Effect of Mineral and Organic Nitrogen Fertilization and K-Humate Addition on Soil Properties (Orchard Field Experiment)

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Abstract: This study was carried out through two successive seasons (2008 and 2009) in a private orange orchard in Qalubia governorate, Egypt in a three years old Navel orange trees budded on sour orange rootstock on clay loam soil (Typic Torriorthents). Planting distance was 2.5 × 5.0 meters apart and flood irrigation was used by river Nile water. Two nitrogen rates were used 150 and 300 g N/tree/year in three form, 100% mineral nitrogen (M.N.) as ammonium nitrate, 100% organic nitrogen (O.N.) as compost and mixed 50% M.N.+ 50% O.N. each of these treatments with or without K-humate addition (6 kg/feddan). All fertilization treatments were divided into equal five doses added every two months from February to October during the two seasons. The obtained results showed that soil pH values increased significantly with treatments of O.N. and mixed N form. Soil saturation percent increased significantly with organic nitrogen treatments. The highest value of soil organic matter content was obtained with treatment of 300g N/tree/year in organic form and with addition of K-humate (4.7%). There is not clear role of humic acid at 6 kg/feddan on the soil organic matter content. Total soil N content recorded higher significant values with the nitrogen addition as organic form compared with mineral form. Regarding to the N rate treatments of 300 g N/tree/year gave higher significant total soil N content than of 150 g N/tree/year. The treatment of organic nitrogen form at 300 g N/tree/year with K-humate addition had highest significant soil available P and K compared with all other treatments in both seasons. In spite of the content of K-humate of K was 7%, there is no stable trend for the K-humate application for the two seasons. There were inconstant trends in soil available Ca, Mg, Fe, Mn and Zn.
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Key words: Ammonium nitrate – Compost – K-humate – Navel orange – Nonbearing trees – Soil characteristics – Soil mineral content.

1. Introduction:

The typically low natural levels of soil organic matter in arid regions such as Egyptian and Mediterranean often are lowered by inappropriate agricultural practices, which negatively affect crop yields and increase the risk of erosion and desertification in these areas (Caravaca *et al.*, 2002 and Senesi *et al.*, 2006). Nutrient availability is one of the major factors influencing the suitability of organic substrates for growing plants (Caballero *et al.*, 2007) which may depend not only on their elemental composition, but also on other factors affecting nutrient forms and dynamics such as adsorption capacity, pH, biological stability of the growing medium and presence of dissolved organic compounds. Melero *et al.* (2007) found that the total organic carbon, humic acids content, microbial biomass and enzymatic activities increased with organic fertilization, which indicate an improvement of soil fertility through organic fertilization. Also their results hold the importance of the incorporation of organic management and crop rotation to improve the quantity and quality of organic matter in dry-land and especially in Mediterranean soil, which are characterized by low organic matter content. In addition, there was an increase of quantity and activity of microbial biomass, aspect of great importance in organic matter turnover and nutrients availability in studied clay soils, which is characterized by its low mineralization rate with respect to other type of soil such as, sandy soil. Mylonas and McCants (1980) showed that the important and beneficial effects of humic substances on plant growth. Shiralipour *et al.* (1992) recorded that The organic matter content of compost is high and its addition to soil often improves soil physical and chemical properties and enhances biological activities. Most agricultural benefits from compost application are derived from improved physical properties related to increased organic matter content rather than its value as a fertilizer. Compost provide a stabilized form of organic matter that improves the physical properties of soil by increasing nutrient and water holding capacity, total pore space, aggregate stability, erosion resistance, temperature insulation and decreasing apparent soil density. Application of compost improves the chemical properties by increasing cation exchange capacity and soil nutrient content.

The above facts advert that the important of organic fertilizer applications but regret the limited availability of organic matter resources traditionally employed in agriculture, such as manure, can not satisfy the current soil requirements. A new sources are being experimented among these sources, humic acid, which is rich in organic matter (Fernandez *et al.*, 2009). Roan *et al.* (2006) recommended heavy dose of organic matter to increase the available nutrients content of soils.

