EFFECT OF APPLIED DIFFERENT NITROGEN SOURCES AND SOME BIO-ORGANO-STIMULANTS ON SWEET PEPPER PLANTS GROWN ON A SALINE CALCAREOUS SOIL

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ABSTRACT:

A field experiment was carried out on a saline calcareous soil cultivated with sweet pepper plants (*Capsicum annuum* L.) under drip irrigation system at a private farm, Nubaria region, El Beheira Governorate, Egypt during two successive seasons 2009 and 2010. The aim target of the current study was identified the effect of soil application for different N-source of (ammonium nitrate, calcium nitrate and ammonium sulfate) as solely treatments or in combination with some bio-organo-stimulants (potassium humate, potassium citrate or yeast) on the plant growth parameters, nutritional status, fruit yield and its quality as expressed by titratable acidity, total soluble solids, total carbohydrates, vitamin C, anthocyanin, total polyphenols, and mineral contents (Ca and K), fruit nitrate, with a special reference to the associated effects on the soil properties and available nutrient contents. The mineral N, P and K fertilizers in their different forms were applied as the recommended rates after Ministry of Agriculture, *i.e.*, 100 kg N fed^{-1}, 48 kg K_2O fed^{-1} and 15.5 kg P_2O_5 fed^{-1}, while potassium humate at 0.5 g L^{-1}, potassium citrate at 1.0 g L^{-1} and yeast at 2 g L^{-1}, which added at the same time of applied nitrogen sources through the drip irrigation system. Taking into consideration K-amount of (K-humate+K-citrate) represents 25% of the applied recommended K-rate.

The obtained results indicated that there were significantly increases in soil organic matter and available nutrients contents as a result of applied different N-sources and bio-organo-stimulants, with a superiority effect for the combined treatment of (ammonium nitrate+ K-humate). On the other hand, soil pH and ECe were took place a parallel opposite trend, where their values exhibited significantly decreases, with a superiority effect for the previous combined treatment. It is noteworthy to mention that, it could be categorized the applied treatments according to their superiority effects on the studied soil properties into two ascending orders: Am-Ni > Am-Su > Ca-Ni and K-Hu > K-Ci > Ye as solely treatments of N-sources and bio-organo-stimulants, respectively. The second order: (Am-Ni+K-Hu) > (Am-Ni+K-Ci) > (Am-Ni+Ye), (Am-Su+K-Hu) > (Am-Su+K-Ci) > (Am-Su+Ye) and (Ca-Ni+K-Hu) > (Ca-Ni+K-Ci) > (Ca-Ni+Ye) as the applied combined treatments.

As for plant parameters of sweet pepper, the data showed that the effective role of the applied treatments on leaf number/plant, branch number/plant, plant height, leaves weight/plant and nutritional status as well as fruit yield and its quality parameters behaved a similar parallel trend as was achieved with the studied soil properties. That was true, since the achieved favourable amelioration in soil properties was positively effected on the plant growth parameters, fruit yield and its quality. Moreover, such findings are confirmed by the best effective role of the combined treatment (ammonium nitrate+ K-humate) that was also achieved the greatest values in plant growth parameters as well as fruit yield and quality of sweet pepper.

Key words: Sweet pepper, N-sources, Bio-organo-stimulants (K-citrate, K-humate and yeast), saline calcareous soil, drip irrigation system.

INTRODUCTION:

Sweet pepper (*Capsicum annuum* L.) is one of the most valuable vegetables grown on newly reclaimed land in Egypt. Peppers are an important source of nutrients in the human diet and an excellent source of vitamins A and C as well as phenolic compounds that are important antioxidants. Levels of these compounds can vary by genotypes and maturities as well as growing conditions **(Guil-Guerreo and Martinez-Guirado, 2006)**. Growth, yield and nutritional value of vegetable crops are largely affected by the applied fertilizers **(Schuphan, 1974)**. So, it is imperative to grow the crop under the most optimum nutrient conditions thus the producer can get the highest profitable yield and also to obtain fruits rich in the nutritional constituents which are vital for health **(McNeal *et al*., 1995)**.

Nitrogen is one of the major nutrients that have many important roles in plant development and physiological process. Improved N management can be achieved by matching N supply with crop needs, improved timing of fertilizer application, and selecting appropriate N sources **(Hochmuth *et al*., 1987)**. Usually plants are able to take up N as nitrate (NO^-_3) and ammonium (NH^+_4), but some may prefer one source or another depending on plant species. Nitrogen sources may affect plant growth via many processes within the soil plant system and inside the plant **(Wiesler, 1997).** The most predominant N forms in commercial fertilizers in Egypt are nitrate (NO_3^-), ammonium (NH_4^+). The response of pepper plants to nitrogen form varies where the nitrate form gave taller plants with bigger girths, which looked greener, had more fruits and gave higher yield than the other N sources. Since fertilizing N in nitrate form gave 72-101% greater yields than ammonium form **(Nielsen 1998)**. Similar results were obtained by **Sarro *et al.* (1995)** who found that using NH_4^+-N decreased fruit yield especially when it was applied for longer periods during the growing season. Moreover, **Houdusse *et al*. (2007**) mentioned that ammonium and/or nitrate caused a significant decrease in pepper plant growth and the presence of nitrate corrected the negative effects of mixed nitrogen forms containing ammonium and/or nitrate on plant growth. Also the highest plant growth, fruit yield, and largest leaf area in hydroponically grown zucchini squash (*Cucurbita pepo* 3 L. cv. Green Magic) resulted when NO_3-N was the sole form of N than when NH_4-N was part of the N treatment **(Chance *et al*., 1999)**.

On the other hand, **Xu *et al.* (2002)** reported that N form had no significant effect on early fruit yield of sweet pepper (*Capsicum annuum* L. cv. Hazera 1195) while, replacing of NO_3-N by NH_4-N increased total fruit yield. In many production areas, foliar spray with biostimulant products are becoming more common for the purpose of improving production and quality. These products vary in chemical composition and often contain mixture of organic and inorganic compounds including essential macro- and micronutrients, K-humates, K-citrates and yeast. Potassium humat substances appear to be beneficial in nutrients, preventing their tie up on plant leaves and improving conductivity of nutrients into plant tissue, resulting in more efficient utilization of nutrients **(Beames, 1986)**.

Potassium humate can be used as organic potash fertilizers. It supplies high levels of soluble potassium in readily available forms. Combined with potassium humat, can be rapidly absorbed and incorporated into plant whether via soil or foliar application methods. Enhancement of plant growth using potassium humate had been reported to be due to increasing nutrients uptake such as N, P, K, Ca, Mg, Fe, Zn and Cu **(David *et al*.,1994)** enhancing photosynthesis, chlorophyll density and plant root respiration which resulted in greater plant growth and yield **(Chen and Aviad., 1990)**. On the other hand, there is several reports indicated the beneficial effect of K- humat on plant growth and one of the major roles to reduce phytotoxicity and thus increasing yield and quality **(Cox and Nelson, 1984)**.

