras poly were obtained from field crop Research Institute, Agricultural Research centre, kafr El-Sheikh Governorate. Seed of sugar beet were sown In 22th of September in 2011/2012 and 2012/2013 seasons .The experimental plot area was 3.0×3.5m (1/400feddan) with six rows in each plot and 30cm apart between hills and nine replicates for each treatment. After 40 days from sowing the seedlings were thinned to leave one plant / hill. All cultural practices were carried out as commonly followed in the district for such crop as recommend by Egyptian Agricultural ministry.

The treatments were arranged in randomized complete block design (RCBD) each treatment had nine replications. Three rows of soil are lifted between each two treatments to provide complete separation of differences.

Plants were sprayed with The applied treatments as humic acid, mono potassium phosphate and vigamax with different used concentrations at 60, 80 and 110 days of plant age during 2011/2012 and 2012/2013 seasons. Harvesting took place on 12th April in the first and second seasons.

The experimental treatments were as follows:

1-Control (Tap water).
2-Humic acid at 15, 20 and 25 g/L
3- Mono potassium phosphate at 1%, 1.5% and 2%.
4- Vigamax at 0.1, 0.2 and 0.4 ml/L.

Humic acid (HA): 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%).

Vigamax bioconstituents: Vigamax is a commercial fertilizer containing (about 20 important free amino acids, made in spanish) Vegamax was a commercial fertilizer containing mineral elements (0.05% Zn, 0.16% Fe, 0.08% Mn, 0.03% Cu, 0.04% B, 0.34% Mg, 0.46%Ca, 0.40% S and 0.005% Co), amino acids (mg/100ml) (aspartic acid, 249; therionine, 45; serine, 56; glutamic, 55; glycine, 50; alanine, 100; proline, 38; valine, 68; cystine, 44; methionine, 18; iso-lucine, 52; tyrosine, 38; phenylalanine, 32; histedine, 12; lycine, 40; arginine, 20 and tryptophane, 20) as well as vitamins (mg/100ml) (B1, 0.08; B2, 2.4; B6, 1.2; B12, 0.82; folic acid, 4.2; pantothenic acid, 0.53 and niacin, 1.14) and cytokinines.

Sampling and collecting data:

During the experimental period three samples were taken at 70, 120 and 200 days after sowing in 2011/2012 and 2012/2013 seasons.

I- Growth characteristics of sugar beet plant :

1- Morphological characteristics:

1- Root length (cm)/plant. 2- Root diameter (cm)/plant.
3- Root size cm^3 4- Root fresh weight (g)/plant.
5- Leaves number /plant. 6- Leaves fresh weight (g)/plant.
7- Root dry weight (g)/plant. 8- Leaves dry weight (g).
9- Leaf area (cm2) /plant according to Derieux et al. (1973).

2- Growth analysis:

The growth analysis, i.e., Net assimilate rate (mg/cm^2) day, Crop growth rate (g)/day and Specific leaf area (cm^2/g) were computed according to Watson, (1952) as the following formula:
1- Net assimilation rate g/cm^2/day. (W2-W1)(logA2-logA1) / (A2-A1)(t2-t1)
2- Crop growth rate g/cm^2/day. (W2-W1)/(t2-t1)
3- Specific leaf area (LA/Lw) cm^2/g according to Hall *et al*. (1993).

Where: W1, A1 and W2, A2 respectively refer to dry weight and leaf area at time t1 and t2 in days.

II- Chemical analysis:

Chemical analyses were carried out on the samples of Leaves during the second season 2012/2013.

Photosynthetic pigments:

Chlorophyll a, b, and carotenoids were calorimetrically determined in the leaves of sugar beet plants at 70 and 120 days after transplanting according to methods described by Wattsiten, (1957) and calculated as mg/g fresh weight.

Determination of minerals content:

Total nitrogen

Total nitrogen was determined in the dry matter of sugar beet leaves at 70 and 120 days after transplanting by using wet digestion according to Piper, (1947) using microkeldahl as described by Horneck and Miller, (1998).

Phosphorus

It was determined calorimetrically according to the method of Sandell, (1950) and calculated as mg/g dry weight.

Potassium:

It was determined by the flame photometer model carl- zeiss according to the method described by Horneck and Hanson, (1998) and calculated as mg/g dry weight.

Determination of sugar:

Total sugar were determined in sugar beet leaves at 70 and 120 days after sowing at 2012/2013 season calorimetrically with the picric acid method as described by Thomas and Dutcher, (1924) and calculated as mg/g dry fresh weight .

Endogenous Phytohormones:

Endogenous Phytohormones were determined quantitatively in sugar beet shoots at 100 days after sowing during 2012/2013 season. The method of Koshioka, et al., (1983) was used for the HPLC "high – performance liquid chromatography" determination of auxin (IAA), gibberellic acid (GA3) and abscisic acid (ABA). cytokinins were determined by UPLC according to Nicander *et al.,* (1993).

III- Yield characteristics and quality of sugar beet plant

At harvest 200 days after sowing in both seasons nine randomly plants from each treatment were taken for estimating the following characteristics.

A-Growth characteristics.

1-Root Length (cm)/plant.
2- Root diameter (cm).
3- Root size / plant.
4-Root fresh weight g/plant as well as ten/feddan.
5- Root dry weight g/plant.

