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Beneficial Effect of Some Organic Soil-Conditioning Agents for Improving Sandy Soil Productivity Under Sprinkler Irrigation System

[1]Mona K.M. Abdel-Razek, [2]Nadia M. Hemeid and [3]Habashy R. Nader

Soils, Water and Environment Research Institute, Agric. Res. Center, Giza, Egypt.

Abstract: A field experiment was carried out on a newly reclaimed sandy textured soil under sprinkler irrigation system at Ismailia Agricultural Research Station located between Latitude 30° 35' 30" N, Longitude 32° 14' 50" E and Elevation 3 meters from the sea level, and cultivated with peanut plants (*Arachis hypogaea*, Giza 5) as a summer crop during the agricultural growing season of 2009. The current study aims to identify the direct beneficial effect of applying some organic soil conditioning agents (seaweed extract, calcium alginate $[(C_6\ H_7\ Ca_{1/2}\ O_6)_n]$ and potassium humate) on some hydrophysical and fertility status of sandy soil (bulk density, total porosity, hydraulic conductivity, moisture constants and nutrients retained) at maximum vegetative growth stage (90 days after sowing) as well as vegetative growth, yield and its attributes of the studied crop, i.e., seedand Foliage yields harvest index, weight of 100 seed, seed oil%, protein% and uptake of N, P, K, Fe, Mn and Zn. The applied rates of organic soil conditioners individual or in combined treatments were solid K-humate (12% K_2O) at a rate of 1.0 kg fed^{-1}, 0.8 L fed^{-1} liquid seaweed extract (10% K_2O) at and 2.5 kg fed^{-1} solid calcium alginate, which were thoroughly mixed with the 5 cm soil surface layer. The results obtained indicated that the applied organic soil amendments either individual or in combined treatments (K-humate+seaweed extract and K-humate+ calcium alginate) showed significant and positive improvements in both soil characteristics and the grown peanut yield parameters under investigation, with a significant superiority for the combined treatments. In general, the beneficial effects of the applied organic materials on the studied different soil hydrophysical properties under peanut crop could be arranged in the following order: K-humate+seaweed extract > K-humate+calcium alginate > seaweed extract > calcium alginate > K-humate. While, the beneficial effects of the applied organic materials on soil fertility (available nutrient contents) and nutritional status of peanut seedandfoliage could be arranged in the following order: K-humate+seaweed extract > K-humate+calcium alginate > K-humate > seaweed extract > calcium alginate It is evident that the applied organic amendments, either as individual or in combined treatments, achieved many of the beneficial effects on soil hydro physical and fertility status as well as plant parameters, since K-humate acted like plant growth hormones. While, other organic amendments (seaweed extract and calcium alginate) partially capable to retain water and nutrients for growing plants due to containing alginic acid, which would act as complexing agent, thus minimizing the loss of nutrients by leaching. These chelating agents, through phenolic and carboxylic active groups for micronutrients and water molecules, are considered as a storehouse with easily or available to be taken by plant roots, and this reflected positively on development of yield and its attributes for studied peanuts crop cultivated under sprinkler irrigation system.

Key words: Organic soil conditioning, K-humate, seaweed extract, calcium alginate and sandy soil.

INTRODUCTION

The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable agriculture. Chemical agriculture has made an adverse impact on the health-care of not only soil but also the beneficial soil microbial communities and the plants cultivated in these soils.

The K-humate derived from lignite brown coal which is alkaline; rich in carboxylic and phenolic groups, aromatic in nature, provide favorable conditions for biological activity, chemical reactions and physical improvement of soil. They promote chemical reaction for cation exchange, increase pH buffering capacity of soils, bind and sequester phytotoxic elements and accelerate transport of nutrients to plants (Amjad *et al.,* 2010).

