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Sweet Corn as Affected by Foliar Application with Amino – and Humic Acids under Different Fertilizer Sources

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TWO FIELD experiments were conducted at the Experimental Station Farm (at Abies), Faculty of Agriculture, Alexandria University, Egypt, during the two summer seasons of 2014 and 2015. The objective of this investigation was to study the main effects of three different fertilizer sources as well as control (20 $m^3 fed^{-1}$ chicken manure, 30 $m^3 fed^{-1}$ cattle manure and 100 – 40 – 60 kg NPK fed^{-1}, as recommended rates from each one of the three sources of fertilizer), foliar spray using two sources of growth stimulants as well as the control (spray with distilled water), (2 g L^{-1} amino acid and 2.5 ml L^{-1} humic acid), and their interaction on growth, yield and its component characters, and some chemical composition of kernels and leaves of sweet corn. The obtained results indicated that the application of chicken manure to sweet corn plants increased the most measured vegetative and kernels quality (plant height, leaves number $plant^{-1}$, kernels dry matter, reducing sugars, total sugars, T.S.S.), while, the application of either chicken manure or cattle manure, significantly, increased sweet corn yield, ears characteristics and NPK leaves content. Regarding the effect of foliar spray by amino – and humic acids, the results pointed out that the application of amino acid foliar spray were significantly associated with corresponding increases in the most important characters of sweet corn plants. The results concerning of the first order – interaction indicated that the application of chicken – or cattle manure fertilizer combined with the foliar spray with amino – or humic acids, resulted in the highest mean values of the vegetative growth characters, and most of the studied yield and its components characters. The most favorable combination treatment was chicken manure combined with amino acid foliar spray, which gave the highest mean values for the most previous studied characters.

Keywords: Sweet corn, Mineral fertilizer, Organic fertilizer, Amino acid and Humic acid.

Sweet corn is one of the most popular vegetables in USA, Canada and Australia. It is become the popular in India and other Asian countries. In Egypt, this untraditional crop has still not getting commercial importance. Moreover, it is an attractive crop for producers to grow because the plant grows quickly and could be harvested as early as 65 – 90 days depending on the cultivar type.

Nevertheless, farmers may get good return by exporting it to many other countries all over the world.

Sweet corn (*Zea mays var*. *rugosa*, L., earlier known as *Zea mays var*. *saccharata*, Sturt) is an annual grass of the Poaceae family. It also called sugar corn and pole corn is a variety of maize with a high sugar content, since, the grains of sweet corn accumulate two to three times more sugars in the endosperm than the normal starchy maize (Doehlert *et al*., 1993). Sweet corn is favorable for fresh consumption because of its delicious taste, soft and sugary texture compared to other corn varieties.

Sweet corn is a heavy feeder crop, and proper soil fertility is critical for high yield (Simon and Balabbo, 2015). So, it is requiring high amount of nutrients such as nitrogen, phosphorus, and potassium, which, are usually applied in the form of mineral fertilizers. Moreover, in developing countries, farmers apply high doses of fertilizers and chemical plant protection measures to realize high crop yield. Mineral fertilizer provides readily available nutrients to crops and this is often associated with excessive absorption of nitrate and sulphate that may cause health problems in humans (Noble and Coventry, 2005). Also, adding chemical fertilizers had a harmful effect on the environment (Adediran *et al*., 2004). Therefore, it is recommended to addition organic matter (plant or animal residues) as a substitute for fertilizer chemistry (Oad, *et al*., 2004). The addition of organic fertilizers efficiently ensures high production and continuous crops by improving soil properties and increase the development of the roots and activity of microorganisms (Abou El-Magd *et al*., 2006, Ayoola and Makinde, 2009, Geisseler *et al*., 2010, Inselsbacher *et al*., 2010). The beneficial effect of using the different types of organic fertilizer including composting, vermicompost, green manure, animal and chicken manures etc. had been reported to improve growth and yield of sweet corn (Gudugi, *et al*., 2012, Ghosh *et al*., 2013, Obi *et al*., 2013 and Amanolahi-Baharvand *et al*., 2014) and improve the chemical and biological qualities of the soil which increases crop productivity than chemical fertilizers (Obi & Ebo, 1995, Boateng*et al*., 2006, Ghosh, *et al*., 2013 and Murmur *et al*., 2013).