B-Root quality:

1-Sucrose percentage was determined according to Le Docte, (1927).
2-Total soluble solids percentages (T.S.S%) which was determined by using 'Hand Refractometer'
3-Extractable white sugar percentage and white sugar yield (t/fed) according to Reinefeld et al (1974).
4- sugar loss percentage and sugar losses yield (t/fed).
5- Juice purity percentage which was calculated according to the following formula, described by Carruthers *et al.* (1962) = (Sucrose/ Total soluble solids) x100
6- Alkalinity coefficient (Ac): AC was determined as described by Harvey and Dutton, (1993).

Statistical analysis:

Data of morphological and yield characteristics were statistical analysis and the means were compared using the least significant difference test (L.S.D) at 5% levels according to Snedecor and Cochran, (1980).

Results and Discussion

This chapter aims to scope light on the results obtained from our study which focused on the effect of foliar application with humic acid (HA), mono potassium phosphate (MKP) and vigamax (amino acids) on plant growth characteristics, bioconstituents, yield and yield components as well as quality parameters of sugar beet crop. Most important results are discussed as following:

Effect of different applied treatments on sugar beet growth characteristics at 70 and 120 days after sowing:

Root length, root diameter, root size and root fresh weight:

Data in Table (1) clearly indicate that foliar application with different applied treatments i.e., humic acid at (15, 20 and 25 g/L), mono potassium phosphate at (1, 1.5 and 2%) and amino acids (vigamax) at (0.1, 0.2 and 0.4 ml/L) significantly increased sugar beet root growth characteristics i.e., root length , diameter, size and root fresh weight of sugar beet at 70 and 120 days after sowing compared with control (untreated plant) during 2011 / 2012 and 2012 / 2013 seasons.

Table 1: Effect of different applied treatments on root characteristics of sugar beet plant at 70 and 120 days after sowing during 2011/2012 and 2012/2013 seasons

Treatments	Characters	Root length (cm)		Root diameter (cm)		Root fresh weigh g/plant		Root size cm^3	
		2012 season							
		70	120	70	120	70	120	70	120
Control	0.00	9.40	14.53	2.49	6.36	164.8	259.6	24.22	95.94
Humic acid	15 g/L	11.05	18.17	3.66	7.10	181.5	321.9	30.41	133.6
	20 g/L	11.47	19.60	4.05	8.63	301.6	542.7	47.60	163.2
	25 g/L	11.19	18.89	3.37	7.83	189.1	362.4	39.87	127.8
MKP	1 %	10.17	17.53	3.43	7.10	168.7	344.3	36.35	129.1
	1.5 %	11.26	18.41	3.96	7.88	170.6	384.6	46.07	131.0
	2%	11.30	18.47	3.99	8.19	297.3	535.5	48.90	147.1
Vigamax	0.1 ml/l	10.37	17.87	3.23	7.68	183.9	360.1	31.34	123.9
	0.2ml/l	11.27	18.27	3.33	8.05	202.9	481.7	36.16	138.9
	0.4ml/l	11.84	20.00	4.44	9.20	313.9	648.8	51.86	169.9
L.S.D	5%	0.64	0.86	0.95	0.53	3.58	5.63	1.15	2.36
2013 season									
Control	0.00	9.87	15.53	2.71	5.74	160.8	289.6	24.98	92.58
Humic acid	15 g/L	10.87	18.33	3.62	7.55	189.3	545.9	26.81	123.6
	20 g/L	11.47	19.63	4.18	9.04	218.3	659.0	36.18	184.4
	25 g/L	11.23	19.13	3.76	7.85	193.4	471.3	33.13	164.2
MKP	1 %	10.27	17.80	3.37	6.64	171.0	440.9	30.57	102.2
	1.5 %	10.53	18.70	3.41	6.95	178.6	507.6	31.79	117.2
	2%	11.20	18.90	3.83	8.37	204.0	605.2	35.88	152.7
Vigamax	0.1 ml/l	10.13	16.80	3.01	6.87	170.8	419.1	30.04	102.4
	0.2ml/l	10.60	17.47	3.16	7.70	197.7	411.8	33.63	139.3
	0.4ml/l	11.60	20.47	4.25	9.44	219.2	694.1	40.64	192.1
L.S.D	5%	1.02	1.05	0.55	0.89	3.16	22.01	7.56	2.78

The most superior treatments were the vigamax at 0.4 ml/L, humic acid at 20 g/L followed by mono potassium phosphate at 2% respectively, were the most effective treatments in this respect.

Also, of interest to note that increase of root diameter may be accompanied with basic anatomical modification in different root tissues especially phloem, xylem and parenchyma cell rings. These data go well with the below mentioned possibility for increasing yielded root. Since, vigorous growth of sugar plant with different applied treatments was the perment result during this early stage of growth. Also, these data will interpert those data about yield and will answer many questions specially why sugar beet plant treated with amino acids (vigamax) at 0.4 ml/L spray gave yield more than the control.

Similar results were also obtained by El-Tohamy and El-Greadly (2007); Khan *et al.,* (2013), Salami and Saadat (2013) and Razieh *et al.,* (2012).