The main objectives of this work were (i) to determine the effect of mineral and organic sources of N fertilizer on the soil characteristics (ii) to evaluate the effect of humic acid application and its cumulative effect with compost applications on properties of soil.

2. Materials and Methods:

This study was carried out in two successive seasons (2008 and 2009) in a private orange orchard in Qalubia governorate Egypt. Three year old Navel orange trees budded on sour orange rootstock were used. The soil was characterized by: pH = 7.55, ECe =1.66 dS/m, organic matter = 2.18%, CaCO3 =1.7%, Sand = 31%, Silt = 36% and clay = 33%, The soil texture class was clay loam (Typic Torriorthents). Flood irrigation system was used. Planting distance was 2.5×5 meters apart. Nitrogen fertilizer was added at two rates (150 and 300 g N/tree/y) as treatment of mineral type (ammonium nitrate 33.5% N), organic type (compost) and mixed (50% M.N + 50% O.N) with or without K-humate (humic acid, Power Humus, Humintech Co., Germany) addition at rate of 6 kg/feddan. Compost was characterized by: Humidity =20%, Salts = 3.0%, pH = 8.7, Organic matter = 37.5%, Intinisity = 1.2 g/cm^3, N = 1.9%, K = 2.1%, P = 0.52%, Fe = 944 mg/kg, Zn = 58 mg/kg and Mn = 473 mg/kg. K-humate was characterized by: organic matter = 87.5%, N = 0.8%, P = 0.16%, K = 7%, Zn = 20 mg/kg, Fe = 500 mg/kg and Mn = 125 mg/kg.

Treatments were as follow:

1- 100 % M.N at 150 g N/tree/y;
2- 100 % M.N at 150 g N/tree/y + K-humate;
3- 100 % M.N at 300 g N/ tree/y;
4- 100 % M.N at 300 g N/tree/y + K-humate;
5- 100 % O.N at 150 g N/tree/y;
6- 100 % O.N at 150 g N/tree/y + K-humate;
7- 100 % O.N at 300 g N/tree/y;
8- 100 % O.N at 300 g N/tree/y + K-humate;
9- 50 % M.N + 50 % O.N (at 150g N/tree/y);
10- 50 % M.N + 50 % O.N (at 150g N/tree/y) + K-humate;
11- 50 % M.N + 50 % O.N (at 300g N/tree/y);
12- 50% M.N + 50% O.N (at 300g N/tree/y) + K-humate.

All fertilization treatments were divided into equal five doses and added every two months from February to October during the two seasons. The treatments were arranged in a randomized complete block design in a factorial experiment (three factors the first is the form of nitrogen, the second is application rate and the third is with or without addition of humic acid) with five replicates for each treatment and each replicate was represented by one tree.

Soil sample were taken from rizosphere (20 cm from soil surface) at the end of both seasons, air dried and kept in plastic bags for analysis. All soil properties were determined according to Page *et al.* (1982). Soil pH was determined in 1 soil : 2.5 water suspension. Electric conductivity (EC) was determined in soil saturation extract. Organic carbon was determined by Walkley and Black method. Soil total nitrogen was determined by MicroKjeldahl method. Soil available P was extracted by Olson's method. Available K, Ca and Mg in the soil were extracted by 1 N ammonium acetate and available Fe, Mn and Zn were extracted by DTPA extractant. Nitrogen was determined by MicroKjeldahl method. Phosphorus was determined colorimetrically by spectrophotometer (Lambda 1A, Perkin Elmer, Inc., MA, USA), using the ascorbic acid method. Potassium was determined by the method of the flame photometer (JENWAY, PFP-7, ELE Instrument Co. Ltd., UK). Calcium and magnesium were determined by titration against versenate solution. Iron, zinc and manganese were estimated by using Atomic Absorption spectrophotometer (Varian Spetra AA20, Victoria, Australia). The above elements were determined according to Page *et al.* (1982).