Recent attention, also, has been given to decreasing pollution sources in modern agriculture. One of the approaches to reduce pollution is the use of bio-stimulants, which have become commonly used as a safety nature of plant growth regulators, polyamines and vitamins. Amino acids (AA) a well-known bio-stimulant which has positive effects on plant growth, yield and significantly mitigates the injuries caused by a biotic stress (Azimi *et al*., 2013). Amino acids play multiplier roles in the plant, where, the basic part of the living cells in the plant is protein, which is constituted of amino acids. A need for vital amino acids is known to be the cause of increased efficiency and quality of the products. The studies showed that amino acids have direct or indirect effects on the physiological functions of the plants. Recently, some studies have proved that amino acids are well known as bio-stimulants, which have positive effects on plant growth, yield of many vegetable crops. Saeed *et al*., (2005) on soybean found that treatments of amino acids significantly improved growth parameters as well as yield and quality. The same results was recorded on strawberry (Abo-Sedera *et al*., 2010) and garlic (Shalaby and El-Ramady, 2014).

Humic acid (HA) is a promising natural resource that can be used as an alternative to synthetic fertilizers to increase crop production. It exerts either a direct effect, such as on enzymatic activities and membrane permeability, or an indirect effect, mainly by changing the soil structure (Kazemi, 2014). In some studies, humic acid was reported to promote the root length (Cenellar *et al*., 2002), and to increase the fresh and dry weight of plants (Chen *et al*., 2004). Due to the positive effect of humic substances on the visible growth of plants, there chemicals have been widely used by the growers.

Keeping in view the above facts, the present study was designed to investigate the effects of different fertilizer sources, growth stimulants and their interactions on growth, yield and quality of sweet corn.

Materials and Methods

In order to investigate the effects of different fertilizer sources, growth stimulants and their interaction on growth, yield and quality of sweet corn, an experiment was conducted at the Experimental Station Farm, at Abies region, Faculty of Agriculture, Alexandria University, Alexandria, Egypt, through two consecutive summer seasons of 2014 and 2015.

Prior to the initiation of each experiment, soil samples from upper layer of the experimental sites to 20 – 30cm depth were collected and analyzed according to the published procedures of Page *et al*., (1982). The results of the soil analyses are given in Table 1. The chemical properties of the used organic sources are presented in Table 2.

TABLE 1. Some soil physical and chemical properties of the experimental sites, during the two summer seasons of 2014 and 2015.

Properties / Seasons	Physical				Chemical					
	Sand (%)	Silt (%)	Clay (%)	Texture	pH	EC ($ds.m^{-1}$)	OM (%)	N (ppm)	P (ppm)	K (ppm)
2014	32.34	23.50	44.00	Clay loam	7.70	1.29	1.12	176.00	35.18	500.00
2015	31.10	22.60	45.80	Clay loam	8.10	1.26	2.43	163.00	32.41	459.00

TABLE 2. Chemical analysis of the used chicken and cattle manures.

Properties / Types of manures	Organic carbon OC (%)	OM (%)	C/N Ratio	N (%)	Available	
					P (ppm)	K (ppm)
Chicken	16.58	28.59	2.50	6.62	9800	1140
Cattle	6.82	11.75	6.82	1.00	6000	1500

In both experiments, the used experimental layout was split-plot system in a randomized complete block design (RCBD) with three replications. Each replicate consisted of twelve treatments, which representing the combinations among the two factors, the main factor in this trait is three sources of fertilizer as well as the control (without addition), (20m^{3}fed^{-1} chicken manure, 30m^{3}fed^{-1} cattle manure and 100 – 40 – 60 kg NPK fed^{-1}, as recommended rates from each one of the three sources of fertilizer). The second factor is foliar spray using two sources of growth stimulants as well as the control (spray with distilled water), (1g L^{-1} amino acid and 2 ml L^{-1}humic acid).

Regarding the arrangement of the different treatments, different fertilizers sources were stetted as the main plots, foliar spray using growth stimulants were considered as the sub-plots. Each experimental unit area was 11.2 m^{2}, including four rows, four meters long and 0.7 meters width, with plant spacing 25cm. The same experimental steps were conducted in the first and second seasons of 2014 and 2015, respectively.

With respect to the two different sources of organic manures, chicken and cattle manures were randomly applied to the surface of each row and incorporated well into about 20 – 40cm depth of the soil one week before sowing process. The forms of three types of mineral fertilizers, NPK were used as follows, ammonium nitrate (33.5%N), calcium superphosphate (15.5%P_2O_5) and potassium sulfate (48.5% K_2O). N and K fertilizers were added to the growing plants in three equal parts at 25, 35 and 45 days from planting, whereas, calcium super phosphate was broadcasted throughout the soil preparation (before planting). The foliar application of amino – and humic acid were obtained from solid and liquid commercial products "Amino Strong Plus", 49% amino acids and 20% N and "Hemo Plus 20", 64% humic acid, 9% N, 3% P_2O_5 and 5% K_2O, respectively. Plants were sprayed with humic acid or amino acid three times at 25 day age, at the beginning of male flowers and in the grain filling stage. The seeds of sweet corn of the hybrid cultivar "Merkur" were sown on the side of the row at 25cm a part on May 15, 2014 and May 25, 2015.