Number of leaves, leaves fresh , leaves and root dry weight:

Data in Table (2) show that all applied treatments significantly increased growth characteristics i.e., leaves fresh weight , leaves and root dry weight of sugar beet at 70 and 120 days after sowing compared with control during 2011 / 2012 and 2012 / 2013 season. The exception was that insignificant increases existed in number of leaves. Here, the most superior treatments on leaves fresh weight , leaves and root dry weight were the vigamax (amino acids) at 0.4 m/L followed by humic acid at 20 g/L then mono potassium phosphate at 2% at 0.4 ml/L respectively at the two growing seasons. These results are of great interest, because at this early stage of growth great simulative effects existed with various applied treatments. Hence, that could be prolonged to the advanced growth stages including each of growth and yield as well as quality of root yield. Also, of interest to note that increase of leaves weight may be accompanied with basic anatomical modification in different tissues especially photosynthetic, phloem and xylem tissues. Therefore, that could be accompanied with great variations in the nature of sugar beet. Besides, increasing of root diameter accompanied with increasing of fresh weight means that applied treatments lead to vigorous growth These results are in agreement with those reported by El-Tohamy and El-Greadly (2007); Abou Dahab and Abd -El-Aziz (2006); Fathy *et al.,* (2003); Dina *et al.,* (2013).

With regard to root dry weight, Data in Table (2) show that root dry weight was significantly increased with different foliar applications. Here, root dry weight its values were 19.10 and 40.30 g/plant with vigamax at 0.4 ml/L meanwhile, its values were 18.26 and 39.75 g/plant with humic acid at 20 g/L and 18.21 and 39.10 g/plant with mono potassium phosphate at 2% treatments respectively, were the most effective treatments in this respect compared with control values 13.00 and 23.32 g/plant at 70 and 120 days after sowing during 2012 season. While during 2013 season root dry weight values were 19.68 and 61.31 g/plant with vigamax at 0.4 ml/L meanwhile, its values were 19.60 and 59.17 g/plant with humic acid at 20 g/L and 18.32 and 54.34 g/plant with mono potassium phosphate at 2% treatments respectively, were the most effective treatments in this respect compared with control values 13.54 and 26.01 g/plant at 70 and 120 days after sowing.

Table 2: Effect of different applied treatments on leaves characteristics and root dry weight of sugar beet plant at 70 and 120 days after sowing during 2011/2012 and 2012/2013 seasons

Treatments	Characters	Number of leaves /plant		Leaves fresh weight g/plant		Root dry weight g/plant		Leaves dry weight g/plant	
		2012 season							
		70	120	70	120	70	120	70	120
Control	0.00	10.33	16.67	196.4	267.1	13.00	23.32	19.00	34.35
Humic acid	15 g/L	11.00	22.33	323.2	497.6	16.30	28.90	20.24	41.08
	20 g/L	11.67	28.00	448.2	641.3	18.26	39.75	26.99	51.52
	25 g/L	11.00	27.67	418.2	513.3	16.98	32.54	25.15	50.91
MKP	1 %	10.33	25.00	290.7	453.7	15.15	30.91	20.24	44.76
	1.5 %	11.00	24.33	304.1	543.6	15.32	34.53	21.47	46.60
	2%	11.57	25.33	388.6	574.4	18.21	39.10	25.83	51.52
Vigamax	0.1 ml/l	10.00	24.33	238.7	359.7	16.51	32.33	18.40	44.76
	0.2ml/l	12.67	25.00	315.7	387.1	18.22	31.58	19.52	46.00
	0.4ml/l	13.67	30.00	502.1	690.0	19.10	40.30	28.83	55.20
L.S.D	5%	2.81	2.48	47.83	30.75	1.06	1.49	0.602	5.34
		2013 season							
Control	0.00	9.00	19.33	214.4	260.3	13.54	26.01	16.56	35.56
Humic acid	15 g/L	11.00	24.33	320.3	462.0	17.89	49.02	20.13	44.76
	20 g/L	12.67	28.67	429.3	601.4	19.60	59.17	23.31	53.67
	25 g/L	11.50	26.33	412.7	531.4	17.36	42.32	20.35	48.44
MKP	1 %	10.67	26.33	296.9	467.6	15.35	39.59	19.63	48.44
	1.5 %	11.00	26.33	325.3	519.6	16.03	45.58	20.24	48.44
	2%	12.00	28.33	391.5	543.8	18.32	54.34	22.08	52.75
Vigamax	0.1 ml/l	10.67	26.33	241.6	347.9	16.33	37.63	19.73	48.44
	0.2ml/l	11.67	27.00	315.8	413.8	17.75	36.97	21.58	49.41
	0.4ml/l	13.67	30.00	501.9	691.5	19.68	61.31	25.15	55.20
L.S.D	5%	1.66	2.76	5.52	37.94	1.13	5.51	5.81	7.27

Regarding, leaves dry weight, data in Table (2) clearly indicate that foliar application with different concentrations of humic acid, mono potassium phosphate and vigamax caused a significantly increases in leaves dry weight of sugar beet with different studied samples. Hence, the most superior treetments were vigamax at 0.4 ml/L followed by humic acid at 20g/L then mono potassium phosphate at 2% during both seasons. Here, leaves dry weight values were 28.83 and 55.20 g/plant with vigamax at 0.4 ml/L meanwhile its values were 26.99 and 51.52 g/plant with humic acid 20 g/L and 25.83 and 51.52 g/plant with mono potassium phosphate at 2% treatments respectively, were the most effective treatments in this respect compared with control values 19.00 and 34.35 g/plant at 70 and 120 days after sowing during 2011 / 2012 season. While during 2012 / 2013 nearly behave as the some as 2011 / 2012 season. Same data also evidently confirmed the stimulatory and significantly effects of different applied treatments upon dry matter production and accumulation in leaves. In general, data in Table (2) being a direct results for that vigorous growth. These results are in agreement with those obtained by Gadimove *et al.,* (2007); Osman, (2006); Fageria *et al.,* (2009); El-Desouky *et al.,* (2011) and Abd El-Aal, (2012).