Application of humic acids (as one of the main fractions of humic substances) in agriculture as soil fertilizer and soil conditioner has been extensively discussed in the literature. To date, numerous researches have demonstrated conclusively that humic acids showed significant impacts on the soil structure and plant growth (Fong *et al.,* 2007). K-humate as humic acid in proper concentrations can enhance plant and root growth (Bacilio *et al.,* 2003). In regard to the potential of the humic acids, continuous development has led to availability of various commercial humic acid based products and they are widely marketed. The humic acid products are usually available in the form of inexpensive soluble salts, referred to as potassium humate (Fong *et*

Corresponding Author: Mona K.M. Abdel-Razek, Soils, Water and Environment Research Institute, Agric. Res. Center, Giza, Egypt.
E-mail: habashaynader@yahoo.com

al., 2007). Potassium humate causes an increase in crop quality and tolerance of plant to drought, saline, cold, diseases and pests stresses (Gadimov *et al.,* 2007).

Calcium alginate $(C_6 H_7 Ca_{1/2} O_6)_n$ as hydrogels are the cross-linked networks containing a large fraction of water, which were used as the precursors of calcium carbonate ($CaCO_3$) mineralization for the first time. The well-defined geometry, the permeability, and the ion-exchange property of these pregels favored the facile fabrication of calcite superstructures through the slow in pouring of ammonia and carbon dioxide gases. When calcium alginate hydrogels sponged up a relatively high amount of liquid, the resulting products with the outside calcite sequences transcribed the sponge like pregel beads with the outside nucleation sites of carboxyl groups.

Alginic acid is a naturally occurring hydrophilic colloidal polysaccharide obtained from the various species of brown seaweed (Phaeophyceae). It is a linear copolymer consisting mainly of residues of ß-1,4-linked D-mannuronic acid and a-1,4-linked L-glucuronic acid. These monomers are often arranged in homopolymeric blocks separated by regions approximating an alternating sequence of the two acid monomers.

On the other hand, alginic acid acts as seaweed extract to control alternate bearing soil-conditioning agent. It combines with metal radicals in the soil, forming polymers of greatly increased molecular weight. These cross-linked polymers improve the water-holding characteristics of the soil (Verkleij, 1992 and Lattner *et al.,* 2003) which, consequently, stimulates root growth and the activities of beneficial microorganisms (Chen *et al.,* 2003).

Seaweeds are the macroscopic marine algae found attached to the bottom in relatively shallow coastal (Thirumaran *et al.,* 2009). Seaweed contained macro nutrients, trace elements, organic substances like amino acids and plant growth regulators such as auxin, cytokinin and gibberellins. (Chapman and Chapman 1980 proved that seaweed extract promoted, the growth and yield of crop plants (Nelson and Van Staden, 1984 and Crouch and Van Staden 1993). The application of seaweed extract for different crop was of great importance to substitute the commercial chemical fertilizers and to reduce the cost of production. Seaweeds are found to be superior to chemical fertilizers due to high level of organic matter, micro and macro elements, vitamins and fatty acids and also rich in growth regulators (Crouch and Van Staden 1993). The growth promoting effect of extract of seaweeds on seed germination (Venkataraman *et al.,* 1993 and Mostafa *et al.,* 1999), Vegetative growth (Sekar *et al.,* 1995) and biochemical characteristics (Thirumalthangam *et al.,* 2003) in agriculture crops has been reported. The carbohydrates and other organic matter present in seaweeds alter the nature of soil and improve its moisture holding capacity (Crouch and Van Staden 1993).

Beneficial effects from the use of seaweed extracts as natural regulators included increased crop yield, delay of fruit senescence, improved overall plant vigour, improved yield quantity and quality, and improve ability to withstand adverse environmental conditions (Featonby and Van Staden, 1983). Application of seaweed extract as organic biostimulant is fast becoming accepted practice in horticulture due to its beneficial effects (Verkleij, 1992).

The current study aims to identify the beneficial effect of some organic soil conditioners (seaweed extract and calcium alginate and potassium humate) for improving sandy soil productivity of peanut grown under sprinkler irrigation system.

MATERIALS AND METHODS

A field experiment was conducted on a newly reclaimed sandy textured soil under sprinkler irrigation system at Ismailia Agricultural Research Station located between Latitude 30° 35' 30" N, Longitude 32° 14' 50" E and elevation 3 meters from the sea level, and cultivated with peanut plants (*Arachis hypogaea*, Giza 5) as a summer crop during the agricultural growing season of 2009. The current study aims to identify the direct beneficial effects of applying some organic soil conditioners (seaweed extract, calcium alginate is the calcium salt of alginic acid and K-humat) on some hydrophysical and fertility status of sandy soil as well as vegetative growth, yield and its attributes of the studied crop. Some hydrophysical, chemical and fertility status of the studied sandy soil are illustrated in Table (1).