In each sub-plot, five plants were randomly chosen from the outer two rows to measure the studied characters as follow, at tasseling and silking stages (after 35 – 40 days from planting time), the vegetative growth characters expressed as plant height (cm), stem diameter (cm), leaves number plant^{-1} and dry matter content (%) were measured. At the harvesting stage (after 70 days from sowing date, in the milky immature kernels), all husked ears of sweet corn plants in the middle two rows in each experimental unit were harvested to determine the characters, ears yield fed^{-1} and number of ears plant^{-1}. The ears yield fed^{-1} was estimated by weighting all harvested husked ears in the middle two rows in each experimental unit and then converted into tonfed^{-1}. Five harvested ears from each sub-plot were randomly selected to determine ear length (cm), ear diameter (cm), husked ear weight (g) and un-husked ear weight (g). The kernels were separated by cutting from the cobs of the five selected ears and weighted. Then, the weight of the kernels were divided by the five randomly ears to estimate the kernels weight ear^{-1} (g). The kernels quality were expressed by the grains constituents from dry matter (%), reducing sugars(%), non-reducing sugars (%), total sugars(%), starch (%) and total soluble solids (T.S.S). directly after harvest, samples of ears kernels, were randomly bulked, as previously described from each experimental unit to determine such compositions in grains. Total soluble solids percentages reading were taken on the samples of immature kernels by hand digital refractometer. Total sugars, reducing – and non-reducing sugars and starch were estimated using the procedure of Association of Official Analytical Chemists (A.O.A.C., 1990) and expresses as percentages. The concentrations of N, P and K contents in sweet corn leaves were determined on the basis of dry matter. Nitrogen and phosphorus were determined colorimetrically, using spectrophotometer at 662 and 650 nanometer, according to Evenhuis and Dewaord (1980) and Toth *et al*., (1948), respectively. Potassium was determined by flam photometer as described by Chapman and Pratt (1961). The determination of the three macro-elements N, P and K were expressed as percentages on dry matter basis.

Statistical analysis

All obtained data were statistically analyzed using Co-Stat Software (2004), computer program for statistics. Duncan's multiple range test was used to compare the differences among the means of the treatments as elucidated by Steel and Torrie (1980).

Results and Discussions

Vegetative growth characters

The results of the main effect of different fertilizer sources and foliar spray by growth stimulants, and their interactions on the vegetative growth, yield and its component characters, kernels quality and chemical composition of leaves of sweet corn plants, in the two summer seasons of 2014 and 2015, are shown in Tables 3, 4, 5 and 6, respectively.

The results in Table 3 illustrated, generally, that the highest mean values of the three characters plant height, leaves number plant^{-1}and dry matter were given by the application of chicken manure treatment followed by cattle manure and mineral NPK fertilizer, compared with those of the control, respectively, in the two growing seasons. This result in correspondence with that obtained by Materechera and Salagae (2002) who found that addition of both chicken – and cattle manure increase plant height and leaves number plant^{-1} of sweet corn. Also, Efthimiadou *et al*. (2009) recorded that sweet corn growth was significantly higher with application of organic fertilizer compared with the conventional fertilizer. Increasing the morphological characters of sweet corn after organic manure application may be due to increasing the soil organic matter content, cation exchange capacity and mineral nutrients, which in turn encouraged the plant growth to go forward (Ayoola and Makinde, 2009, Dikinya and Mufwanzala, 2010,Lazcano*et al*., 2012 and Jasim *et al*., 2014). On the other hand, the results showed that the differences among the three sources of fertilizer and control treatment for the character stem diameter, in the two growing seasons, were found to be insignificant.

Table 3 showed also that the application of amino acid foliar spray, gave significantly more number of leaves plant^{-1} and increased plant height and leaves dry matter, compared to the control treatment, in both summer seasons. While, foliar spray by humic acid did not reflect any significant differences with amino acid foliar spray or control treatment for the two characters plant height and leaves number plant^{-1}. Previous findings indicated that amino acids can directly or indirectly influence the physiological activities and development of plants (Faten *et. al*., 2010 and Shalaby and El-Ramady, 2014), moreover, foliar application of amino effectively increased plant height and number of leaves of garlic, Shalay and El-Ramady (2014). Foliar spray with humic acid affected positively on vegetative growth of tomato, onion and soybean crops, which were recorded by Kazemi (2014), Kandil *et al*., (2013) and Saeed *et al*. (2005), respectively. Concerning the character stem diameter, the data showed that the differences among the mean values were not high enough to be significant, in the two growing seasons.