Leaf area, specific leaf area, crop growth rate (CGR) and net assimilate rate (NAR):

Data in Table (3) show that significant increase of leaf area /plant, specific leaf area, crop growth rate (CGR) and net assimilate rate existed with different applied treatments during the two seasons. Also, it could be noticed that each of vigamax at 0.4 ml/L, humic acid at 20 g/L and mono potassium phosphate at 2% were the most effective treatments. Here, leaf area values were 3578 and 4538 cm² with vigamax at 0.4 g/L meanwhile its values were 2926 and 4188 cm² with humic acid at 20 g/L and 2391 and 3525 cm² with mono potassium phosphate at 2% treatments respectively, compared with control values 1493 and 1987 cm² at 70 and 120 days after sowing during 2011 / 2012 season. While during2012/2013 season leaf area values were 3492 and 4912 cm² with vigamax at 0.4 ml/L meanwhile its values were 2960 and 4277 cm² with humic acid at 20 g/L and

2988 and 3761 cm² with mono potassium phosphate at 2% treatments respectively, were the most effective treatments in this respect compared with control values 1424 and 1937 at 70 and 120 days after sowing.

In this respect increasing of formed leaves on growing plant could be reversed upon many other characters such as leaf area, leaves dry weight and finally yield. With regard to specific leaf area it could be also noticed that nearly behaved as the same as the leaf area. Since, the vigamax (amino acids) at 0.4 m/L followed by humic acid at 20 g/L thin mono potassium phosphate at 2% gaved the highest values in the two assigned seasons.

These results are in agreement with those obtained by Osman (2006); Karakurt *et al.,* (2008); Hanafy *et al.,* (2010); Saeed and ashraf (2011); Pechkova and Hrivna (2013); Sahar and Nejed (2014); Abd El- Aal (2012) and Zewail (2014).

Table 3: Effect of different applied treatments on growth correlations of sugar beet plant at 70 and 120 days after sowing during 2011/2012 and 2012/2013 seasons

Treatments	Characters	Leaf area cm²		Specific leaf area (cm²/g)		Crop growth rate (g)/day		Net assimilate rate (mg/cm²) day	
		2012 season							
		70	120	70	120	70	120	70	120
Control	0.00	1493	1987	78.57	57.84	27.60	18.14	29.29	21.43
Humic acid	15 g/L	2954	4206	118.1	65.54	55.20	24.55	21.45	21.75
	20 g/L	2926	4188	145.9	102.3	64.40	25.05	131.7	82.48
	25 g/L	2540	3337	125.4	68.42	46.00	23.76	50.35	66.04
MKP	1 %	2143	2731	85.20	58.60	30.65	18.45	46.51	22.43
	1.5 %	2408	2751	89.21	61.46	30.65	16.88	62.97	33.98
	2%	2391	3525	101.4	63.91	61.25	22.23	63.40	75.02
Vigamax	0.1 ml/l	2088	2952	107.0	65.95	49.60	23.00	32.81	17.91
	0.2ml/l	2089	2930	113.4	63.69	55.20	26.05	47.11	82.29
	0.4ml/l	3578	4538	166.6	82.21	64.40	37.71	144.1	89.43
L.S.D	5%	364.1	291.6	1.67	1.01	2.294	1.845	5.136	4.265
	2013 season								
Control	0.00	1424	1937	85.99	54.47	36.80	13.05	27.71	20.17
Humic acid	15 g/L	2631	4173	103.6	62.18	58.75	17.65	21.90	20.49
	20 g/L	2960	4277	134.0	93.23	61.35	21.46	112.6	41.27
	25 g/L	2607	3012	130.7	77.48	42.85	14.58	56.26	24.09
MKP	1 %	1936	2494	98.62	51.48	55.20	14.58	49.23	24.48
	1.5 %	2190	2828	108.2	58.38	58.20	16.20	73.38	28.89
	2%	2988	3761	128.1	70.07	60.95	20.70	73.44	34.28
Vigamax	0.1 ml/l	2120	2971	107.4	61.33	49.35	19.95	51.30	28.32
	0.2ml/l	2121	2971	98.28	60.12	48.50	25.16	57.88	38.73
	0.4ml/l	3492	4912	171.5	94.71	63.85	26.18	126.4	45.46
L.S.D	5%	273	300.7	0.742	1.52	1.677	1.215	5.453	1.087

With regard to crop growth rate (CGR), Data in Table (3) show that crop growth rate was significantly increased with different applied treatments. Here, crop growth rate values were 64.40 and 37.71 (g)/day with vigamax at 0.4 ml/L meanwhile its values were 64.40 and 25.05 (g)/day with humic acid at 20 g/L and 61.25 and 22.33(g)/day with mono potassium phosphate at 2% treatments respectively, were the most effective treatments compared with control values 27.60 and 18.14 (g)/day at 70 and 120 days after sowing during 2011 / 2012 season. While during 2012 / 2013 season crop growth rate values were 63.85 and 26.18 (g)/day with vigamax at 0.4 ml/L meanwhile its values were 61.35 and 21.46 (g)/day with humic acid at 20 g/L and 60.95 and 20.70 (g)/day with mono potassium phosphate at 2% treatments respectively, were the most effective treatments in this respect which compared with control values 36.80 and 13.05 (g)/day at 70 and 120 days after sowing.