Data obtained throughout this study were statistically analyzed using the analysis of variance method as reported by Snedecor and Cochran (1980) and the differences between means were differentiated by using Tukey's multiple range test.

3. Results and Discussion

As shown in Table (1) all factors and its interactions significantly affected soil pH in the first season. Organic N at 300g N/tree/year without K-humate then organic N at 150g N/tree/year with K-humate then organic N at 150g N/tree/year without K-humate treatments had the highest pH values (Table, 1). For the second season data in Table (2) revealed that the nitrogen form and the double interaction between nitrogen form and rate as well as between nitrogen rate and K-humate addition recorded significant effects on soil pH value. Whereas, the higher pH values were recorded with treatments of organic and mixed forms than that of mineral form. Double interaction between nitrogen form and rate showed that the higher value of soil pH was recorded with organic at 300g N/tree/year and lowest one for mineral form at 300g N/tree/year. For The interaction between nitrogen rate and humic acid addition, it is cleared that the highest pH values were recorded with 300g N/tree/year without humic acid addition.

It could be noticed that, the ranges between the values of soil pH for all treatments in the two seasons were 7.25 to 8.11. No constant trend effect for humic acid addition on pH value was recorded. The increment of pH value with organic matter treatment could be due to ammonia release during degradation of organic matter and which had alkaline effect. The increase in soil pH with compost application was recorded by Roan *et al.* (2006) and Warman *et al.* (2009).

Data of the electric conductivity of soil saturation extract (EC) for the first season was affected significantly with all treatment factors and its interaction as shown in Table (1). The highest values were recorded for mineral N at 150g N/tree/year with K-humate then mineral N at 150g N/tree/year without K-humate, mineral N at 300g N/tree/year with K-humate and mixed N at 150g N/tree/year without K-humate treatments. Data shown in Table (2) showed that soil EC values for the second season were affected significantly by nitrogen rate, humic acid addition and their double interaction. The increment of soil EC was cleared in the interaction between nitrogen rate and K humate, the highest value was recorded with 300g N/tree/year with humic acid addition. The increment of EC values could by deduced to addition of organic or mineral fertilizers. This increment didn't affect on the tree growth because the highest value not increased up to 3.1 dS/m (Table, 2), in spite of it must be taken in consideration the leaching requirements to prevent salt accumulation in rizosphere. The same results were found by Madejon *et al.* (2001). They studied the effect on chemical properties of a Xerochrept (Cambisol) soil after 2 year of compost application. A slight increase of soil salinity was observed in the compost and in the fertilizer treatments. Nevertheless, this increase did not case sodium hazard to the soil.

Soil saturation percent affected significantly by nitrogen form only where organic nitrogen form had highest value (Tables 1 and 2 for the first and second seasons, respectively). This increment could be due to addition of organic matter that had high water holding capacity. Shiralipour *et al.* (1992) recorded that the organic matter content of compost is high and its addition to soil often improves soil physical and chemical properties and enhances biological activities. Most agricultural benefits from compost application to soil are derived from improved physical properties related to increase organic matter content rather than its value as a fertilizer. Compost provide a stabilized form of organic matter that improves the physical properties of soil by increasing nutrient and water holding capacity, total pore space, aggregate stability, erosion resistance, temperature insulation and decreasing apparent soil density.

Data in Table (1) showed that the form of N and the application of K-humate and the interaction between them affected significantly on the soil organic matter content for the first season. Where, the treatments of organic N with K humate had the highest soil organic matter content as shown by Tukey's multiple range test. For the second season (Table, 2) soil organic matter content had affected significantly by nitrogen rate and form and K-humate addition and their interactions. The highest value was obtained with treatment of 300g N/tree/year in organic form and with addition of K-humate (4.7%). The other treatments either with or without K-humate addition had no significant differences on the 150g N/tree/year in organic form with K-humate addition treatment (Table, 2). This denoted that there is not a clear role of humic acid at 6 kg/feddan on the soil organic matter content. Madejon *et al.* (2001) found that soil organic matter increased in soil treated with compost when compared with control and mineral fertilizer treatments.