The applied rates of organic soil conditioners were calcium alginate solid at 2.5kg fed^{-1} as individual or combined with solid K-humate at a rate of 1.0 kg fed^{-1} (12% K_2O) liquid seaweed extract at 0.8 L fed^{-1}(10% K_2O), then were thoroughly mixed with the top 5 cm soil layer. The experiment was laid out with five main treatments: K-humate, calcium alginate, seaweed extract, K-humate+calcium alginate and K-humate+ seaweed extract that were applied in the fixed plots, with an area of 10.5 m^2 (3.0×3.5m) for each one, with three replicates, arranged in a complete randomized block design.

The IR (infra red) bands of the used K-humate were identified according to the standard method described by Kononova, (1966) to identify the active groups (Stevenson, 1994), as shown in Table (2a and b). It is noteworthy to mention that the active -OH and -COOH represent pronounced values, so as K-humate is considered as a best metabolic effect. In addition, Nardi *et al.,* (1999) suggested that humic fractions exhibited an auxin like activity. Some component specifications of used soluble seaweed extract are illustrated in Table (3).

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

Soil characteristics	Value	Soil characteristics	Value
Particle size distribution%:		Soluble cations (soil paste $mmole_cL^{-1}$):	
Sand	87.25	Ca^{2+}	0.82
Silt	8.90	Mg^{2+}	0.58
Clay	3.85	Na^{+}	0.95
Textural class Sandy		K^{+}	0.14
Soil chemical properties:		Soluble anions (soil paste $mmole_cL^{-1}$):	
pH (1:2.5 soil water suspension)	7.69	CO_3^{2-}	0.00
$CaCO_3$ %	1.33	HCO_3^{-}	1.40
Organic carbon %	0.21	Cl^{-}	0.71
ECe (dS/m, soil paste extract)	0.25	SO_4^{2-}	0.34
Soil physical properties:			
Bulk density g cm^{-3}	1.68	Total aggregate %	14.79
Hydrulic conductivity (cm h^{-1})	5.84	Avail. Water %	7.11
Soil moisture at wilting point %	4.98	Soil moisture at field capacity %	12.09
Available Nutrients mg kg^{-1}			

N	P	K	S	Fe	Mn	Zn
11.79	5.58	70.01	0.99	6.42	0.88	0.51

Table 2: Some chemical compositions of used K-humate properties.

a) Typical analysis.

Humic Acid	Moisture	pH (1%)	Water Solubility	Appearance
70%	15%	9-10	90%	Black granules

b) Organic, mineral components and functional groups.

C	H	O	N	S	
50 %	2 %	30 %	0.7 %	0.3 %	
Na	K_2O	Ca	Mg	Fe	Cu
0.5%	12%	0.5 %	0.05 %	1500 mg/kg	5 mg/kg
Zn	Mn	P_2O_5	Si	Mo	B
15 mg/kg	15 mg/kg	0.05%	10mg/kg	0.5 mg/kg	200 mg/kg
Al	Cr	Pb	As	Hg	Cd
0.1%	10 mg/kg	15 mg/kg	5 mg/kg	1mg/kg	1 mg/kg
Total acidity	Total carboxyl	Total hydroxyl	Total carbonyl	Phenolic hydroxyl	Alcoholic hydroxyl
588 cmol/kg	382 cmol/kg	195 cmol/kg	43 cmol/kg	126 cmol/kg	54 cmol/kg

Table 3: Some component specification of used seaweed extract.

Organic Matter	Potassium (K_2O)	Nitrogen	Water Solubility	Free amino acids	Algenic Acid
45%	10 %	1.5%	100%	20.4 ppm	15 %
pH (1%)	Mannitol	Phosphorus	Cytokinines Auxins and Gibberellins	Density	Appearance
9.0-11.0	5 %	0.8 %	600 ppm	0.633	Black liquid

All plots received nitrogen fertilizer at the rate of 40 kg fed^{-1} nitrogen as ammonium sulphate (20.6 % N), added in two equal doses (one and two months after planting). Phosphorus was added at the rate of 35 kg fed^{-1}(12.5% P_2O_5), while K was added at a rate of 40 kg fed^{-1} K_2O as potassium sulphate (48% K_2O) during the preparation of soil cultivation, taking into consideration K-amount of K-humate and seaweed extract.