Data in Table 3 illustrated that the interaction between fertilization sources and foliar spray by growth stimulants, significantly affected on the mean values of leaves number plant^{-1}and leaves dry matter and significantly increased the plant height. While, the mean values of stem diameter character did not differ significantly by the interaction effect between the two studied factors, during the two seasons. The optimum interactive treatment combination for the four studied characters was chicken manure fertilizer plus the foliar spray with amino – or humic acid, in both growing seasons.

TABLE 3. Effect of fertilizer sources, growth stimulants and their interactions on vegetative growth characters of sweet corn, during the seasons of 2014 and 2015.

Seasons		2014				2015			
Characters / Treatments		Plant height (cm)	Stem diameter (cm)	Leaves No. plant-1	Leaves dry mater (%)	Plant height (cm)	Stem diameter (cm)	Leaves No. plant-1	Leaves dry mater (%)
Fertilizer sources									
Control		111.54 b	2.38 a	7.49 b	27.49 d	116.58 b	2.66 a	8.44 b	30.04 c
Mineral fertilizer		135.27 a	2.58 a	8.41 a	36.18 c	135.99 a	2.88 a	9.43 a	37.75 b
Cattle manure		131.33a	2.58 a	8.09 ab	44.12 b	130.16 a	2.93 a	9.15 a	46.74 a
Chicken manure		142.22 a	2.63 a	8.55 a	51.11 a	147.30 a	3.19 a	9.69 a	53.05 a
Growth stimulants									
Control		134.83 b	2.51 a	7.68 b	37.09 b	129.50 b	2.79 a	8.72 b	37.34 b
Amino acid		135.61 a	2.56 a	8.61 a	42.40 a	140.56 a	2.98 a	9.65 a	44.34 a
Humic acid		129.83 ab	2.55 a	8.12 ab	39.67 b	134.95 ab	2.98 a	9.17 ab	44.01 a
Fertilizer sources x Growth stimulants									
Control	Control	102.83 f	2.33a	7.16 d	24.24 g	107.93 e	2.58 b	7.41 d	25.65 f
	Amino	120.96 de	2.41 a	7.50 b-d	29.85 f	125.98 cd	2.71 ab	8.60 cd	32.06 ef
	Humic	110.83 ef	2.33 a	7.33 cd	28.38 fg	115.83 de	2.63 ab	8.20 d	32.06 ef
Mineral	Control	123.33 c-e	2.41 a	7.91 a-d	32.38 ef	126.99 cd	2.71 ab	8.96 b-d	32.43 d-f
	Amino	132.33 b-d	2.45 a	7.99 a-d	40.54 cd	137.28 bc	2.83 ab	9.16 a-d	40.61 cd
	Humic	132.33 b-d	2.41 a	7.99 a-d	35.63 de	137.26 bc	2.71 ab	8.99 a-d	39.70 c-e
Cattle	Control	132.83 b-d	2.58 a	8.16 a-d	41.40 c	137.92 bc	2.88 ab	9.17 a-d	41.51 bc
	Amino	138.33 ab	2.74 a	8.56.ab	47.40 ab	143.72 ab	3.04 ab	9.68 a-c	50.28 a
	Humic	134.33 bc	2.58 a	8.50 a-c	43.56 bc	139.15 b	3.04 ab	9.50 a-c	49.35 ab
Chicken	Control	139.16 ab	2.74 a	8.66 ab	50.35 a	144.07 ab	3.13 ab	9.81 ab	51.04 a
	Amino	149.99 a	2.83 a	8.99 a	51.81 a	154.95 a	3.55 a	10.11 a	54.08 a
	Humic	145.83 ab	2.75 a	8.83 a	51.16 a	149.02 ab	3.21 ab	9.83 ab	54.02 a

Yield and its components

Pertaining to the results of the effect of the sources of fertilization on yield and ear characteristics, Table 4 illustrated, generally, that the application of either chicken manure or cattle manure, significantly, increased the ear length, ear diameter, husked ear weight, un-husked ear weight, kernel weight ear^{-1}, ears number plant^{-1} and ears yield fed^{-1}compared with those of the control, in the two summer seasons. Also, using NPK mineral fertilizer increased significantly the previous means characters, compared with the control, but, still less than the two sources of organic manure. This may be due to that organic fertilizers can increase microbial activity in soils between 16% and 20% as compared to inorganic fertilizers (Dinesh *et al*., 2010), and, also, organic manure can offer enough nitrogen to micro-organisms that are living in the soil, which convert the nutrients from unavailable to available form for plants, during the growing period, which was reflected on ear characters and yield of sweet corn. Application by organic fertilizer was superior in influencing yield of sweet corn and its components as mentioned by Efthimiadon *et al.* (2009), Lazcano *et al.* (2011), Gudugi *et al.* (2012) and Jasim *et al.* (2014).