Ammonia loss is governed by soil factors such as pH, cation exchange capacity, temperature and moisture **(Ahmed, *et al.*, 2002)**. The amount of ammonia-N loss ranges from 10-60% of the total N applied **(Baraldi, *et al*., 1991)** with the ever growing concern about the polluting effect of excessive use of nitrogen fertilizers on the environment, improvement of ammonia-N use efficiency in agriculture can not be over emphasized. One of the approaches that could be used to improve N use efficiency is to mix it with acidic organic materials such as K-humat and K-citrate which have the ability to retain NH_4^+ ions from ammonia-N during hydrolysis and at the same time reducing pH during hydrolysis. Organic carbon (K- humate, K-citrate and yeast) is known to play an important role in providing plant nutrients as well as interfering in aggregate stability under favorable conditions **(Bryan, 1976)**. K-substances have a good effect in controlling N loss from NH_4-N and NO_3-N, even in small quantities, thus this attempt was made to evaluate its effectiveness on pepper. A previous study showed that humic acid has a great effect in reducing N loss. Whilst, humate could give a direct effect to plant photosynthesis, chlorophyll density and plant root respiration, which simultaneously affect and promote plant growth **(Chance, *et al*., 1999)**. Yeast is considered as a natural source of cytokinins that stimulates cell division and enlargement as well as the synthesis of protein, nucleic acid and chlorophyll **(Ebeed and Abd El-Migeed, 2005)**. The mixtures supplements of fertilizers can compensate for the constraining effects on nutrient availability and uptake usually presented in the new reclaimed lands **(Guertal, 2000)**.

The main interest in this study was to evaluate the most proper nitrogen sources and some bio-organo-stimulants (potassium humate, potassium citrate and yeast) for a newly reclaimed saline calcareous soil under drip irrigation system, with a special reference to find out whether of these treatments that had a beneficial effect on yields as well as on fruit quality of sweet pepper.

MATERIALS AND METHODS:

A field experiment was conducted on a saline calcareous soil at a private farm, Nubaria region, El Beheira Governorate, Egypt during two successive seasons of 2009 and 2010. Four weeks-age sweet pepper seedlings (*Capsicum annuum* L.) were obtained from a local commercial nursery. Healthy seedlings of uniform size were selected and transplanted on Feb. 26, 2009 and Feb. 28, 2010. A split plot design, with three replicates was used. The studied treatments were carried in fixed plots of 3.5 x 3 m (10.5 m^2) for each one.

The main treatments were potassium humate (0.5 g L^{-1}) or potassium citrate (1.0 g L^{-1}) and yeast (2.0 g L^{-1}). At the same time, a control was treated with water.

A drip irrigation system was set up to deliver water and nutrients though injection into the irrigation system. The applied fertilizer rate were calculated on the basis of 12000 emitters fed^{-1}, 30 cm between both two emitter, 100 cm between both two lines and discharge of 4 L h^{-1} of each emitter. Each sweet pepper seedling was transplanted just an emitter placed.

Some physical, chemical and fertility properties of the investigated soil are presented in Table (1), which were determined according to the methods described by **Piper (1950), Richards (1954) and Jackson (1973)**. Available N, P and K contents were extracted by 1% potassium sulphate, 0.5 M sodium bicarbonate and 1N ammonium acetate, respectively, and determined according to **Jackson (1973)**. Available micronutrient contents of Fe, Mn, Zn and Cu were extracted by DTPA **(Lindsay and Norvall, 1978)** and determined using Atomic Absorption Spectrophtometer.

Table (1): Some physical and chemical properties of the experimental soil.

Soil characteristics	Value	Soil characteristics	Value
Particle size distribution%:		*Soluble cations (m molc L^{-1})*	
Sand	48.23	Ca^{2+}	14.80
Silt	29.12	Mg^{2+}	11.90
Clay	22.65	Na^{+}	26.20
Textural class	SCL*	K^{+}	0.700
Soil chemical properties:		*Soluble anions (m molc L^{-1})*	
pH (1:2.5 soil water suspension)	8.40	CO_3^{2-}	0.00
$CaCO_3$ %	35.60	HCO_3^{-}	2.90
Organic matter %	0.67	Cl^{-}	37.50
ECe (dS/m, soil paste extract)	5.32	SO_4^{2-}	13.20

Available macro & micronutrients (mg kg^{-1})						
N	P	K	Fe	Mn	Zn	Cu
27.1	4.94	209.9	4.2	0.84	0.48	0.32

* SCL = Silt Clay loam

Also, based on the recommended fertilizer doses of pepper plants, which received 100 kg N fed^{-1}, the N-different sources were applied through drip irrigation system intervals. P and K fertilizers were applied as 15.5 kg P_2O_5 fed^{-1} 36kg K_2O fed^{-1}, and incorporated to the soil before planting. Taking into consideration K-amount of (K-humate+K-citrate) represents 25% of the applied recommended K-rate. Irrigation was regularly monitored according to weather conditions to keep the moisture content at the optional level. At the same time, control treatment was irrigated with water to exclude the effect of application.

Four whole plant samples per plot were selected at 75 days after transplanting for determining the vegetative growth (*i.e.* plant height, number of branches, plant fresh and dry weights). When the fruits reached their maturity, plant yield of ripe fruits were harvested, were fruit harvested four times during the season. Yield was determined by counting and weighting all mature fruits on each plant. The combined yield of the four harvests was considered as total yield.

Random samples of 20 fruits in each treatment were selected to measure the quality of the fruit, which are the properties related to color, odor and taste as expressed by measuring total soluble solids (TSS) and titratable acidity **(AOAC, 1990)**. About ten grams of fresh fruit sample was blended and the juice was used to measure TSS using standard handheld refracto meter. Titratable acidity in fruit juice was measured by volumetric titration with standardized 0.1N sodium hydroxide, using phenolphthalein as an internal indicator and expressed as % citric acid (**AOAC, 1990)**. For determining total carbohydrates, 0.5 g of dried fruits was placed in a test tube, and 10 ml of sulfuric acid (1N) was added, and then tube was sealed and placed overnight in an oven at 100ºC. After that the solution was then filtered into a measuring flask. The total sugars were determined colorimetrically according to the method of **Smith *et al.* (1956)**.