Some physical, chemical and fertility properties of the investigated soil (bulk density, total porosity, hydraulic conductivity, moisture constants and nutrients retained) at maximum vegetative growth stage (90 days after sowing) were determined according to the standard methods as described by Piper, (1950); Richards, (1954); Jackson, (1973) and Page *et al.*, (1982). Available N, P and K were extracted by 1% K_2SO_4, 0.5 M solution sodium bicarbonate and 1 N ammonium acetate respectively, and were determined according to Jackson, (1973). Available micronutrients of Fe, Mn and Zn were extracted by DTPA (Lindsay and Norvell, 1978) and determined using Atomic Absorption Spectrophotometer.

Yield of peanut and its attributes (seed and Foliage yield, harvest index, weight of 100 seed, seed oil, protein and nutrient contents and uptake of N, P, K, Fe, Mn and Zn were determined.

For each plot, the chosen samples of both seeds and foliage taken at harvest were dried; ground and wet digested using H_2SO_4+$HClO_4$ acid mixture. In the digested products, N was determined with a micro-Kjeldahl (Chapman and Pratt, 1961). Phosphorus was determined colourmetrically, according to Watanab and Olsen, (1965). Potassium was determined using a Flamephotometer, according to Jackson, (1973). Iron, manganese and zinc were determined using an Atomic Absorption Spectrophotometer. Crud protein was calculated by multiplying total N-content by 6.25 (Deyoe and Shellenberger, 1965). Oil content for peanut seeds was determined according to Bligh and Dyer, (1959). All collected data were statistically analyzed according to Gomez and Gomez, (1984).

RESULTS AND DISCUSSIONS

The current work may be helpful for identifying the best soil agro-management practices of some newly reclaimed soils for maximizing their productivity, specially for soils have no partially capable to retain neither water nor nutrients for growing plants. In addition, these soils are poor not only in the nutrient-bearing minerals, but also in organic matter, which are a storehouse for the essential plant nutrients; in turn the productivity of different crops tends to decrease markedly (Moustafa *et al.,* 2005).

Effect of Applied Organic Soil Amendment on Soil Hydrophysical and Fertility Status:

The identified changes in the studied hydrophysical properties of sandy soil under consideration as related to the application of organic soil conditioners during the summer season is presented in Table (4).

Table 4: Different changes in soil hydrophysical and fertility status at the maximum vegetative growth stage of peanut plants as related to the influence of the applied organic soil conditioners.

Treatments	Soil characteristics					
	Hydrophysical					
	BD	TP	HC	FC	WP	AW
Control	1.78	40.27	16.94	12.65	4.71	7.94
K-Humate	1.71	42.51	15.19	13.15	5.21	8.75
Ca-alginate	1.58	45.16	13.92	15.41	6.14	9.26
Seaweed extract.	1.59	46.34	12.98	16.15	6.24	9.91
K-H+ Ca-alginate	1.50	50.05	10.99	19.15	7.27	11.88
K-H+ Seaweed extract	1.46	50.34	9.46	19.95	7.30	12.65
LSD at 0.05	0.20	1.01	1.25	0.92	0.88	1.85
Treatments	Nutrients status mg kg^{-1}soil					
	N	P	K	Fe	Mn	Zn
Control	16.69	5.00	64.12	5.44	0.91	0.50
K-Humate	38.36	6.31	85.01	7.91	1.45	0.77
Ca-alginate	23.97	5.77	77.92	6.71	1.18	0.61
Seaweed extract.	24.64	5.90	78.89	6.85	1.22	0.62
K-H+ Ca-alginate	47.08	7.73	102.31	10.22	1.92	0.99
K-H+ Seaweed extract	49.34	8.10	104.98	10.85	1.98	1.05
LSD at 0.05	7.00	1.22	7.32	2.01	0.23	0.34