All main factors and the interaction between N form and the K-humate treatments affected significantly on the soil $CaCO_3$ content for the first season as shown in Table (1). Treatments of mineral N form with K-humate, organic N form without K-humate, mixed N form without and with K-humate had a higher $CaCO_3$ content than the treatments of mineral N form without K-humate and organic N form with K-humate (Table, 1). For the second season soil calcium carbonate content was affected by nitrogen form and rate as well as the interaction between nitrogen form and humic acid addition. Organic nitrogen form without humic acid addition treatments recorded the highest value of calcium carbonate. Whereas, the increment in calcium carbonate was not more than 0.26% (Table, 2). This increment may be due to the source of compost and its content of calcium carbonate.

Total nitrogen content in the soil for the first season ranged from 0.11 and 0.17% (Table, 3). It affected significantly with the N form, rates and their interaction. The highest N contents were for 300g N/tree/year as mineral, organic forms and 150g N/tree/year as organic form treatments. Analysis of variance in Table (4) showed that the total soil nitrogen content for the second season affected significantly by form and rate of nitrogen application. Multiple range analyses test revealed that, the nitrogen type addition as organic form recorded higher significant soil nitrogen content compared with mineral type. Regarding to the N rate treatments of 300g N/tree/year gave higher significant total soil N content than of 150g N/tree/year. The highest total soil nitrogen content with organic nitrogen type may be attributed to slow release and leaching of organic nitrogen than that of mineral type which easy to leach with drainage water. All treatments gave lower soil nitrogen content than optimum level as recorded by Landon (1991). The above results were in agreement with Madejon *et al.* (2001). They reported that organic fertilization increased the N content of the soil when compared with control and inorganic fertilizer treatments.

Available phosphorus content was affected significantly by all studied factors and their interaction as reveal analysis of variance for the first and second seasons (Tables 3 and 4). The treatment of organic nitrogen form at 300g N/tree/year with K-humate addition had the highest significant soil phosphorus content compared with all other treatments for the two seasons. Also it could be noticed that the treatments with organic and mixed nitrogen form for the second season (Table, 4) gave the same values from statistical stand point. They gave critical available soil phosphorus content except the treatment of 300g N/tree/year which recorded optimum level of available soil phosphorus content as recorded by Landon (1991). The increment of soil phosphorus content may be due to addition of compost. Canali *et al.* (2004) reported that compost and poultry manure increased soil potentially available nutritive elements to crops.

All factors, N form, rates and K-humate addition and their interactions affected significantly on the soil available K for the two seasons as showed in Tables (3 and 4). The highest significant soil potassium available content was recorded by treatment of 300g N/tree/year in organic form with K-humate addition for the two seasons. The availability level of soil K was optimum for all treatments as noticed by Landon (1991). In spite of the content of K-humate from K was 7%, there is no stable trend for the K-humate application for the two seasons. It may be due to the inadequate K-humate rate, where the application rate was 6 kg/feddan as commercial recommended amount.

The effects of the all treatment factors and their interaction on the soil available Ca, Mg, Fe, Mn and Zn for the two seasons were illustrated in Tables (3 and 4). There were inconstant trends in soil available Ca, Mg, Fe, Mn and Zn. It could be noticed that all treatments had optimum level on soil available Ca and Mg content. Soil available levels ranged from 593 to 724 mg/100g and 105 to 124 mg/100g for the first season and 846 to 961 mg/100g and 102 to 161 mg/100g for the second season for Ca and Mg, respectively. But the available contents of Fe, Mn and Zn were insufficient levels for all treatments. The ratio between Ca and Mg was higher than 5:1 which decrease soil phosphorus availability and the higher ratio of K to Mg than 2:1 cause decrement of Mg uptake (Landon, 1991).