Moreover, with regard to net assimilation rate (NAR), Data in Table (3) show that Net assimilate rate was significantly increased with different applied treatments. Here, net assimilate rate values were 144.1 and 89.43 (mg/cm²) day with vigamax at 0.4 ml/L meanwhile its values were 131.7 and 82.48 (mg/cm²) day with humic acid at 20 g/L and 63.40 and 75.02 (mg/cm²) day with mono potassium phosphate at 2% treatments respectively, compared with control values 29.29 and 21.43 (mg/cm²) day at 70 and 120 days after sowing during 2011 / 2012 season. While during 2012 / 2013 season net assimilate rate values were 126.4 and 45.46 (mg/cm²) day with vigamax at 0.4 ml/L meanwhile its values were 112.6 and 41.27 (mg/cm²) day with humic acid at 20 g/L and 73.44 and 34.28 (mg/cm²) day with mono potassium phosphate at 2% treatments respectively, compared with control values 27.71, 13.85 and 20.17 (mg/cm²) day at 70 and 120 days after sowing. These results are in agreement with those obtained by Osman (2006); Karakurt *et al.,* (2008); Hanafy *et al.,* (2010); Saeed and ashraf, (2011); Pechkova and Hrivna, (2013); Sahar and Nejed (2014); Abd El- Aal (2012) and Zewail (2014).

Vigamax (amino acids) treatments suggested to participate a beneficial role since, IAA synthesis exist in plants, all starting from Tryptophan .The biosyntheses of cinamic acids (which are the starting materials for the synthesis of phenols) are derived from phenylalanine and tyrosine. Tyrosine is hydroxy phenyl amino acid that is used to build neurotransmitters and hormones. Organic nitrogenous compounds are the building blocks in the synthesis of proteins, which are formed by a process in which ribosomes catalyze the polymerization of amino acids. Amino acids are particularly important for stimulation cell growth. They remove the ammonia from the cell. This function is associated with amide formation, so they protect the plants from ammonia toxicity. They can serve as a source of carbon and energy, as well as protect the plants against stress. Amino acids also function in the synthesis of other organic compounds, such as protein, amines, purines and pyrimidines, alkaloids, vitamins, enzymes, terpeniods and others Attoa *et al.,* (2002).

For humic acid, its compounds may have various biochemical effects either at cell wall, membrane level or in the cytoplasm, such as, increasing of photosynthesis and respiration rates in plants, enhances protein synthesis and plant hormone like activity. Humic acid may possibly enhance the uptake of some macro (N, K, and P) (Nardi *et al.,* 2002; Eyheraguibel *et al.,* 2008). The main enzymes involved in the antioxidative defense, such as SOD, catalase, ascorbate peroxidase and peroxidase, were also monitored by humic acid. Moreover, humic acid acts as an activator of several enzymes (more than 35 different enzymes), which involve oxidation reactions, carboxylation, carbohydrates metabolism, phosphorus reactions and citric acid cycle. As important as these enzymes, protein-manganese in Photosystem II and superoxide dismutase can be pointed. Also activates several enzymes of the shikimic acids pathway and subsequent pathways, leading to the biosynthesis of aromatic amino acids, such as tyrosine, various secondary products, such as lignin, flavonoids, as well as IAA.

On the other hand, accordingly to beneficial effects of potassium has many functions in plant growth. it is essential for photosynthesis, enzymes activity to metabolize carbohydrates, for the manufacture of amino acid and proteins, facilitates cell division and growth, as well as transport of sugars produced by photosynthesis to storage organs like grains, beet roots, tubers and fruits, adds stalk and stem stiffness, increases drought tolerance, increases disease resistance, potassium regulates many metabolic processes and opening and closing of stomates

For Phosphorus (P) is vital to plant growth and is found in every living plant cell. It is involved in several key plant functions, including energy transfer, photosynthesis, transformation of sugars and starches, nutrient movement within the plant and transfer of genetic characteristics from one generation to the next (Rengel, 2005, Better Crops, 2010 and Khan *et al.,* 2013).

Effect of different applied treatments on sugar beet Chemical composition at 70 and 120 days after sowing during 2012/2013 season:

Photosynthetic pigments:

Data presented in Table (4) indicate the different applied treatments increased each of chlorophyll a, b and carotenoids content compared with the control at 70 and 120 days after sowing during 2013 season. Also, treatments of vigamax (amino acids) at 0.4 ml/L, humic acid at 20 g/l and mono potassium phosphate at 2% were the most effective in this respect in descending order. These results are of great interest, because they are lightly considered direct reason for the more dry matter production and distribution in leaves of sugar beet plants as affected by different applied treatments. These results are in agreement with those obtained by Chapagain (2001); El-Ghamry *et al.,* (2009); El-Nagger, (2009); Eisa *et al.,* (2012) and Dina *et al.,* (2013).