Concerning the effects of foliar spray by amino– or humic acid on ear characteristics and ears yield fed^{-1}, data in Table 4 showed that amino acid foliar spray significantly increased these characters, compared with the both treatments, humic acid foliar spray and control, with only two exceptions. These exceptions were noticed on mean values of ear length and ear diameter characters, which did not differ significantly from mean values of foliar spray by humic acid treatment, during the two growing seasons. The later results can support the finding of (Ebrahimi *et al.*, 2014), who reported that amino acid foliar application increased ears number plant^{-1} and yield of sweet corn. Similar results on the stimulatory effects of amino acid on other plants were noticed by Shalaby and El-Ramady (2014), who found that foliar application of amino acid showed the heaviest garlic bulb weight.

It is clear from data in Table 4 that the interaction effects between each of the fertilizer sources and foliar application by growth stimulants on ear characteristics and ear yield fed^{-1} were significant, but, with different magnitudes, in both years. Application of chicken manure combined with of amino acid gave significantly the highest mean values of these characters, followed by the application of chicken manure with foliar spray by humic acid with insignificant differences between one another, in both seasons.

TABLE 4. Effect of fertilizer sources, growth stimulants and their interactions on ears yield and its components of sweet corn, during the seasons of 2014 and 2015.

Seasons		2014							2015						
Treatments \ Characters		Ear length (cm)	Ear diameter (cm)	Husked ear weight (g)	Un-husked ear weight (g)	Kernels weight ear^{-1} (g)	Ears number plant^{-1}	Ears yield ton fed^{-1}	Ear length (cm)	Ear diameter (cm)	Husked ear weight (g)	Un-husked ear weight (g)	Kernels weight ear^{-1} (g)	Ears number plant^{-1}	Ears yield ton fed^{-1}
Fertilizer sources															
Control		18.23c	3.97c	135.00c	91.00b	69.16b	1.30 d	4.82 c	18.07c	3.92c	160.00b	115.00c	89.16b	1.46c	5.00c
Mineral fertilizer		19.80b	4.72b	236.50b	194.66a	166.33a	1.57 c	6.53 b	19.68b	4.96b	251.50a	219.66b	186.33a	1.83b	7.53b
Cattle manure		20.06b	4.90a	244.66ab	200.83a	172.50a	1.62 b	6.86 ab	19.90ab	5.12a	256.50a	225.83ab	186.33a	1.84b	7.87b
Chicken manure		21.04a	4.93a	278.00a	210.83a	190.83a	1.79 a	7.74 a	20.84a	5.19a	291.16a	249.16a	210.00a	2.03a	8.50a
Growth stimulants															
Control		18.86b	4.49b	213.00c	168.75b	142.50b	1.71 b	5.76 c	18.73 b	3.63a	238.00b	193.12b	162.50b	1.71b	6.14c
Amino acid		20.51a	4.73a	235.37a	185.12a	161.75a	1.92 a	7.50 a	20.31 a	3.97a	253.62a	213.25a	181.75a	1.92a	7.90a
Humic acid		19.86a	4.67ab	222.25b	169.12b	144.87b	1.74 b	6.93 b	19.83 a	3.79a	241.37b	201.62b	164.87b	1.74b	6.89b
Fertilizer sources x Growth stimulants															
Control	Control	17.83e	3.80d	116.50f	71.50f	56.50f	1.16 e	3.59 e	17.60 e	3.07e	141.50e	96.50f	76.50f	1.16e	3.09g
	Amino	17.86e	4.08d	148.50e	104.00e	78.50e	1.67 cd	4.30 de	18.75 de	4.37cd	173.50d	124.00e	98.50e	1.67cd	4.80f
	Humic	18.83de	4.04d	140.00e	97.50 e	72.50ef	1.55 d	3.60 e	17.80 e	4.3d	165.00de	122.50e	92.50ef	1.55d	4.11f
Mineral	Control	19.00de	4.55c	233.00d	185.00 d	160.00d	1.71 cd	6.08 d	18.76 de	4.59 b-d	258.00c	210.00d	180.00d	1.71cd	7.75e
	Amino	19.25cd	4.71a-c	235.00cd	196.50 cd	165.00cd	1.79 cd	7.22 c	19.25 cd	4.92 a-d	260.00c	221.50cd	185.00cd	1.795d	8.63c-d
	Humic	19.50cd	4.66bc	233.00d	187.50 d	163.00d	1.72 cd	7.00 c	19.25 cd	4.89 a-d	258.00c	212.50d	183.00d	1.72cd	8.08de
Cattle	Control	20.16b-d	4.80a-c	241.50b-d	200.00b-d	171.00b-d	1.85bc	7.63bc	20.01b-d	5.07a-c	266.50c	225.00 cd	191.00b-d	1.85bc	8.20 de
	Amino	20.40bc	4.94a-c	249.50bc	205.00 bc	175.00b-d	1.88bc	8.26b	20.28 bc	5.24ab	274.50cb	230.00 cd	195.00b-d	1.88bc	9.26c
	Humic	20.40bc	4.82a-c	244.00b-d	200.00bd	172.50b-d	1.87bc	7.78bc	20.10 b-d	5.13ab	269.00bc	227.50 cd	192.50b-d	1.87bc	8.78cd
Chicken	Control	20.55bc	5.03ab	251.50b	205.00bc	182.50 bc	1.93bc	9.59b	20.35bc	5.31a	277.50bc	237.50 bc	202.50bc	1.93bc	9.59c
	Amino	21.39ab	5.11a	300.00a	227.50a	200.00 a	2.25a	10.96a	22.12a	5.34a	313.00a	265.00 a	235.00a	2.25a	11.70a