Conclusion

The results showed that the higher pH values were obtained with treatments of O.N. and mixed forms than that of M.N. there is no constant trend for K- humate addition on pH values. Soil saturation percent increased significantly with organic nitrogen treatments. The highest value of soil organic matter was obtained with treatment of 300g N/tree/year in organic form and with addition of K-humate (4.7%). The other treatments either with or without K-humate addition had no significant difference include that the 150g N/tree/year as organic form with K-humate addition treatment. This denoted that there is no a clear role of humic acid at 6 kg/feddan on the soil organic matter content. Total soil N content recorded higher significant values with the nitrogen addition as organic form compared with mineral type. Regarding to the N rate treatments of 300g N/tree/year gave higher significant total soil N content than of 150g N/tree/year. The treatment of organic nitrogen form at 300g N/tree/year with K-humate addition had the highest significant soil available P and K compared with all other treatments for the two seasons. In spite of the content of K-humate from K was 7%, there is no stable trend for the K-humate application for the two seasons. There were inconstant trends in soil available Ca, Mg, Fe, Mn and Zn.

From these results we recommended that mixed source of N fertilizer (50% mineral N + 50% organic N) at 150g N/tree/year is the best N fertilizer, and the application of commercial K-humate or humic acid is not recognized for the young Navel orange trees in clay loam (Typic Torriorthents) soil.

Table 1. Analysis of variance and multiple range test of some characteristics of soil treated with different forms and rates of N and K-humate in the first season.

Source of variance		pH 1: 2.5	EC Soil paste dS/m	Saturation Percent	Organic Matter %	$CaCO_3$
Analysis of variance						
N forms		***	***	***	***	***
Rates		***	***	NS	NS	**
K-humate		***	***	NS	***	**
N forms X Rates		***	***	NS	NS	NS
N forms X K-humate		***	***	NS	***	***
Rates X K-humate		***	***	NS	NS	NS
N forms X Rates X K-humate		***	***	NS	NS	NS
Tukey's Multiple range test						
Main effect						
N Forms	Mineral	7.46C	1.63A	53.0B	2.00B	1.90B
	Organic	7.90A	1.18C	56.7A	3.03A	1.89B
	Mixed	7.73B	1.33B	53.8B	2.20B	2.11A
Rates	150g N/tree/y	7.64B	1.47A	54.5A	2.36A	2.01A
	300g N/tree/y	7.75A	1.29B	54.6A	2.46A	1.92B
K-humate	Without	7.67B	1.30B	54.6A	2.07B	2.01A
	With	7.73A	1.46A	54.4A	2.75A	1.92B
N forms X Rates						
Mineral X 150		7.30F	1.85A	53.1A	2.00A	1.96A
Mineral X 300		7.63E	1.41B	52.8A	2.01A	1.83A
Organic X 150		7.93A	1.21CD	56.5A	2.96A	1.91A
Organic X 300		7.87B	1.15D	57.0A	3.10A	1.86A
Mixed X 150		7.70D	1.35B	54.0A	2.11A	2.15A
Mixed X 300		7.77C	1.31BC	53.6A	2.28A	2.08A
N forms X K-humate						
Mineral X Without		7.44E	1.40B	52.8A	1.85B	1.85BC
Mineral X With		7.48D	1.86A	53.1A	2.16B	1.95AB
Organic X Without		7.95A	1.10D	57.0A	2.30B	2.06A
Organic X With		7.85B	1.26C	56.5A	3.76A	1.71C
Mixed X Without		7.62C	1.41B	54.0A	2.08B	2.11A
Mixed X With		7.85B	1.25C	53.6A	2.31B	2.11A
Rates X K-humate						
150 X without		7.55C	1.46A	54.6A	2.01A	2.04A
150 X with		7.73B	1.48A	54.4A	2.71A	1.97A
300 X Without		7.79A	1.15B	54.5A	2.14A	1.97A
300 X With		7.72B	1.43A	54.4A	2.78A	1.87A
N forms X Rates X K-humate						
Mineral X 150 X without		7.25I	1.60B	53.0A	1.83A	1.86A
Mineral X 150 X with		7.35H	2.10A	53.3A	2.16A	2.06A
Mineral X 300 X Without		7.64F	1.20CD	52.6A	1.86A	1.83A
Mineral X 300 X With		7.62F	1.63B	53.0A	2.16A	1.83A
Organic X 150 X without		7.91C	1.20CD	57.0A	2.30A	2.10A
Organic X 150 X with		7.95B	1.23CD	56.0A	3.63A	1.73A
Organic X 300 X Without		7.99A	1.00E	57.1A	2.30A	2.03A
Organic X 300 X With		7.76E	1.30C	57.3A	3.90A	1.70A
Mixed X 150 X without		7.49G	1.56B	54.2A	1.90A	2.16A
Mixed X 150 X with		7.91C	1.13DE	54.0A	2.33A	2.13A
Mixed X 300 X Without		7.74E	1.26CD	54.1A	2.26A	2.06A
Mixed X 300 X With		7.79D	1.36C	53.3A	2.30A	2.10A