Vitamin C was determined by using the 2, 6 dichlorophenol-indophenol dyes according to method described by **Nielsen (1998)**, where 1 g of fresh fruit tissue was weighed and grounded using mortar and pestle with addition of 2 ml of metaphosphoric acetic acid. The mixture was filtered and the extract was made up to10 ml with the metaphosphoric-acetic acid mixture. Five ml of the metaphosphoric-acetic acid solution was pipetted followed by 2 ml of the samples extract. The samples were titrated separately with the indophenol dye solution until a light rose pink persisted for 5 sec. The amount of dye used in the titration was determined and used in the calculation of vitamin C content (mg/100g FW). Anthocyanins were determined in air dried pepper fruits as the method described by **Tibor and Francis (1967)**. A mixture of ethanol 95% and 1.5 N HCl (85:15) was prepared and its pH was adjusted to 1. A known mass was macerated with 50 ml extracting solvent and stored at 4°C. The extract was completed to a known volume with extracting solvent. The color of the extract was measured at the absorption maximum (520nm) using Spectrophotometer.

Determining of total polyphenols, where 0.5 g of dried fruits was blended with 40 ml of 70% aqueous acetone then boiled to extract the total polyphenols and was left to cool. The mixture was then filtered and the residue was mixed with another 20 ml of 70% aqueous acetone and the extraction process was repeated twice. Ten drops of concentrated hydrochloric acid were added to 1ml of the extract, and then heated rapidly to boiling in a water bath for about 10 minutes. After cooling, 1ml of the Folin–Ciocalteu reagent and 1.5 ml of sodium carbonate solution (14%) were added. The mixture was diluted to 10 ml with distilled water then thoroughly mixed. The reaction mixture was heated in boiling water for 5 minutes, and then cooled. The developing color was measured at 520 nm using spectrophotometer as described by **Wettasinghe and Shahidi (1999)**.

Soil samples were collected, air-dried, ground and passed through a 2 mm sieve and assessed for particle size distribution, water holding capacity, and soil reaction. The electrical conductivity, water soluble cations and anions were determined in the extract of the saturated soil paste the available N, P and K nutrients were determined by **Black *et al*. (1982).**

All data were averaged for the successive two seasons and subjected to the analysis of variance (ANOVA), using least significant difference (L.S.D) at P = 0.05, according to **Gomez and Gomez (1984)**.

RESULTS AND DISCUSSION:

The dramatic increase in using fertilizers and higher production costs in the recent years requires more attention from producers to reduce pollution and production cost. This reduction can be obtained by selecting the proper form of fertilizers that is suitable for the soil type and plant species as well as using a beneficial biostimulants to obtain a real increase in crop yield and quality as well as high economic return.

I. Soil characteristics and available nutrients:

a) Some soil properties:

The effects of applied different N-sources and bio-organo-stimulants treatments on some soil properties at the maximum vegetative growth stage are presented in Table (2). The results showed that the soil organic matter was significantly increased as a result of applied different N-sources and bio-organo-stimulants, being an ascending order of Am-Nit > Am-Su > Ca-Ni vs. K-Hu > K-Ci > Ye as solely treatments. The relative increase percentages in soil organic matter at the applied treatments N-sources plus K-Hu, K-Ci and Ye were 13.79, 11.76 and 7.31 % as a mean value, respectively. The corresponding values for bio-stimulants plus Am-Ni, Am-Su and Ca-Ni were 17.72, 16.88 and 15.79 %, respectively. The main effects of applied K-humat, K-citrate and yeast treatments were imposed, with a significant trend at P = 0.05. The interactions revealed that the variations in soil organic matter for any applied N-sources were limited among K-humate, K-citrate and yeast, imposing significant differences. These significant increases were among the combined treatment of (Am-Ni +K-Hu), with an increase percentage of 47.07 % over the control treatment.

Table (2): Some soil characteristic at a maximum vegetative growth stage as affected by the applied N-sources and bio-organo-stimulants.

Treatments (T)	Biostimulants (Bi)				Mean	L.S.D. at 5 %
	0	K-Hu	K-Cit	Yeast		
Organic matter %						
Control	0.68	0.87	0.85	0.82	0.81	
Ammonium nitrate	0.79	1.00	0.98	0.94	0.93	T = 0.03
Calcium nitrate	0.76	0.96	0.93	0.88	0.88	Bi = 0.03
Ammonium sulfate	0.76	0.98	0.96	0.90	0.90	T x Bi = 0.05
Mean	0.74	0.99	0.95	0.88		
Soil pH						
Control	8.35	8.00	8.09	8.12	8.05	
Ammonium nitrate	7.76	7.31	7.33	7.63	7.54	T = 0.08
Calcium nitrate	7.80	7.62	7.82	7.92	7.79	Bi = 0.10
Ammonium sulfate	7.77	7.81	7.90	8.01	7.76	T x Bi = 0.18
Mean	7.92	7.66	7.82	7.91		
EC, dSm^{-1}						
Control	5.35	5.37	5.35	5.35	5.36	
Ammonium nitrate	5.30	2.65	2.97	2.88	3.45	T = 0.30
Calcium nitrate	4.99	3.27	3.87	3.28	3.85	Bi = 0.40
Ammonium sulfate	5.22	3.33	4.00	3.31	3.97	T x Bi = 0.50
Mean	5.22	3.66	3.92	3.71		

K-Hu=K-Humate, K-Cit=K-Citrate

The data documented proved that soil moisture and nutrient retention were relatively improved due to the applied bio-organo-stimulants, which enhancing markedly increased organic substances. It could be emphasized lay such bio-organo-stimulants to ameliorate soil aggregation that acts well for improving the soil moisture characteristics. On the assessment of the proposed treatment variables on soil pH, the results presented in Table (2) indicated that the detected soil pH was significantly affected by the main effect of bio-organo-stimulants treatments. The changes in soil pH between K-Hu, K-Ci and yeast treatments and the control were actually limited by 0.23- 0.35 units. On the contrary, the effect of soil applications imposed remarkable variations on soil pH among the different N-sources. The LSD comparison proved that the changes in soil pH between the respective N-sources and the control ranged from 0.23 to 1.04 units. As expected, the lowest pH was recorded from NH_4 treatment. Ammonium nitrate is an important N fertilizer in agriculture. However, in this study it failed to improve dry matter production as compared to the other treatments although the concentration of NH_4^+ under bio-organo-stimulants treatments (K-humate, K-citrate and yeast), such treatment was the highest in terms of NH_4^+ accumulation, K-Hu was more effective as compared to the other treatments.