BD= soil bulk density (g cm^{-3}), TP= Total porosity%, HC=Hydraulic conductivity (cm h^{-1}).
FC= soil moisture at field capacity%, WP= soil moisture at wilting point%.
AW=soil moisture at available range% and K-H=Potassium Humate

In general, the studied soil characteristics responded markedly to all the tested treatments under peanut cultivation during the summer season added either individually or together. Data also indicated that the individual and combined treatments showed a positive effect for improving the soil characteristics, i.e., the values of bulk density and hydraulic conductivity were decreased, whereas total porosity and retained moisture at field capacity, wilting point and available range as well as available nutrient contents (N, P, K, Fe, Mn and Zn) increased with increasing the applied organic soil conditioners.

Soil Bulk Density and Total Porosity:

The results obtained in Table (4) showed also clearly that the applied organic soil conditioners as individual or in combined treatments play a dual positive role, i.e., reducing soil bulk density vs increasing total soil porosity. Thus, the promotive effect of organic amendments on the soil porosity in the studied sandy soil may be due to the values of soil bulk density behaved the opposite trend with those obtained from total porosity. In general, this increase may be related to the increase of storage pores in the studied sandy soil and physical improvement of soil, which can be regarded as an index of an improved soil structure. Moreover, a thin coat of translocated K-humate as organic material partially covered the walls interconnected vughs (Brewer, 1964 and Amjad *et al.,* 2010), which are usually the most common pores in this soil.

Hydraulic Conductivity and Soil Moisture Constants:

The improvement or the pronounced decrease in hydraulic conductivity of the studied sandy soil may be attributed to the creation of micro pores, and the dominance of meso and micro pores on the expose other pore sizes. These results are in agreement with those of El-Fayoumy and Ramadan (2002). Concerning the magnitudes of the changes in available water range, field capacity and wilting point at different applied organic materials, data showed that, in general, the soils treated with the combined organic soil conditioners (K-humat at Ca-alginate) possess relatively high values as compared to those amended with K-humate. This due to the fact that organic substances attain a pronounced high content of active organic compounds that enhancing the water molecules to be chelated. Thus, the applied organic soil conditioners surpassed K-humate to improving the previous soil hydophysical properties. This was true, since the active -OH and -COOH represent pronounced values and have been found to be a profound effect on not only the biological activity, but also on soil structure (El-Fakharani, 1999 and Moustafa *et al.*, 2005).Also, the applied organic materials such as calcium alginate are the cross-linked networks containing a large fraction of water, which were used as the precursors of calcium carbonate ($CaCO_3$) mineralization for the first time. When calcium alginate hydrogels sponged up a relatively high amount of liquid, the resulting products with the outside calcite sequences transcribed the sponge like pregel beads with the outside nucleation sites of carboxyl groups (Anamika *et al.*, 2009). In addition, along that the alginic acid, the carbohydrates and other organic matter present in seaweeds alter the nature of soil and improve its moisture holding capacity (Thirumaran *et al.*, 2009) and Verkleij, (1999) reported that application of seaweed liquid extract enhanced the water retention capacity of soil.

Soil Fertility Status as Expressed by Nutrients Availability:

Data illustrated in Table (4) revealed that K-humate containing basically humic acid when added as individual treatment or combined with other organic soil conditioners surpassed the the other treatments for enhancing the availability of essential plant nutrients (N, P, K, Fe, Mn and Zn). This is true, since humic acid partially capable to retain nutrients for growing plants, where it would act as complexing agents (Mackowiak *et al.*, 2001). Enhanced plant growth following addition of humic substances has sometimes been related to increased micronutrient availability especially iron and zinc. There are also numerous reports of metal concentration being reduced to non- toxic levels following addition of complexion humic substances. Soil pH and organic matter content significantly affect the solubility of Fe, Mn, Zn and Cu (Prasad and Sinha, 1982). Humic acid can incorporate iron into chelate, maintaining its availability to plants, although still in insoluble form (Ramasamy *et al.*, 2006). Therefore, these chelating agents, through active groups for micronutrients, are considered as a storehouse with easily mobile or available to uptake by plant roots, and in turn reflected positively on development of yield and its attributes for the studied crops.