Minerals content and total sugars of leaves at 70 and 120 days after sowing:

Data in Table (4) illustrated that all applied in leaves treatments were effectively increased leaves N, P and K content of treated plants compared with those of the untreated plant. Again, during 2013 season, most effective treatments were vigamax (amino acids) at 0.4 ml/L, humic acid at 20 g/L and mono potassium phosphate at 2% respectively. The simulative effect of these treatments might be due to the higher mineral metabolic requirements to obtain vigorous growth and yield potentialities there by more minerals uptake and translocation .Notice data of growth and yield. Here, it could be concluded that increase of leaf area and photosynthetic pigments as well as increment of dry matter accumulation in leaves reverse the stimulatory effects of these elements on the efficiency of photosynthesis process, hence more photosynthates being created as well as enhancement of minerals translocation from roots to leaves .In this connection the highest value were obtained when plants treated with vigamax at 0.4ml/L. As regard to the advantageous of vigamax could be due to its essential bionconstituents. For the increase obtained with humic acid, MKP and vigamax treatments might be attributed to its role in prevent the formation of free radicals thereby, the membrane leakage chlorosis and necroses of leaves. Besides, it may prevent the oxidative degeneration of IAA and consequently increases the level of IAA in plants. Such increase causes an enhancement of plant growth and mineral nutrients uptake and translocation or partially due to that sugar acts as an osmoregulator in plant cell; the process that participates in enhancing mineral uptake and translocation in plants and consequently the higher concentration of mineral in plant tissues (Brown *et al*., 1993, Marschner, 2005). These results are in agreement with those obtained by

Shaheen *et al.,* (2010); Akinci *et al.,* (2009); Lin and Danfeng (2003); EL-gamal (2009) and Saeed and Ashraf ,(2011).

As for the total sugars data in Table (4) exhibited their dominant increases with all applied treatments at the three assigned times of determination. Also, vigamax (amino acids) at 0.4ml/L treatment gave the highest values of their concentrations respectively. That was true during the three times of determination during 2013 season. In addition, increment of sugars in sugar beet leaves with different applied treatments considered a direct result of the obtained vigorous growth that being accompanied with high photosynthesis efficiency. Thereby, plants with this case of vigorous growth and entire feeding system could be give high yield with high quality. Once again, treated plants of these treatments were of the higher carbohydrates and sugars concentrations might be exported sufficient sugars at early stages. Those essentially required for root storage activities. Moreover, carbohydrates and sugars roles as cellular cry protective or osmoregulators agent, they protected proteins and enzymes against denaturation induced by stress, as well as basic substrate for ATP synthesis. These results are in agreement with those reported by Lu and Huang, (2003).

Table 4: Effect of different applied treatments on bioconstituents of sugar beet plant at 70 and 120 days after sowing during 2012/2013 seasons

Treatments	Characters	Chlorophyll A mg/g f.w		Chlorophyll B mg/g f.w		Carotenoids mg/g f.w		N(mg/g) D.W		P(mg/g D.W)		K(mg/g D.W)	
		70	120	70	120	70	120	70	120	70	120	70	120
Control	0.00	1.58	1.79	0.80	0.81	0.45	0.41	20.6	22.6	1.7	2.2	31.2	33.5
Humic acid	15 g/L	2.08	2.97	1.06	1.13	1.38	1.20	21.8	26.6	2.3	2.7	41.0	42.2
	20 g/L	2.36	3.86	1.32	2.62	1.77	1.48	31.8	38.0	2.6	3.3	45.1	48.7
	25 g/L	1.97	2.97	1.02	1.96	1.62	1.48	26.7	34.0	2.4	3.1	42.1	46.2
MKP	1 %	1.82	3.01	1.04	2.13	1.48	1.31	26.1	27.0	2.1	2.9	33.1	42.1
	1.5 %	2.12	2.62	1.15	2.10	1.64	1.33	29.1	31.5	2.5	3.2	35.3	44.0
	2%	2.24	3.58	1.10	2.23	1.75	1.39	31.7	35.4	2.2	3.0	43.1	45.6
Vigamax	0.1 ml/l	1.64	2.84	1.31	1.81	1.38	1.26	22.3	28.0	2.2	2.5	37.0	42.1
	0.2ml/l	1.98	3.18	1.30	1.61	1.47	1.37	27.1	31.2	2.4	3.2	40.2	44.6
	0.4ml/l	2.39	4.41	1.57	2.73	1.84	1.56	34.6	38.1	3.1	3.4	46.1	50.2

Table 4: *Cont.*

Treatments	Characters	Total -sugars mg/g f.w		Gibberel-lins (µg/g) F.w	Auxins (µg/g)F.w	Cytokinins (µg/g) F.w	Abscisic (µg/g) F.w
		70	120	90	90	90	90
Control	0.00	0.48	0.56	180.31	3.11	4.76	0.903
Humic acid	15 g/L	0.76	0.82	190.81	4.18	5.27	0.565
	20 g/L	0.80	0.92	314.07	27.61	11.7	0.688
	25 g/L	0.81	0.90	192.97	3.43	7.78	0.622
MKP	1 %	0.57	0.70	188.92	8.13	9.51	0.522
	1.5 %	0.62	0.81	226.17	9.30	10.2	0.621
	2%	0.72	0.91	226.89	12.82	10.6	0.654
Vigamax	0.1 ml/l	0.72	0.93	329.93	8.38	8.81	0.621
	0.2ml/l	0.95	1.03	330.81	11.11	9.86	0.631
	0.4ml/l	1.02	1.10	407.18	28.61	12.3	0.662

Endogenous phytohoromones of leaves at 90 days after sowing:

Data in Table (4) show the changes in endogenous phytohoromones, indole acetic acid (IAA), abscisic acid (ABA), gibberellic acids (GA_3) and cytokinins of sugar beet plant sprayed with vigamax (amino acids), humic acid and mono potassium phosphate treatments, which greatly improved the morphological and metabolical performances of sugar beet plant as obvious from the previously mentioned and discussed results obtained in the present study) compared with control at 90 days after sowing during 2013 season. As for auxin level, it was highly increased in sugar beet with different assigned treatments compared with that of untreated plants. Again, vigamax (amino acids) at 0.4 ml/L was the most effective followed by humic acid at 20 g/L and mono potassium phosphate at 2%. With regard to, gibberellin level, data in Table (4) also clearly show that the level of gibberellin like-substances, level in sugar beet leaves was behaved as the same as auxins. Furthermore, Table (4) clearly indicates that the level of cytokinines positively responded to the different assigned treatments. Since, the activity was the lowest in case of the control. Generally, these phytohormones those promote growth aspects (i.e., growth promoters, auxins, gibberellin and cytokinin) were highly increased with different assigned treatments. Here the treatment of vigamax (amino acids) at 0.4 ml/L, humic acid at 20 g/l and mono potassium phosphate at 2% gaved the highest values activity of promoting phytohormones level, where the increment reached more than two times of control value. Also, increment of endogenous hormones in sugar beet plants obtained in the present study could be interpret both of the obtained modifications in different studied histological features (Table 4) and the improvement of growth (Tables, 1-4) and yield (Tables, 5-6). For example, increasing cytokinins could be in favor of increasing the number of formed leaves and that could also increase transverse growth on the account of longitudinal one as well as increasing of sink organs (i.e., root) ability to accumulate and storage more assimilates. Once again, vigamax at 0.4 ml/L, humic acid at 20 g/L and mono potassium phosphate at 2% treatments showed the highest value of cytokinins, IAA and GA_s in sugar beet leaves. For higher levels of promoting hormones obtained with vigamax treatment may be attributed to its promoting effects on growth and yield With regard to the growth inhibitor, (abscises acid) its level was reduced with various assigned treatments compared with the control, but the reduction acid was more obvious with vigamax at 0.4 ml/L.

Moreover, increasing of promoters and reducing of inhibitor abscisic acid with different assigned treatments compared with the control i.e., vigamax (amino acids) at 0.4 ml/L and humic acid at 20 g/L followed by mono potassium phosphate 2% which were the most effective. In this respect, these results being of great interest for interpreting each of the obtained vigorous growth and the great root yield of sugar beet plant attained in the present study These results are in agreement with those obtained by Abd el-magwoud *et al.,* (2007); El-Tohamy *et al.,* (2008) El-Ghamry *et al.,* (2009). Hawkesford *et al.,* (2012); Salwa, (2013) and Adebusoye, (2013).

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On the other hand, accordingly to beneficial effects of potassium has many functions in plant growth. it is essential for photosynthesis, enzymes activity to metabolize carbohydrates, for the manufacture of amino acid and proteins, facilitates cell division and growth, as well as transport of sugars produced by photosynthesis to storage organs like grains, beet roots, tubers and fruits, adds stalk and stem stiffness, increases drought tolerance, increases disease resistance, potassium regulates many metabolic processes and opening and closing of stomates.

For Phosphorus (P) is vital to plant growth and is found in every living plant cell. It is involved in several key plant functions, including energy transfer, photosynthesis, transformation of sugars and starches, nutrient movement within the plant and transfer of genetic characteristics from one generation to the next (Rengel, 2005; Better Crops, 2010 and Khan *et al.,* 2013).

Root yield and quality of sugar beet at 200 days after sowing:

Data presented in Tables (5 & 6) clearly show that root yield and its components of sugar beet were highly increased as affected by different applied treatments in relatively similar fashion as previously mentioned results. Since, all applied treatments significantly increased root length, root diameter, root fresh weight, root size, root yield, sugar yield and sugar loss in molass quality, extractable sugar and Alkaline co-efficient and yield quality in sugar beet root compared with the control during the two growing seasons.

Same data revealed that the highest root length, root diameter, root fresh weight, root size, root yield and sugar yield were obtained with vigamax (amino acids) at 0.4 ml/L, humic acid at 20 g/L and mono potassium phosphate at 2% treatments. Also, it could be noticed that these increment of root yield and its component values related to the control reached to or even more than one and half times of control values with the applied treatments. Regarding to of root quality characteristics, the same data in Table (6) indicate that all treatments were significantly improved quality compared with control one. The highest content of root yield and quality were obtained with vigamax (amino acids) at 0.4 ml/L, humic acid at 20 g/L and mono potassium phosphate at 2% treatments during the two seasons. Also, sugar loss in molass, Extractable sugar and Alkaline co-efficient were greatly differed among most of treatments and control especially at 5% level of significance. Herein, it was observed that the stimulative effect of such treatment on sugar beet root yield was mainly due to their promotional effect on root sugar quality rather than root weight

Table 5: Effect of different applied treatments on root yield characteristics of sugar beet plant at 200 days after sowing during 2011/2012 and 2012/2013 seasons