*, ** and *** significant effect at $P < 0.05$, 0.01 and 0.001, respectively, NS = not significant.*

The same streaks within factors are not different but a value A > B > C …etc at 5% level.

Table 2. Analysis of variance and multiple range test of some characteristics of soil treated with different forms and rates of N and K-humate in the second season.

Source of variance		pH 1: 2.5	EC Soil paste dS/m	Saturation percent	Organic matter %	$CaCO_3$
			Analysis of variance			
N forms		***	NS	***	***	NS
Rates		NS	*	NS	**	*
K-humate		NS	***	NS	**	***
N forms X Rates		***	NS	NS	**	NS
N forms X K-humate		*	NS	NS	*	***
Rates X K-humate		***	***	NS	*	NS
N forms X Rates X K-humate		NS	NS	NS	***	NS
			Tukey's Multiple range test			
Main effect						
N Forms	Mineral	7.85B	1.6A	52.83B	2.08C	1.91A
	Organic	7.97A	1.8A	57.83A	3.26A	1.93A
	Mixed	7.96A	1.5A	54.00B	2.55B	1.84A
Rates	150g N/tree/y	7.94A	1.4B	55.27A	2.44B	1.92A
	300g N/tree/y	7.91A	1.8A	54.50A	2.82A	1.86B
K-humate	Without	7.94A	1.3B	55.38A	2.45B	1.94A
	With	7.91A	1.9A	54.38A	2.81A	1.84B
N forms X Rates						
Mineral X 150		7.92B	1.5A	53.66A	2.10B	1.90A
Mineral X 300		7.77C	1.6A	52.00A	2.07B	1.91A
Organic X 150		7.90B	1.5A	58.16A	2.78B	1.98A
Organic X 300		8.05A	2.1A	57.50A	3.74A	1.88A
Mixed X 150		7.99AB	1.3A	54.00A	2.44B	1.88A
Mixed X 300		7.92B	1.7A	54.00A	2.66B	1.80A
N forms X K-humate						
Mineral X Without		7.90AB	1.1A	53.16A	2.07C	1.91B
Mineral X With		7.79B	2.0A	52.50A	2.10C	1.90B
Organic X Without		7.99A	1.4A	59.00A	2.82B	2.06A
Organic X With		7.95A	2.2A	56.66A	3.71A	1.80B
Mixed X Without		7.93A	1.5A	54.00A	2.47BC	1.85B
Mixed X With		7.98A	1.5A	54.00A	2.62BC	1.83B
Rates X K-humate						
150 X without		7.89BC	1.5B	55.77A	2.43B	1.97A
150 X with		7.98AB	1.4B	54.77A	2.45B	1.86A
300 X Without		8.00A	1.1B	55.00A	2.48B	1.91A
300 X With		7.83C	2.4A	54.00A	3.17A	1.82A
N forms X Rates X K-humate						
Mineral X 150 X without		7.90A	1.3A	54.33A	2.07B	1.90A
Mineral X 150 X with		7.95A	1.8A	53.00A	2.14B	1.90A
Mineral X 300 X Without		7.92A	1.0A	52.00A	2.07B	1.93A
Mineral X 300 X With		7.63A	2.2A	52.00A	2.07B	1.90A
Organic X 150 X without		7.88A	1.7A	59.00A	2.92B	2.13A
Organic X 150 X with		7.92A	1.3A	57.33A	2.65B	1.83A
Organic X 300 X Without		8.11A	1.1A	59.00A	2.72B	2.00A
Organic X 300 X With		7.99A	3.1A	56.00A	4.77A	1.76A
Mixed X 150 X without		7.90A	1.6A	54.00A	2.30B	1.90A
Mixed X 150 X with		8.09A	1.1A	54.00A	2.57B	1.86A
Mixed X 300 X Without		7.97A	1.4A	54.00A	2.65B	1.80A
Mixed X 300 X With		7.88A	2.0A	54.00A	2.67B	1.80A