The low pH of the soil treated with organic based N fertilizers does not necessarily suggest that those treatments did not markedly decrease the pH of the soil. Their effect could be temporary as reported by **Ahmed *et al*. (2006)**, where a short term effect of nitrogen sources mixed with acidic materials temporarily reduced soil pH. The tendency of HA to react with NH_4, released by ammonium, was high in the formulated fertilizers consisting HA. The presence of high NH_4^+ due to continues hydrolysis of ammonium and overload of NH_4^+ could enhance fixation processes **(Ahmed *et al*., 2008)**. The acidic nature of $(NH_4)_2$ SO_4 reduced its effect on dry matter production. This acidity without liming may cause poor plant growth and development. As for ammonium sulfate, in the form of sulfate (SO_4^{2-}) reduces soil pH and affects NH_3^+ volatilization functional groups present in humic molecules together with its characteristics produced a lot of effects on NH_4^+ recovery. Less oxygen functional groups present in HA reduced soil exchangeable NH_4^+ **(Guil-Guerrero and. Martinez-Guirado (2006)**. However, may have enabled the humic molecules to retain more NH_4^+ at this low pH. Hence, the low cation exchange capacity (total acidity) of K-Hu could be one of the reasons for inefficiency of HA. According to **Tan (2005)**, the total acidity of HA varies from 7.4-8.1 meq g^{-1}, while that of citric acid, ranges between 7.5 and 8.2 meq g^{-1}. The interaction study of the variable treatments did not appear any significant trend at P = 0.05.

The relative drop in EC_S values among the variable biostimulants could be particularly inferred efficiency of K-HA in enhancing all removal from the studied soil due creating the conductive pores between the soil stable aggregates. The low amount of K-HA used in fertilizer formulation could be a significant factor. Since, K-humat substances are believed to contain a very small amount of permanent charges which are responsible for CEC development with 10% estimation from its total negative charges **(Tan *et al.*, 1992.)**, its contribution to cations retention would be subjective and relying on its quantity used.

b. Status of soil nutrient availability at the Harvest stage:

The results outlined in Table (3a) showed the positive effects of the applied K-humate on available contents of N, P and K exhibiting an ascending order of K-Hu > K-Ci > Ye > control.

Table (3a): Soil macro and micronutrients content at the harvest as affected by N-sources and bio-organo-stimulants applications.

Treatments (T)	Biostimulants (Bi)				Mean	L.S.D. at 5 %
	0	K-Hu	K-Cit	Yeast		
N, mg kg^{-1}						
Control	2.78	29.8	30.5	30.1	29.7	T = 1.10 Bi = 0.20 T x Bi = 2.10
Ammonium nitrate	2.98	42.7	41.2	39.5	38.3	
Calcium nitrate	28.5	39.5	38.1	35.1	35.3	
Ammonium sulfate	28.1	40.2	39.7	37.9	36.5	
Mean	28.6	38.1	37.4	35.7		
P, mg kg^{-1}						
Control	5.0	6.4	6.0	5.8	5.80	T = 0.27 Bi = 0.32 T x Bi = 2.20
Ammonium nitrate	5.7	7.9	7.8	7.0	7.10	
Calcium nitrate	5.3	6.9	6.5	6.4	6.28	
Ammonium sulfate	5.55	7.1	7.3	7.0	6.73	
Mean	5.38	7.07	6.90	6.55		
K, mg kg^{-1}						
Control	221	222	220	218	220.5	T = 3.90 Bi = 4.10 T x Bi = 6.00
Ammonium nitrate	217	248	240	219	234.0	
Calcium nitrate	215	231	230	231	226.5	
Ammonium sulfate	220	240	239	230	231.7	
Mean	218.3	235.3	232.3	228.0		
Fe, mg kg^{-1}						
Control	4.30	4.90	4.70	4.80	4.67	T = 0.31 Bi = 0.20 T x Bi = 0.50
Ammonium nitrate	4.70	6.40	6.00	5.90	5.75	
Calcium nitrate	4.60	5.20	5.70	5.00	5.13	
Ammonium sulfate	4.40	6.10	5.90	5.80	5.55	
Mean	4.50	5.65	5.56	5.37		
Mn, mg kg^{-1}						
Control	0.86	0.91	0.89	0.87	0.88	T = 0.1 Bi = 0.03 T x Bi = 0.18
Ammonium nitrate	0.90	1.45	1.43	1.40	1.29	
Calcium nitrate	0.87	1.00	1.00	0.95	0.96	
Ammonium sulfate	0.87	1.40	1.33	1.21	1.20	
Mean	0.88	1.19	1.16	1.11		
Zn, mg kg^{-1}						
Control	0.49	0.56	0.54	0.52	0.53	T = 0.24 Bi = 0.02 T x Bi = 0.11
Ammonium nitrate	0.54	1.36	1.31	1.29	1.13	
Calcium nitrate	0.50	1.12	1.09	1.00	0.93	
Ammonium sulfate	0.52	1.29	1.32	1.21	1.09	
Mean	0.51	1.08	1.06	1.01		
Cu, mg kg^{-1}						
Control	0.34	0.39	0.35	0.37	0.36	T = 0.05 Bi = 0.04 T x Bi = 0.05
Ammonium nitrate	0.39	1.25	1.15	1.12	0.98	
Calcium nitrate	0.35	1.09	1.00	0.95	0.85	
Ammonium sulfate	0.37	1.20	1.12	1.00	0.91	
Mean	0.36	0.98	0.91	0.86		

K-Hu=K-Humate, K-Cit=K-Citrate

Table (3b): Critical limits of micronutrients after Lindsay and Norvell (1978).

Critical limits	Fe	Mn	Zn	Cu
Low	< 4.0	< 2.0	< 1.0	> 1.0
Medium	4.0 – 6.0	2.0 – 5.0	0.5 – 1.0	1.0 -1.5
High	> 6.0	>.5.0	> 1.0	1.9-7.8

It was noticed that soil treated with K-Hu stimulated the leaf N, P, K contents effectively, being the highest when ammonium nitrate was included. The corresponding N, P and K values were 31.6, 7.4 and 225 mg kg^{-1} for K-Hu vs 30.3, 6.4 and 223 mg kg^{-1} for K-Ci, respectively. This could be explained to the stimulatory effect of K-Hu on the inoculated N-sources that acted well for releasing more available nutrients from organic substrate **(Amin *et al* 2008)**.