It is worthy to mention that the positive effect of organic soil conditioners may be due to these organic soil amendments enhanced crop production and fertilizer uptake by plants through its improvement of hydrophysical properties and thus increased soil ability to supply plants with their requirements of water and air along the growing season. On the other hand, alginic acid (as seaweed extract) acts as a soil-conditioning agent. It combines with metal radicals in the soil, forming polymers of greatly increased molecular weight. These cross-linked polymers improve the water-holding characteristics of the soil (Lattner *et al.*, 2003) which, consequently, stimulates root growth and the activities of beneficial microorganisms (Chen *et al.*, 2003).

In general, the beneficial effects of the applied organic materials on the studied different soil hydrophysical properties under peanut crop could be arranged in the following order:

K-humate+seaweed extract > K-humate+calcium alginate > seaweed extract > calcium alginate > K-humate. While, the beneficial effects of the applied organic materials on soil fertility (available nutrient contents) under cultivated crop could be arranged in the following order:

K-humate+seaweed extract > K-humate+calcium alginate > K-humate > seaweed extract > calcium alginate. Again, it may be worth to suggest that seaweed extract is a stable, non-toxic, water-soluble product which contains all major and minor plant nutrients, and all trace elements. Because of the chelating properties possessed by the starches, sugars and carbohydrates in seaweed, the trace elements do not settle out, even in alkaline soils, but remain available to plants.

Effect of the Applied Treatments on Crop Yield and Its Components:

Seed and Foliage or Straw Yield:

Results in Table (5) indicate the effect of applied individual and combined treatments (K-humate, seaweed extract, calcium alginate, K-humate+calcium alginate and K-humate +seaweed extract) on peanut seed and foliage yields. Data obtained showed marked increases in each of seed and foliage yields reached 56.43, 40.08, 43.81, 68.50 and 71.56% for seed vs 66.52, 60.14, 65.45, 77.59 and 80.97% for foliage over control treatment, respectively.

Table 5: Effect of the applied organic soil conditioners on peanut yields and its quality.

Treatments	Seed yield (kg fed^{-1})	Foliage yield (kg fed^{-1})	Weight of 100 seed (g)	Harvest Index	Protein %		Seed oil content %
					Seed	Foliage	
Control	910.2	1527.7	46.21	37.3	12.86	8.12	21.12
K-Humate	1423.9	2539.9	69.17	55.9	19.64	11.81	28.77
Ca-alginate	1275.1	2446.5	63.19	34.2	16.49	10.72	26.81
Seaweed extract	1309.0	2527.6	65.63	34.1	17.65	11.17	27.02
K-H+ Ca-alginate	1533.8	2705.3	74.51	36.1	22.13	12.89	31.44
K-H+ Seaweed extract	1561.6	2764.8	77.92	36.0	22.63	13.66	32.42
LSD at 0.05	233.0	522.3	9.29	--	1.01	0.52	1.30

K-H=Potassium Humate.

It is evident that the combined treatments showed superior increases as well as K-humate and seaweed extract as an individual treatment, followed by calcium alginate in case of peanut crop cultivated in sandy soil. It worthy to mentioned that application of K-humate in combination with both seaweed extract and calcium alginate, enhanced the role of both seaweed extract and calcium alginate as organic materials for increasing seed and foliage of peanut plants, where the treatment of K-humate+seaweed extract showed the highest yields, followed by K-humate+calcium alginate and K-humate solely added. These results could be explained according to the finding of Quaggiotti *et al*., (2004) who reported that the humic acid as K-humate is colloidal in nature with particles of different size. In the rhizosphere, an interaction between the root system and humic matter is possible when humic matter present in the soil solutions are small enough to flow into apoplast and reach the plasma membrane. Viveganandan and Jauhri (2000) found that humic acid in general is the most versatile organic compound. This is mainly due to its natural origin from soil processes, contains chemical structures which can oxidize or reduce elements, photosensitize chemical reactions and enhance or retard the uptake of toxic compounds or micronutrients to plants and microorganisms thereby greatly benefiting plant growth (Bacilio *et al.,* 2003; Nardi *et al.,* 2002 and Reza *et al.,* 2009).