Kernels quality

Concerning the results of different fertilizer sources and growth stimulants and their interactions on kernels quality of sweet corn are listed in Table 5. The results revealed that using chicken manure fertilizer, significantly, increased the five characters, kernels dry matter, reducing sugars, non-reducing sugars, total sugars, and T.S.S. compared to the other treatments, during the two summer seasons. Also, using cattle manure fertilizer did not reflect any significant differences from the application by chicken manure in the case of non-reducing sugars character. The same results was given by Moursy *et al*., 2007, who found that addition organic manure reflected significant effect for T.S.S. of onion bulb. Significant differences were detected for the starch content as a result of applying the fertilizer sources and the best concentration was given by the application of chicken manure, in the two growing seasons.

TABLE 5. Effect of fertilizer sources, growth stimulants and their interactions on percentages of dry matter, reducing sugars, non-reducing sugars, total sugars, starch and TSS of sweet corn kernels, during the seasons of 2014 and 2015.

Seasons		2014						2015					
Treatments \ Characters		Kernels dry matter (%)	Reducing sugars (%)	No-Reducing sugars (%)	Total sugars (%)	Starch (%)	T.S.S. (%)	Kernels dry matter (%)	Reducing sugars (%)	No-Reducing sugars (%)	Total sugars (%)	Starch (%)	T.S.S. (%)
Fertilizer sources													
Control		35.431 c	5.510d	0.628b	6.138 d	5.856 a	11.816 c	34.630 d	5.877 d	0. b761 b	6.638 d	6.108 a	11.751 d
Mineral fertilizer		44.019 b	6.552c	0.749ab	7.302 c	4.593 b	12.541 b	42.780 c	6.886 c	0.911 b	7.797 c	4.965 b	12.493 c
Cattle manure		44.293 b	8.049b	0.755ab	8.804 b	3.546 c	13.641a	45.460 b	7.848 b	1.203 a	9.051 b	4.018 c	13.594 b
Chicken manure		48.193 a	9.372a	0.916a	10.288 a	2.556 d	13.985 a	48.320 a	9.672 a	1.181 a	10.853 a	3.181 d	14.061 a
Growth stimulants													
Control		40.984 b	6.973c	0.709b	7.682 c	4.511 a	12.662 c	39.990 c	7.053 c	0.935 a	7.988 c	4.886 a	12.595 c
Amino acid		44.041 a	7.807a	0.833a	8.641 a	3.755 c	13.387 a	45.070 a	8.157 a	0.958 a	9.115 a	4.278 c	13.363 a
Humic acid		43.927 a	7.331b	0.744ab	8.076 b	4.148 b	12.937 b	43.330 b	7.501 b	1.150 a	8.651 b	4.591 b	12.951 b
Fertilizer sources x Growth stimulants													
Control	Control	29.175 h	5.119 h	0.519 e	5.638 k	6.265a	11.20e	26.760 i	5.419 j	0.719 cd	6.138 i	6.475 a	11.257 d
	Amino	40.105 f	5.886f	0.667c-e	6.553 i	5.430c	12.30cd	40.210g	6.386h	0.665 d	7.051 gh	5.695 c	12.204 bc
	Humic	37.015 g	5.526g	0.619de	6.225 j	5.875b	11.95d	37.010h	5.826i	0.899 a-d	6.725 h	6.155 b	11.758 cd
Mineral	Control	41.865 ef	6.118f	0.699c-e	6.896 h	4.905d	12.30cd	41.860fg	6.518h	0.858 b-d	7.376 g	4.990 e	12.253 bc
	Amino	43.33 de	6.868 e	0.738 b-d	7.601 g	4.280f	12.60 bc	43.680df	7.168fg	0.933 a-d	8.101 f	4.600 f	12.752 b
	Humic	43.155 de	6.672 e	0.733 b-e	7.41 g	4.595e	12.475b-d	42.800ef	6.972g	0.943 a-d	7.915 f	5.300 d	12.471 b
Cattle	Control	44.545 c-e	7.933 d	0.765b-d	8.552 f	3.890g	12.850b	44.540c-e	7.344f	1.199 a-c	8.543 e	4.330 g	12.806 b
	Amino	46.395 bc	8.19d	0.778b-d	9.061 d	3.110i	14.000a	46.210b-d	8.490d	1.071 a-d	9.561 c	3.875 i	12.974 a
	Humic	45.15 b-d	8.024d	0.775 b-d	8.799 e	3.640h	13.800a	45.620b-d	7.711e	1.341 ab	9.052 d	4.055 h	13.692 a
Chicken	Control	46.505 bc	8.633c	0.871 a-c	9.398 c	2.985i	14.075a	46.890 bc	8.933c	0.965 a-d	9.898 c	3.440 j	14.061 a
	Amino	50.170 a	10.287a	1.062 a	11.349 a	2.200k	14.250a	50.170 a	10.587a	1.162 a-d	11.749 a	2.945 l	14.364 a
	Humic	47.905 ab	9.196b	0.921 ab	10.117 b	2.485j	14.150a	47.900 ab	9.496 b	1.418 a	10.914 b	3.160 k	14.133 a