Regarding the effect of N-sources and bio-organo-stimulants applications used, it was observed that the soil N, P and K contents followed an ascending order of Am-Ni > Am-Su > Ca-Ni. > control. Such variations could be ascribed to the differential reaction of N-sources combined with bio-organo-stimulants on protecting the plant membranes and proteins **(Amin *et al*., 2008)**. These results are agreement with those reported by **Antoun and Besada (1990)** who showed that soil N, P and K increased with the application of different organic source. As for organic materials in the soil decay, macromolecules of a mixed aliphatic and aromatic nature are formed. The humic substances in the soil have multiple effects **(Amin *et al*. 2008)**, where indirect effects involve improvements of soil properties such as aggregation, aeration, permeability, water holding capacity, micronutrient transport and availability **(Arfan *et al*., 2007).** Meanwhile, the direct effects are those, which require uptake of humic substances into the plant tissue resulting in various biochemical effects **(Amin *et al*., 2008)**.

The magnitude of available micronutrients in the studied soil as affected by the applied treatments are shown in Table (3a). The obtained data showed that the studied Fe, Mn, Zn and Cu lay within the low-medium range according to the critical levels of micronutrients, Table (3b), undertaken by **Lindsay and Norvell (1978)** for sweet pepper at all applied treatments of N-sources and biostimulants applications under drip irrigation system. In general, this is true since these soils are not only poor in the nutrients bearing minerals, but also in organic and inorganic colloids, which are considered a storehouse for the essential plant nutrients.

II Growth and yield performances:

a. Vegetative growth:

With particular reference to the control, the results reported in Table (4) revealed that the main effects of soil bio-organo-stimulants applications in posed significant trend on the all measured growth criteria at P = 0.05. Data showed clearly that N-sources and biostimulant application interacted significantly and had a positive effect on all the vegetative growth parameters. It was clear that the greatest values for plant height, number of branches/plant, plant fresh and dry weight in the average of two studied season were obtained by applying ammonium nitrate combined with K-humate as biostimulant.

On the other hand, ammonium sulfate followed by calcium nitrate treatments with biostimulant application achieved the next favourable values for all these vegetative growth parameters. Regarding biostimulant application, potassium humate was more effective than potassium citrate and yeast in increasing all the studied vegetative growth parameters and both of them showed a significant increase over the control. In respect to, plant height there was insignificant difference between potassium citrate and humate but both biostimulants were significantly higher than control. Several researches found that applying nitrogen fertilizer in the form of ammonium nitrate gave the most vigorous vegetative growth of potato plants **(Baker *et al.*, 1980).** The enhancement of plant growth due to fertilizing with ammonium nitrate may be attributed to the presence of N forms, nitrate (NO_3^-) and ammonium (NH_4^+) that is documented to be superior over sole NO_3^--N or NH_4^+-N sources **(Marchner, 1995)**.

Table (4): Vegetative growth parameters and fruit yield of sweet pepper as affected by different N-sources and bio-organo-stimulants.

Treatments (T)	Biostimulants (Bi)				Mean	L.S.D. at 5 %
	0	K-Hu	K-Cit	Yeast		
Plant height (cm)						
Control	31.6	36.8	34.9	33.0	34.1	T = 2.70 Bi = 1.20 T x Bi = 1.70
Ammonium nitrate	37.0	53.5	50.1	42.7	45.8	
Calcium nitrate	32.2	50.9	48.6	39.1	42.7	
Ammonium sulfate	35.8	52.8	49.1	40.5	44.6	
Mean	34.2	48.5	46.1	38.4		
Plant fresh weight (g)						
Control	79.8	100.0	90.5	87.5	108.9	T = 0.40 Bi = 0.80 T x Bi = 0.50
Ammonium nitrate	90.5	150.9	144.7	135.2	130.3	
Calcium nitrate	85.7	141.7	137.8	136.1	125.3	
Ammonium sulfate	87.1	147.2	142.7	137.1	128.5	
Mean	85.8	136.1	127.8	123.9		
Plant dry weight (g)						
Control	18.8	21.7	20.5	17.7	19.7	T = 1.20 Bi = 0.40 T x Bi = 1.60
Ammonium nitrate	25.7	36.9	35.0	33.7	32.8	
Calcium nitrate	20.9	30.7	29.7	26.9	27.1	
Ammonium sulfate	22.3	33.9	34.1	31.2	30.4	
Mean	21.9	30.9	29.7.1	27.4		
Total fruit yield (ton fed^{-1})						
Control	2.00	2.92	2.85	2.70	2.62	T = 1.60 Bi = 0.90 T x Bi = 1.00
Ammonium nitrate	3.71	6.97	5.55	4.90	5.28	
Calcium nitrate	2.90	3.71	3.31	3.01	3.03	
Ammonium sulfate	2.89	5.83	4.93	3.52	4.29	
Mean	2.88	4.88	4.17	3.45		

K-Hu=K-Humate, K-Cit=K-Citrate

Moreover, the enhancement of plant growth using potassium humate had been reported to be due to the increase in nutrients uptake or enhancement of photosynthesis, chlorophyll density and plant root respiration which resulted in greater plant growth **(Chen and Aviad, 1990)**. Regarding the yield parameters, it was clear that there was a positive interaction between the two studied factors, *i.e.*, N forms and biostimulation in increasing all yield components of pepper plants.

Also, ammonium nitrate combined with potassium humate was the best treatment for increasing the total yield, followed by ammonium sulfate with potassium humate. On the other hand, plants received ammonium nitrate without biostimulant application had the highest early yield followed by calcium nitrate combined with potassium humate.

Moreover, data presented showed that biostimulation either with potassium humate or citrate had a significant effect on total yield. This is might be due to the vegetative growth stimulation by soil application using drip irrigation system of potassium humate or citrate which resulted in a positive delay in flowering and fruiting stages. Similar results were obtained by **Ghoname *et al.*, (2009)** who mentioned that there was an increase in tomato fruit yield with application of humic acid. The increase in the dry weights of pepper plants might be attributed to an increase in leaf area as well as number of branches, as a result of increasing photosynthetic activity and improvement in plant growth of pepper plants. These results are agreement with those reported by **Amin, *et al*. (2008)** who found that a progressive increase in each of plant height, number of spikes, leaf area, and dry weight by increasing K-Hu and K-Ci levels up to 200 mg L^{-1}, photosynthetic pigments in the leaves. In this connection, **Ghoname *et al*. (2009)** found that N-from plus K-Hu and K-Ci application led to increase significantly the dry weights of plants.