***Weight of 100 Seed*:**

Data presented in table (6) indicated that the weight of 100 seed for the grown peanut was positively affected by the different applied treatments of K-humate, seaweed extract and calcium alginate as individual or combined ones (K-humate+seaweed extract and K-humate+calcium alginate). The relative increase in 100 seed weight of peanut reached 49.68, 36.74, 42.02, 59.07 and 68.62% over the control treatment, respectively. These results were true for peanut as summer crop, and confirmed as effect of the organic materials obtained by Rathore, (2009) who reported that the applications of seaweed extract could be a promising option for yield enhancement. These benefits are more related to the improvement of soil hydrophysical properties that is increased soil ability to supply plants with their requirements of water and air along the growing season (Poganiac, 1972).

Harvest Index:

Values of the harvest index of peanut, in Table (5), showed that the applied treatments of K-humate, seaweed extract and calcium alginate as individual or combined (K-humate+seaweed extract and K-humate+calcium alginate) exhibited a significantly response, with superiority for the combined one. The aforementioned applied treatments significantly increased the harvest index over the control, but with insignificant differences among them.

***Seed and Foliage Protein and Peanut Seed Oil Contents of Peanut*:**

Data of protein content as affected by the applied K-humate and organic materials as well as their combination are illustrated in Table (5). The protein content in peanut seed and foliage as affected by the applied treatments (K-humate, seaweed extract, calcium alginate, K-humate+seaweed extract and K-humate+calcium alginate) showed positive and significant increases. In general, it is obvious that the beneficial effect of K-humate, seaweed extract and K-humate+calcium alginate as combined treatments followed by K-humate as individual treatment surpassed the other tested ones (seaweed extract and calcium alginate as individual treatments). The corresponding relative increases were 52.48, 28.23, 37.24, 72.08 and 75.97% for peanut seed vs 45.44, 32.09, 37.56, 58.74 and 68.72% for foliage over the control treatment, respectively. These results were true due to indirect and direct effects on the physiological processes of plant growth. They provide minerals, increase the micro-organism population, provide biochemical substances, and carry trace elements and growth regulators (Young *et al.,* 2004 and 2006).

Regarding oil content, data in Table (5) revealed that the magnitude of the increases for the treatments of K-humate, seaweed extract, calcium alginate, K-humate+seaweed extract and K-Humate+calcium alginate were 36.22, 26.94, 27.93, 48.86 and 53.50% over the control treatment, respectively. It is evident that seed oil content as a percentage was progressively increased (48.86 - 53.50% over the control), when peanut plants were treated with K-humate-combined treatments (K-humate+calcium alginate and K-humate+seaweed extract). This may be due to the effect of humic for enhancing the biosynthesis of seed oil of peanut plants. Kok *et al.,* (2010) stated that different doses of seaweed extract represented varying effects on yield and quality; 3000 ppm seaweed extract particularly gave the best results for the yield quality and Said-Al Ahl and Hussein (2010) reported that the oil production increased significantly with K-humate application.

Nutritional Status of Peanut Plants as Affected by the Applied Treatments:

The N, P and K uptake by both seed and foliage or straw of peanut as affected by different applied organic soil amendments are shown in Table (6 and 7). It is noticed that N, P and K uptake showed significant and positive response to applied treatments; the highest increases were strictly associated with the applied K-humate in combination with seaweed extract, since N content as kg/fed raised over the control treatment in peanut seed-foliage with 3.61-3.0 times. The corresponding values of P and k were 3.7-3.9 and 4.9-2.6 times, respectively. Also, data revealed that the N, P and K uptake by peanut exhibited pronounced increases as a result of the direct effects of the applied treatments as compared to their control. These beneficial effects are more attributed to the improvements status of soil-water regime of studied sandy soil, consequently increasing nutrients availability for plants (Wanas, 1996). Moreover, Kachinsky and Mosolova, (1976) reported that the applied organic polymers contain nitrogen and potassium in their molecules, were found to be available for plant utilization. So, the applied treatments could be arranged according to their positive effects into the descending order of:

K-humate+seaweed extract > K-humate+calcium alginate > K-humate > seaweed extract > calcium alginate.