Regarding the main effect of foliar spray by amino – and humic acids on kernels quality of sweet corn, the results pointed out that the application of amino acid foliar spray were significantly associated with corresponding increases in all mean values of the studied kernels quality components, except starch character. Moreover, humic acid foliar spray gave the same results for the two characters kernels dry matter and non-reducing sugars with insignificant differences with the application of amino acid treatment, in the first season and non-reducing sugars, in the second season. Application of amino acid foliar spray gave, significantly, the lowest (desirable) mean value, followed by humic acid and control treatments, in the two growing seasons. Fruit dry matter and TSS content of tomato increased significantly with foliar application of humic acid, Kazemi (2014).

Respecting the interaction effect between the two studied factors, fertilizer sources and growth stimulants, in both growing seasons, resulted in steady corresponding increments, with significant differences in the most studied kernels quality components. Application of chicken manure fertilizer with amino acid gave significantly the highest mean values of the most studied characters of kernels quality.

Chemical composition of leaves

Data presented in Table 5 showed the effects of all studied factors on nutrient contents, N, P and K of sweet corn leaves. The results reflected that the concentration of phosphorus in sweet corn leaves did not reflect any significant increases as a result of applying the sources of fertilizers, compared with control treatment. Nevertheless, significant differences were detected for both nitrogen and potassium elements. The highest mean values of N and K content was given by the application of organic fertilizer (chicken or cattle manures), followed by NPK mineral fertilizer with significant differences. Hu and Barker (2004) on tomato and Mohammed (2011) on pepper mentioned that the organic fertilizer application led to higher concentration and total accumulation of NPK in leaves.

As for the effects of foliar application of the used amino – and humic acids, generally, the results indicated clearly that the concentrations of phosphorus in sweet corn leaves did not reflect any significant increases as a result of applying the two sources of growth stimulants (amino – or humic acids), compared to the control treatment, in the two growing seasons. While, significant differences were detected for the nitrogen and potassium leaves content compared to the control, in the two seasons, with one exception for potassium leaves content in the second season, where, foliar spraying by amino – or humic acids did not recorded any significant differences with control treatment. Similar results were obtained by Kazemi (2014), who reported that sprayed by humic acid resulted in a significant increase in N and K content of tomato leaves. Also, Khaled and Fawy (2011) stated that foliar application of humic acid had a significant effect on P and K uptake in corn.

The comparisons among the various treatment combinations which reflecting the interaction effect between the two studied main factors, Table 5, showed some positive and significant interactions effects on the performance of the mineral contents (N and K) of sweet corn leaves, while, leaves P content means did not affect by the interaction applications. Generally, it was noticed that application by chicken manure fertilizer, combined with amino acid or humic acid foliar spray, lead to marked increased on mean values of mineral contents of (N and K) of leaves.

TABLE 6. Effect of fertilizer sources, growth stimulants and their interactions on percentages of nitrogen, phosphorus and potassium contents of sweet corn leaves, during the seasons of 2014 and 2015.