*, ** and *** significant effect at $P < 0.05$, 0.01 and 0.001, respectively, NS = not significant.*

The same streaks within factors are not different but a value A > B > C …etc at 5% level.

Table 3. Analysis of variance and multiple range test of total N and some available macro and micronutrient contents in soil treated with different forms and rates of N and K-humate in the first season.

Source of variance		Macronutrients					Micronutrients		
		%	mg/kg		mg/100g		mg/kg		
		N	P	K	Ca	Mg	Fe	Mn	Zn
Analysis of variance									
N forms		***	***	***	***	***	***	*	***
Rates		***	***	***	***	***	*	NS	NS
K-humate		NS	***	***	***	***	NS	***	***
N forms X Rates		***	***	***	***	***	***	***	***
N forms X K-humate		NS	***	***	***	***	***	***	**
Rates X K-humate		NS	***	***	***	***	***	***	**
N forms X Rates X K-humate		NS	***	***	***	***	***	***	***
Tukey's Multiple range test									
Main effect									
N Forms	Mineral	0.14B	7.1B	258C	674A	117B	2.9A	1.7A	0.5B
	Organic	0.16A	16.7A	435A	626B	124A	2.5B	1.6AB	0.9A
	Mixed	0.13C	7.9B	296B	620C	125A	3.0A	1.5B	0.6B
Rates	150 g/tree/y	0.14B	8.3B	338A	631B	121B	2.7B	1.6A	0.7A
	300 g/tree/y	0.15A	12.8A	321B	649A	123A	2.8A	1.6A	0.7A
K-humate	Without	0.14A	9.3B	276B	636B	125A	2.8A	1.5B	0.6B
	With	0.14A	11.8A	383A	645A	119B	2.8A	1.7A	0.8A
N forms X Rates									
Mineral X 150		0.12B	5.6D	271D	662C	119C	2.6C	1.4D	0.6C
Mineral X 300		0.17A	8.5C	244E	687A	114D	3.2A	1.8A	0.5C
Organic X 150		0.16A	12.5B	426B	625C	121BC	2.5C	1.7AB	0.8B
Organic X 300		0.17A	21.0A	445A	627C	128A	2.5C	1.5CD	1.0A
Mixed X 150		0.13B	6.8D	317C	607D	122B	3.2A	1.6BC	0.7BC
Mixed X 300		0.12B	9.0C	275D	633B	128A	2.8B	1.4D	0.6C
N forms X K-humate									
Mineral X Without		0.15A	7.5D	249E	688A	118C	3.1AB	1.4C	0.5C
Mineral X With		0.14A	6.7D	266D	661B	115D	2.7C	1.8A	0.5C
Organic X Without		0.16A	11.0B	282C	616D	128A	2.5D	1.5BC	0.8B
Organic X With		0.17A	22.5A	589A	636C	121B	2.5D	1.6B	1.1A
Mixed X Without		0.12A	9.5C	297B	603E	129A	2.9BC	1.5BC	0.5C
Mixed X With		0.13A	6.2D	295B	638C	121B	3.1A	1.5BC	0.7B
Rates X K-humate									
150 X without		0.14A	8.7C	269D	625D	131A	3.1A	1.6B	0.5C