Table 6: Effect of applied organic soil conditioners on macro and micronutrient contents and their uptake by seed of peanut plants.

Treatments	Macronutrients content (%)			Micronutrients content (mg kg^{-1})			Seed dry weight (kg fed^{-1})	Macronutrients uptake (kg fed^{-1})			Micronutrients uptake (g kg^{-1})		
	N	P	K	Fe	Mn	Zn		N	P	K	Fe	Mn	Zn
Control	1.88	0.232	0.278	154.0	37.8	19.8	677.1	12.8	1.77	1.88	104.3	25.5	13.4
K-Humate	3.14	0.423	0.628	264.8	59.1	34.7	1165.3	36.6	4.93	7.32	308.8	68.87	40.44
Ca-alginate	2.64	0.304	0.590	222.8	48.6	25.6	1043.1	26.8	3.09	6.00	226.4	49.34	25.9
Seaweed extract	2.82	0.312	0.611	231.0	50.5	26.1	1173.5	32.3	3.56	6.99	264.1	57.73	29.8
K-H+ Ca-alginate	3.54	0.452	0.726	283.4	63.4	40.8	1228.9	42.4	5.41	8.69	339.2	75.82	48.8
K-H+ Seaweed extract	3.62	0.464	0.742	289.5	63.8	41.4	1278.2	46.3	5.93	9.24	370.0	81.54	52.9
LSD at 0.05	0.14	0.03	0.17	42.9	3.5	2.29	166	5.63	1.00	0.58	58.3	6.25	10.2

K-H=Potassium Humate.

As for Fe, Mn and Zn uptake by both peanut seed and foliage, data in Table (6) showed the applied K-humate stimulate seaweed extract and calcium alginate towards increasing micronutrients uptake, since progressive increases in Fe, Mn and Zn and raised over the control treatment in peanut seed-foliage with 3.5-2.8, 3.2-2.9 and 3.9-2.7 times, respectively.

The aforementioned results indicated that the applied organic amendments affect directly or indirectly nutrients uptake. This means that the applied organic soil amendments are considered as a storehouse with easily mobile or available to be taken by plant roots. Consequently, these benefits are reflected positively on development of yield.

Also, these findings indicated an important role for K-humate in improving the efficiency of nutrients uptake, and in turn increasing the quantity and quality of both peanut seed and foliage. These results are confirmed by Mackowiak, (2001) and Madlain, (2002) who reported that the beneficial effect of humic acid on dry matter yields may be attributed to improving the bio-availablity of micronutrients by complexion, which prevent early micronutrients deficiency. Application of seaweed extract induced higher yields and a better nutrient use efficiency (Rathore *et al.*, 2009 and Viqar, 2011).

Table 7: Effect of applied organic soil conditioners on macro and micronutrients and their uptake by foliage of peanut plants.

Treatments	Macronutrients content (%)			Micronutrients content (mg kg^{-1})			Foliage dry weight (kg fed^{-1})	Macronutrients content (kg fed^{-1})			Micronutrients content (g kg^{-1})		
	N	P	K	Fe	Mn	Zn		N	P	K	Fe	Mn	Zn
Control	1.19	0.121	0.879	197.1	32.0	24.8	1309.0	15.2	1.54	11.2	251.3	40.8	31.6
K-Humate	1.89	0.247	1.279	286.4	46.7	33.4	2030.7	37.4	4.89	25.3	566.6	92.4	66.0
Ca-alginate	1.72	0.229	1.151	228.9	39.9	27.5	1955.8	32.7	4.40	21.9	436.1	76.1	52.4
Seaweed extract	1.79	0.252	1.817	235.1	40.9	27.7	2021.5	35.2	4.63	23.8	462.7	80.4	54.6
K-H+ Ca-alginate	2.06	0.274	1.403	319.3	53.5	42.5	2166.2	43.5	5.78	29.6	673.7	112.8	83.6
KH+ Seaweed extra	2.19	0.280	1.422	329.6	54.8	40.1	2212.5	47.1	6.04	30.7	710.2	118.2	86.5
LSD at 0.05	0.65	0.044	0.101	22.1	2.1	1.98	169.1	1.00	0.84	1.1	88.4	11.3	3.5

K-H=Potassium Humate.

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