The treatment with yeast significantly increased vegetative growth and yield of plants. The positive effects of yeast application were referred to its contents of proteins, amino acids, vitamins and hormones as well as some micro nutrients. All these compounds work as a readily available growth supplements to plants which eventually improve plant growth and production.

b. Plant growth characteristics:

Leaf number per plant as well as leaves fresh and dry weights followed a similar trend as mentioned above (Table 5) where combining ammonium nitrate source and potassium humate soil application gave the greatest significant values of these parameters. Generally ammonium nitrate was the best N form followed by ammonium sulfate and calcium nitrate**,** while potassium humate was superior to potassium citrate and both were significantly higher than control. Similar results were obtained by **Soltani *et al.* (2007)** who mentioned that increasing NH_4-N in nutrient solution caused reduction in cucumber fruit dry matter. The simulative effect of potassium humate in enhancing fruit characteristics may be attributed to that some plant hormone-like substances seem to be present in the humic substances, thus exerting a possible stimulating effect on leaves growth **(Pizzeghello, 2002)**. Generally, all applied materials improved plant vegetative growth such as number of leaves and branches which must have been reflected on total plant leaf area. This means higher light interception and more assimilate production which appeared in the form of high fresh and dry weights of the plants.

c. Leaf nutrient contents:

The data in Table (6) showed that application of potassium humate significantly increased the nutrient contents in pepper leaves, *i.e,* nitrogen, phosphorus and potassium relative to the control treatment.

Table (5): Some plant parameters as affected by different N-sources and biostimulants applications.

Treatments (T)	Biostimulants (Bi)				Mean	L.S.D. at 5 %
	0	K-Hu	K-Cit	Yeast		
Leaf number plant^{-1}						
Control	149	176	156	150	158	T = 2.00 Bi = 5.00 T x Bi = 18.0
Ammonium nitrate	155	231	200	184	193	
Calcium nitrate	142	188	179	167	169	
Ammonium sulfate	150	200	189	178	179	
Mean	149	197	181	169		
Number of branches plant^{-1}						
Control	8	12	10	11	10	T = 2.00 Bi = 1.00 T x Bi = 2.00
Ammonium nitrate	13	19	17	14	16	
Calcium nitrate	9	15	12	10	12	
Ammonium sulfate	10	17	15	12	14	
Mean	10	16	14	12		
Leave fresh weight (g plant^{-1})						
Control	23.94	24.97	27.21	25.01	25.28	T = 1.40 Bi = 2.21 T x Bi = 3.11
Ammonium nitrate	24.50	37.81	35.77	27.80	31.47	
Calcium nitrate	22.70	31.71	28.70	21.97	26.27	
Ammonium sulfate	23.43	34.05	30.81	25.59	28.47	
Mean	23.64	32.14	30.62	25.09		
Leave dry weight (g plant^{-1})						
Control	12.90	15.20	14.40	13.32	13.96	T = 0.77 Bi = 0.54 T x Bi = 0.91
Ammonium nitrate	13.60	17.60	16.79	15.99	15.99	
Calcium nitrate	13.30	14.95	14.43	14.01	14.17	
Ammonium sulfate	13.45	16.51	15.79	15.00	15.18	
Mean	13.31	16.07	15.33	14.58		

K-Hu=K-Humate, K-Cit=K-Citrate

Table (6): Leaf nutrient contents of sweet pepper as affected by different N-sources and biostimulant applications.

Treatments (T)	Biostimulants (Bi)				Mean	L.S.D. at 5 %
	0	K-Hu	K-Cit	Yeast		
Nitrogen %						
Control	2.20	2.70	2.60	2.40	2.48	T = 0.31 Bi = 0.22 T x Bi = 0.40
Ammonium nitrate	3.60	4.90	4.30	4.00	4.20	
Calcium nitrate	3.00	3.50	3.20	3.00	3.18	
Ammonium sulfate	3.20	4.20	4.00	3.70	3.72	
Mean	3.03	3.83	3.38	3.25		
Phosphors %						
Control	0.24	0.27	0.25	0.19	0.24	T = 0.02 Bi = 0.03 T x Bi = 0.07
Ammonium nitrate	0.30	0.45	0.37	0.31	0.36	
Calcium nitrate	0.20	0.35	0.30	0.28	2.28	
Ammonium sulfate	0.25	0.40	0.33	0.30	0.32	
Mean	0.25	0.37	0.31	0.27		
Potassium %						
Control	1.40	2.00	1.80	1.60	1.70	T = 0.20 Bi = 0.17 T x Bi = 0.40
Ammonium nitrate	1.90	2.90	2.60	2.30	2.42	
Calcium nitrate	1.50	2.50	2.00	1.90	1.98	
Ammonium sulfate	1.80	2.70	2.20	2.00	2.18	
Mean	1.65	2.53	2.15	1.69		

K-Hu=K-Humate, K-Cit=K-Citrate

The data revealed that maximum values of N, P and K contents of pepper were obtained by 0.5 g L^{-1} of potassium humate and potassium citrate. These results are agreement with those obtained by **Shakivora *et al.* (2003)** who found that the N content, proteins and nitrate reductase activity were increased in *Phaseolus vulgari*s by application of potassium humat at 0.1%, potassium citrate applied at 0.5 g L^{-1} increased the uptake of N, P and K in wheat grains over the control. In addition, soil application of potassium humate significantly increased N, P and K contents in pepper at 0.5 g L^{-1} relative to their untreated controls. Also, potassium humate significantly increased N, P and K contents in leaves and yield of Berry **(Soltani *et al.*, 2007)**.

d. Fruit nutrient contents:

As shown from data presented in Table (7) that N-sources had a positive effect on the mineral contents of sweet pepper fruits. Furthermore, biostimulants, either with potassium humate or citrate, significantly increased fruit mineral content as compared with control plants. However, there was insignificant difference between both of the two tested biostimulators on fruit mineral content. Nitrate form supplied either as ammonium nitrate or calcium nitrate significantly increased nitrate content over ammonium sulfate. This result is in accordance with that of **Wang *et al*. (2009)** who mentioned that nitrate accumulation in spinach shoots was dramatically increased with the increase of NO_3-N in the nutrient solution. Also, concentration of nitrate in plant tissues was found to be dependent on the concentration of N present in the nutrient solution **Kotsirasa *et al*. (2002)**. On the other hand, **Saleh *et al*. (2006)** noted that humic acid significantly decreased nitrogen nitrate content and improved fruit quality of treated vines.

Table (7): Fruit nutrient contents in sweet pepper as affected by applied different N-sources and biostimulant applications.