Seasons		2014			2015		
Characters / Treatments		N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
Fertilizer sources							
Control		1.00 d	0.12 a	1.02 d	1.10 c	0.25 a	0.92 c
Mineral fertilizer		1.52 c	0.16 a	1.39 c	1.86 b	0.30 a	1.56 b
Cattle manure		2.37 b	0.23 a	1.75 b	2.13 a	0.31 a	2.41 a
Chicken manure		2.53 a	0.32 a	2.35 a	2.41 a	0.47 a	2.57 a
Growth stimulants							
Control		1.76 c	0.18 a	1.45 c	2.01 b	0.27 a	1.77 a
Amino acid		2.14 a	0.22 a	1.81 a	2.24 a	0.27 a	2.01 a
Humic acid		1.96 b	0.21 a	1.63 b	2.21 a	0.26 a	1.81 a
Fertilizer sources x Growth stimulants							
Control	Control	0.81 l	0.10 a	0.92 i	0.85 g	0.21 a	0.73 g
	Amino	1.17 j	0.11 a	1.17 h	1.53 f	0.25 a	1.12 eg
	Humic	1.03 k	0.12 a	0.99 i	1.25 f	0.23 a	0.92 fg
Mineral	Control	1.34 i	0.13 a	1.21 h	1.61 ef	0.27 a	1.36 d-f
	Amino	1.71 g	0.16 a	1.50 fg	1.99 c-e	0.28 a	1.83 cd
	Humic	1.5 h	0.18 a	1.46 g	1.97 de	0.28 a	1.48 de
Cattle	Control	2.11 f	0.21 a	1.64 ef	2.12 cd	0.29 a	2.12 bc
	Amino	2.61 d	0.24 a	1.86 d	2.37 c	0.32 a	2.56 ab
	Humic	2.39 e	0.26 a	1.75 de	2.17 cd	0.29 a	2.25 bc
Chicken	Control	2.78 c	0.28 a	2.04 c	2.93 b	0.34 a	2.58 ab
	Amino	3.1 a	0.34 a	2.68 a	3.57 a	0.43 a	2.85 a
	Humic	2.92 b	0.34 a	2.34 b	3.45 ab	0.35 a	2.58 ab

Conclusion and Recommendation

From this experiment, application of chicken manure in combination with amino - or humic acids foliar spray showed better performance than the other treatments. So, it can be concluded that use of chicken manure can meet the crop nutrient demand throughout the growth stages or increasing yield and quality of corn through improvement the soil physical, chemical and biological properties. Moreover, amino - and humic acids have directly or indirectly influence the physiological activities of the plant.

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تأثير الرش بالهيوميك والأحماض الأمينية على الذرة السكرية تحت مصادر مختلفة من التسميد

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تم تنفيذ تجربتان حقليتان بمزرعة كلية الزراعة – جامعة الإسكندرية بمنطقة أبيس خلال الموسمين الصيفيين لـ٢٠١٤ و٢٠١٥ حيث كان البحث يهدف إلى دراسة تأثير ثلاث مصادر من السماد وهى ٢٠م٣/فدان سماد دواجن، ٣٠م٣/فدان سماد الماشية والمعدل الموصى به من عناصر النيتروجين – الفوسفور - البوتاسيوم وهو ١٠٠ – ٤٠ – ٦٠ كجم/ فدان. أيضا تم الرش بمصدرين من محفزات النمو الى جانب معاملة الكنترول (رش بالماء المقطر) وهى ٢جم/لتر حامض الأمينو، ٢.٥مل/لتر حامض الهيوميك. وكذلك دراسة التداخل بينهم على النمو والإنتاجية وكذلك بعض تقديرات الجودة للحبوب فى محصول الذرة.

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وأظهرت النتائج أن استخدام سماد الدواجن على الذرة السكرية قد عكس زيادة معنوية على قياسات النمو الخضرى ومعظم صفات الجودة للحبوب (ارتفاع النبات – عدد الأوراق للنبات – المادة الجافة للحبوب – السكريات المختزلة – السكريات الكلية – المواد الصلبة الذائبة الكلية). بينما المعاملة بأى من السماد الداجنى أو سماد الماشية عكس زيادة معنوية على محصول الذرة السكرية وكذلك مواصفات الجودة للكيزان وكذلك محتوى الأوراق من عناصر النيتروجين، الفوسفور والبوتاسيوم. ابرزت النتائج كذلك أن الرش بأى من حامض الأمينو أو الهيوميك كان مرتبطا بالزيادة المعنوية لمعظم الصفات موضع الدراسة. أما فيما يخص التداخل بين المعاملات المختلفة للعاملين موضع الدراسة فقد عكست النتائج أن المعاملة العاملية للتداخل بين الرش سواء بالأمينو أو الهيوميك تحت المعاملة بأى من مصدرى السماد العضوى قد تسبب فى زيادة مواصفات النمو الخضرى ومعظم الصفات المحصولية وكذلك مواصفات الجودة وأن أفضل معاملة تداخليه هى المعاملة بالسماد العضوى الداجنى مع الرش بالأمينو والتى عكست أعلى قيم للمتوسطات بالنسبة للصفات المدروسة.