Treatments	Characters	Root length (cm)	Root diameter (cm)	Root weigh g/plant	Root dry weight g/plant	Root size cm³	Root-yield (ten/fed)	Sugar-yield (ten/fed)	Sugar loss in molass
		2012 season							
Control	0.00	19.36	10.93	1017	91.35	219.5	16.20	2.694	8.53
Humic acid	15 g/L	24.63	13.10	1267	113.7	334.6	20.12	3.893	5.69
	20 g/L	26.40	14.20	1817	169.1	352.9	27.32	5.942	6.62
	25 g/L	24.13	13.23	1250	103.2	334.7	23.18	4.735	6.63
MKP	1 %	25.13	13.22	1433	128.6	296.3	22.14	4.348	3.30
	1.5 %	24.70	13.57	1517	136.2	306.7	25.82	5.347	5.14
	2%	25.07	13.87	1783	160.1	342.8	25.75	5.739	6.84
Vigamax	0.1 ml/l	25.33	12.63	1950	175.1	280.9	23.52	4.457	5.99
	0.2ml/l	26.47	13.10	2100	188.5	306.0	26.44	5.092	6.27
	0.4ml/l	27.57	14.53	2200	197.5	361.5	28.34	5.993	7.79
L.S.D	5%	1.20	1.03	70.34	4.07	2.84	1.27	0.057	0.13
		2013 season							
Control	0.00	19.47	10.33	950	98.15	208.7	17.96	3.218	8.40
Humic acid	15 g/L	25.50	12.67	1207	108.3	361.6	22.19	4.244	7.59
	20 g/L	26.83	13.86	1697	152.3	371.1	28.63	5.936	7.64
	25 g/L	25.23	12.69	1118	109.2	346.0	23.49	4.949	6.98
MKP	1 %	25.10	12.03	1217	100.3	313.0	24.81	4.939	6.19
	1.5 %	26.13	12.13	1277	114.6	331.9	26.87	5.476	6.83
	2%	26.43	13.47	1470	132.0	365.2	25.55	5.835	6.85
Vigamax	0.1 ml/l	25.10	11.87	1443	129.1	282.6	23.61	4.256	6.27
	0.2ml/l	26.30	12.27	1550	124.9	307.2	27.55	5.432	6.93
	0.4ml/l	27.90	14.72	1726	156.5	378.2	29.24	6.579	7.75
L.S.D	5%	1.89	0.88	47.47	4.19	3.29	0.32	0.065	0.89

Table 6: Effect of different applied treatments on root yield bioconstituents of sugar beet plant at 200 days after sowing during 2011/2012 and 2012/2013 seasons

Treatments	Characters	Sucrose%	T.S.S%	Purity %	Alkaline co-efficient	Extractability%	Quality %
		2012 season					
Control	0.00	16.63	20.55	80.92	4.25	46.68	71.30
Humic acid	15 g/L	19.35	23.72	81.57	4.02	55.46	79.90
	20 g/L	21.29	25.05	86.46	4.29	70.29	86.07
	25 g/L	20.43	24.03	85.01	4.04	63.98	82.33
MKP	1 %	19.64	24.38	80.55	3.16	55.77	76.53
	1.5 %	20.71	24.27	85.33	3.74	61.34	80.80
	2%	20.75	24.73	86.82	3.49	67.85	85.43
Vigamax	0.1 ml/l	18.95	23.03	82.28	3.36	55.58	79.57
	0.2ml/l	19.26	23.43	82.20	3.91	61.82	82.83
	0.4ml/l	22.15	25.78	87.52	4.22	71.12	86.80
L.S.D	5%	0.74	1.00	2.79	0.706	2.00	0.92
		2013 season					
Control	0.00	17.92	21.21	84.48	4.46	45.15	71.30
Humic acid	15 g/L	19.13	22.49	85.06	3.90	67.59	79.70
	20 g/L	22.84	25.29	90.31	3.92	75.40	87.00
	25 g/L	21.07	24.22	86.99	3.85	64.62	82.07
MKP	1 %	19.91	23.52	84.65	3.18	59.25	77.00
	1.5 %	20.38	23.71	85.95	3.54	64.08	80.43
	2%	21.12	25.03	89.31	3.64	83.50	86.20
Vigamax	0.1 ml/l	18.03	22.57	79.88	3.24	63.69	79.73
	0.2ml/l	19.72	23.58	83.63	3.83	68.78	82.60
	0.4ml/l	21.67	25.39	88.84	4.36	70.29	86.40
L.S.D	5%	0.89	0.87	2.19	0.216	1.477	2.26

This also could be due to the pronounced enhanceable effect of the same treatments on growth behavior, N, P and K content, metabolic activity (chlorophyll and carbohydrate content), and the other bioconstituents, i.e. carotenoids and phenols content. All of them positively correlated with root yield. Once again, plants of these treatments were of the highest carbohydrates content might be exported sufficient sugars, those which essentially required for root storage activities, then final yield (Fathy *et al.,* 2003). Similar results were obtained by Hong-juan *et al.,* (2012); Mona *et al.,* (2012) and Dina *et al.,* (2013); El-Bassiouny *et al.,* (2014); Nabila, (2014).

Also, as shown in Table (6) different applied treatments significantly increased the root quality of sugar beet plant (i.e., sucrose, T.S.S and purity) and the root yield minerals content as well during the two growing seasons of this study. Also, it could be noticed that vigamax (amino acids) at 0.4 ml/L, humic acid at 20 g/L and mono potassium phosphate at 2% gave the highest quality characteristics of root yield that reached more than one and half times during two seasons comparing with the control values. In addition, this stimulation of dry matter production considered as a direct result of that vigorous growth including the photosynthetic area and photosynthetic pigments in leaves of sugar beet plants during different stages of growth. Similar results were obtained by Hong-juan *et al.,* (2012); Mona *et al.,* (2012) and Dina *et al.,* (2013); El-Bassiouny *et al.,* (2014); Nabila (2014).

Finally, it could be concluded that foliar application with vigamax (amino acid) at 0.4 ml/L or humic acid at 20 g/L or mono potassium phosphate 2% at 70, 90 and 120 days after sowing of sugar beet plants considered as the greatest treatments not only on root yield but also yield quality as well.

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