Treatments (T)	Biostimulants (Bi)				Mean	L.S.D. at 5 %
	0	K-Hu	K-Cit	Yeast		
Nitrate content (mg kg^{-1})						
Control	44.0	50.0	47.0	45.0	46.50	T = 3.21 Bi = 2.38 T x Bi = 2.50
Ammonium nitrate	72.1	80.6	78.1	75.7	76.63	
Calcium nitrate	64.5	74.1	71.1	70.2	69.97	
Ammonium sulfate	69.8	76.2	74.2	72.7	73.23	
Mean	62.60	70.22	67.61	65.90		
Ca content (mg kg^{-1})						
Control	240	281	264	257	260.5	T = 3.10 Bi = 0.03 T x Bi = 12.0
Ammonium nitrate	301	390	372	345	332.0	
Calcium nitrate	273	342	321	302	334.5	
Ammonium sulfate	287	361	345	320	328.5	
Mean	275.3	343.5	325.5	328.5		
K content (mg kg^{-1})						
Control	320	300	280	260	290.0	T = 44.20 Bi = 32.60 T x Bi = 35.0
Ammonium nitrate	361	571	477	411	455.0	
Calcium nitrate	300	399	372	350	355.3	
Ammonium sulfate	321	449	432	401	400.8	
Mean	325.5	429.8	390.3	353.5		

K-Hu=K-Humate, K-Cit=K-Citrate

Concerning to potassium and calcium content, it was noticed that nitrate form supplied either as ammonium nitrate or calcium nitrate significantly increased both elements as compared with other N forms. Both nitrate and ammonium can be taken up and metabolized by plants. Since, increasing the level of NO_3 in the growing media stimulates organic anion synthesis and hence, cation accumulation. However, N forms preferential for crop growth much depends on plant species and other environmental factors. Results obtained in this work are in agreement with those of **Kotsirasa *et al* (2002)** who stated that the concentration of K, Ca, Mg and NO_3 in all regions of cucumber fruit was higher when NO_3 constituted 75% or more of the total N in the nutrient medium, but was reduced by increasing concentrations of NH_4. Also, other researches reported that total uptake of Ca, Mg, and K decreased with increasing NH_4-N proportion in the nutrient solution which suggests that NH_4-N was competing with these cations in pepper fruits. **Chance *et al*. (1999)** reported that applying N as ammonium nitrate significantly increased Ca content of spinach leaves as compared with ammonium sulfate and urea. In respect to biostimulants, it was found that K- humate have an enhancing effect on the absorption.

e. Fruit quality parameters:

Organoleptic properties expressed as (soluble solid) TSS and acidity in sweet pepper fruits Table (8) were significantly affected by both studied factors. Pepper plants received ammonium nitrate combined with potassium humate soil application under drip irrigation system had fruits with best organoleptic indicators, *i.e.*, TSS and acidity. Results of **Tabatabaei *et al*. (2007)** indicted that TSS of strawberry fruits was increased with increasing NH_4 ratio in the nutrient solution. Moreover, the fertilizer containing humic acid increased apple fruit weight, yield and soluble solid content **(Li *et al*., 1999)**.

The vegetative growth and yield were harmony with the results of nutritional value indicators of fruits, where the effects of N-sources and biostimulation treatments on sweet pepper plants were significantly interacted and enhanced all nutritional value indicators. Also, sweet pepper plants received N in the form of ammonium nitrate combined with potassium humate recorded the best nutritional value indicators, *i.e.*, total carbohydrate contents, anthocyanin, ascorbic acid, total polyphenols, than the other treatments. This significant increase may be attributed to the favorable effect of this treatment on fruit weight (Table 4). In case of anthocyanin content, it was clear that the effect of applied N-sources could be categorized in an ascending order of ammonium nitrate > ammonium sulfate > Ca nitrate.

Nitrogen is considered a master element in plant nutrition and it plays an important role in all physiological growth processes of plant as stimulation of plant growth, yield and chemical constituents in different plants. However, considerable differences existed in the response of various species to different N-sources. In addition to, organic and/or inorganic fertilizers exert beneficial effects on nutritional value of snap bean **(El-Basyouny, 1995)** and on soybean **(Ahmed *et al.*, 2002)**. Thus, the increase in carbohydrate content may be due to the activation of photosynthetic machinery as a result of stimulating effect of different N forms on photosynthetic process as N is a constituent of chlorophyll molecules.

Table (8): Fruits quality parameters of sweet pepper as affected by different N-sources and biostimulant applications.

Treatments (T)	Biostimulants (Bi)				Mean	L.S.D. at 5 %
	0	K-Hu	K-Cit	Yeast		
T.S.S of fruits (g)						
Control	179	220	192	185	194.0	T = 33.10 Bi = 27.16 T x Bi = 41.0
Ammonium nitrate	277	590	507	495	467.3	
Calcium nitrate	255	471	401	381	377.0	
Ammonium sulfate	260	510	500	480	379.0	
Mean	242.8	447.9	400.0	385.3		
Acidity %						
Control	3.82	4.21	4.00	3.97	4.00	T = 0.28 Bi = 0.35 T x Bi = 0.43
Ammonium nitrate	4.81	6.39	5.58	5.21	5.49	
Calcium nitrate	4.31	5.20	4.82	4.37	4.68	
Ammonium sulfate	3.62	5.66	5.07	4.97	4.83	
Mean	4.14	5.37	4.87	4.63		
Ascorbic acid (mg/100g FW)						
Control	105.6	118.5	109.2	100.7	108.5	T = 10.30 Bi = 5.40 T x Bi = 5.20
Ammonium nitrate	118.7	145.6	140.7	132.5	134.4	
Calcium nitrate	110.9	130.0	125.5	123.8	122.6	
Ammonium sulfate	114.5	134.1	132.1	126.2	126.7	
Mean	112.4	132.1	126.9	120.8		
Total carbohydrate %						
Control	16.8	20.5	19.0	18.9	18.8	T = 1.20 Bi = 0.90 T x Bi = 2.10
Ammonium nitrate	22.2	26.0	24.6	22.7	23.9	
Calcium nitrate	20.0	22.9	20.6	19.3	20.7	
Ammonium sulfate	21.1	24.4	22.9	20.9	22.3	
Mean	20.0	23.5	21.8	20.5		
Total polyphenol %						
Control	0.56	0.68	0.68	0.63	0.66	T = 0.02 Bi = 0.04 T x Bi = 0.05
Ammonium nitrate	0.64	0.97	0.89	0.87	0.84	
Calcium nitrate	0.60	0.85	0.83	0.80	0.77	
Ammonium sulfate	0.62	0.87	0.85	0.83	0.79	
Mean	0.61	0.84	0.81	0.78		
Anthocyanin (mg/100g DW)						
Control	42.0	75.2	72.7	70.1	65.0	T = 0.40 Bi = 1.00 T x Bi = 2.90
Ammonium nitrate	55.6	87.1	84.9	80.9	77.1	
Calcium nitrate	50.9	84.0	80.3	78.7	73.5	
Ammonium sulfate	53.7	80.1	78.2	76.7	72.1	
Mean	50.6	81.6	79.0	76.6		

K-Hu=K-Humate, K-Cit=K-Citrate

Moreover, the increase in phenolic content may be attributed to the increase in carbohydrate content. Since, phenolic compounds occur in pepper in connection with sugar. These results are in agreement with those outlined by **Matersk *et al.* (2003)** who mentioned that N forms markedly increased soluble sugar content (total, reducing and non reducing) and ascorbic acid. Moreover, the highest ascorbic acid concentration of pepper was recorded with ammonium nitrate followed by ammonium sulfate and calcium nitrate. Regarding the biostimulants, the humic substances can affect plant physiology and stimulate growth due to their hormone like activity, where humic substances have cytokinin and auxin.

Chen and Avaid (1990) and Zaghloul *et al.* (2009*)* stated that application of potassium humate increased soluble sugar content of *Thuya orientalis* L. shoots compared to control. Moreover, application of humic acid significantly increased ascorbic acid and endogenous antioxidants of Kentucky bluegrass **(Zhang and Schmidt, 1999)**. The most interesting result in this study is the increase of ascorbic acid, total polyphenols and anthocyanin in pepper fruits resulted from the application of two studied factors. Since, these compounds play an important role in increase fruit quality as they considered important antioxidants for human nutrition **(Guil-Guerrero,and Martinez-Guirado, 2006)**. These antioxidants perform their function by counteracting the oxidizing effect on lipids by scavenging highly reactive oxygen free radicals.

CONCLUSION:

From the aforementioned results, it can be concluded that, the application of biostimulants (potassium humate, potassium citrate and yeast) as soil application through drip irrigation system under saline calcareous soil increased sweet pepper yield. The growth and yield parameters of pepper plants via the enhancement of the biosynthesis of photosynthetic pigments as well as improved as a result of the nutritional status of pepper plants grown on a newly reclaimed soil and also to find whether biostimulants (potassium humate, potassium citrate and yeast) had a beneficial effect on early and total yields as well as fruit quality of sweet pepper with a relatively higher ability for increasing available micronutrients in the soil.

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تأثير إضافة مصادر مختلفة من النتروجين وبعض المحفزات الحيوية-العضوية على نباتات الفلفل الرومى النامية فى تربة جيرية ملحية

رأفت نظمى زكى نادر رمزى حبشى
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أجريت تجربة حقلية على تربة جيرية ملحية منزرعة بنباتات الفلفل الرومى (*Capsicum annuum* L.) تحت نظام الرى بالتنقيط بمزرعة خاصة، منطقة النوبارية، محافظة البحيرة، مصر خلال موسمين متتاليين ٢٠٠٩، ٢٠٠١. والهدف الرئيسى من هذه الدراسة يتعلق بتحديد مدى تأثير إضافة أرضية لمصادر مختلفة من النتروجين (نترات الأمونيوم، نترات الكالسيوم، كبريتات الأمونيوم) كمعاملات منفردة أو مشتركة مع بعض المحفزات الحيوية-العضوية (هيومات البوتاسيوم، سترات البوتاسيوم، الخميرة) على قياسات نمو النبات، الحالة الغذائية، محصول الثمار وجودتها معبرا عنها بمستوى الحموضة، المواد الصلبة الذائبة الكلية، الكربوهيدرات الكلية، فيتامين C، الأنثوسيانين، البولى فينولات الكلية، المحتوى العنصرى من (Ca and K)، محتوى الثمار من النترات، مع إعطاء أهمية خاصة للتأثرات المصاحبة على خواص التربة والمحتوى من المغذيات الميسرة. ولقد أضيف الأسمدة المعدنية لكل من النتروجين، البوتاسيوم، الفوسفور فى صورها المختلفة طبقا للمعدلات الموصى بها من وزارة الزراعة، وهى ١٠٠ كجم N/فدان، ٤٨ كجم K_2O/فدان، ١٥.٥ كجم P_2O_5/فدان، بينما أضيفت هيومات البوتاسيوم بمعدل ٠.٥ جم/لتر، سترات البوتاسيوم بمعدل ١.٠ جم/لتر، الخميرة بمعدل ٢.٠ جم/لتر، وذلك فى نفس وقت إضافة مصادر النتروجين من خلال نظام الرى بالتنقيط. آخذا فى الإعتبار أن كمية البوتاسيوم فى كلا (هيومات البوتاسيوم+سترات البوتاسيوم) تمثل ٢٥ ٪ من المعدل المضاف والموصى به.

وتشير النتائج المتحصل عليها إلى ان هناك زيادات معنوية فى محتوى التربة من المادة العضوية والمغذيات الميسرة كنتيجة لإضافة المصادر المختلفة لكلا النتروجين والمحفزات الحيوية-العضوية، مع تاثير أفضل للمعاملة المشتركة (نترات أمونيوم+ هيومات بوتاسيوم). وعلى الجانب الآخر، فان Soil pH and ECe قد أخذا إتجاها موازيا ومعاكسا، حيث أظهرت قيمهما نقص معنوى، مع تاثير أفضل للمعاملة المشتركة السابق ذكرها.

ومن الجدير بالذكر، أنه أمكن تصنيف معاملات الإضافة تبعا لأفضلية تأثيرها على صفات التربة تحت الدراسة فى ترتيبين تنازليين: Am-Ni > Am-Su > Ca-Ni and K-Hu > K-Ci > Ye، وذلك كمعاملات منفردة لكلا المصادر المختلفة للنتروجين والمحفزات الحيوية-العضوية على الترتيب، ام بالنسبة للترتيب الثانى فيختص بالمعاملات المشترك، على النحو التالى:

(Am-Ni+K-Hu) > (Am-Ni+K-Ci) > (Am-Ni+Ye), (Am-Su+K-Hu) > (Am-Su+K-Ci) > (Am-Su+Ye) and (Ca-Ni+K-Hu) > (Ca-Ni+K-Ci) > (Ca-Ni+Ye)

وبالنسبة للقياسات النباتية للفلفل الرومى، توضح النتائج أن الدور الفعال للمعاملات المضافة على عدد الأوراق/نبات، عدد التفريعات/نبات، طول النبات، وزن الأوراق/نبات، الحالة الغذائية وكذلك محصول الثمار وقياسات جودته قد سلك إتجاها موازيا ومشابها لتلك المحقق مع صفات التربة تحت الدراسة. وهذا حقيقى، حيث أن التحسن الجيد والمحقق فى صفات التربة قد إنعكس بصورة إيجابية على قياسات نمو النبات، محصول الثمار وجودتها. علاوة على أن هذه النتائج تتأكد بالدور الفعال والجيد للمعاملة المشتركة (نترات أمونيوم+ هيومات بوتاسيوم) والتى أيضا قد حققت أعلى القيم فى قياسات نمو النبات، ومحصول وجودة ثمار الفلفل الرومى.