150 X with		0.14A	7.9C	407A	638C	111D	2.4B	1.6B	0.8A
300 X Without		0.15A	9.9B	283C	647B	119C	2.5B	1.4C	0.7B
300 X With		0.15A	15.7A	360B	652A	127B	3.1A	1.7A	0.7B
N forms X Rates X K-humate									
Mineral X 150 X without		0.13A	6.1CH	252DE	652C	132B	2.8B	1.4CD	0.5DE
Mineral X 150 X with		0.11A	5.1H	291C	672B	107F	2.4C	1.5CD	0.6CDE
Mineral X 300 X Without		0.17A	8.8DEF	247E	724A	105FG	3.4A	1.5CD	0.5DE
Mineral X 300 X With		0.17A	8.2EFG	242E	650C	124C	3.1A	2.2A	0.5DE
Organic X 150 X without		0.16A	12.0BC	263D	609G	142A	3.2A	1.6BC	0.7BCD
Organic X 150 X with		0.17A	13.0B	590A	641D	101G	1.8D	1.8B	0.9B
Organic X 300 X Without		0.17A	10.0CDE	301C	623F	114E	1.8D	1.5CD	0.8BC
Organic X 300 X With		0.17A	32.0A	589A	632E	142A	3.2A	1.3D	1.2A
Mixed X 150 X without		0.13A	8.1EFG	293C	613G	119D	3.3A	1.5CD	0.4E
Mixed X 150 X with		0.13A	5.5H	341B	602H	125C	3.1A	1.5CD	0.9B
Mixed X 300 X Without		0.12A	11.0BCD	301C	593I	140A	2.5C	1.3D	0.6CDE
Mixed X 300 X With		0.13A	7.0FGH	249E	674B	117DE	3.1A	1.5CD	0.6CDE

*, ** and *** significant effect at $P < 0.05$, 0.01 and 0.001, respectively, NS = not significant.*
The same streaks within factors are not different but a value A > B > C …etc at 5% level.

Table 4. Analysis of variance and multiple range test of total N and some available macro and micronutrient contents in soil treated with different forms and rates of N and K-humate in the second season.

Source of variance		Macronutrients					Micronutrients		
		%	mg/kg		mg/100g		mg/kg		
		N	P	K	Ca	Mg	Fe	Mn	Zn
Analysis of variance									
N forms		-***	***	***	***	***	**	**	***
Rates		**	***	***	NS	NS	NS	NS	***
K-humate		NS	***	*	NS	NS	NS	NS	***
N forms X Rates		NS	**	**	**	***	**	***	***
N forms X K-humate		NS	***	***	***	NS	NS	**	***
Rates X K-humate		NS	*	*	**	**	NS	NS	***
N forms X Rates X K-humate		NS	***	***	***	*	NS	NS	***
Tukey's Multiple range test									
Main effect									
N Forms	Mineral	0.16B	3.8B	331B	880B	143A	3.4AB	1.1B	0.6C
	Organic	0.20A	17.9A	746A	894B	123B	4.2A	1.2A	1.1A
	Mixed	0.19A B	10.2B	609B	937A	131B	2.9B	1.1B	0.8B
Rates	150 g/tree/y	0.17B	8.1B	427B	905A	130A	3.6A	1.2A	0.9A
	300 g/tree/y	0.20A	13.1A	697A	902A	135A	3.4A	1.1A	0.8B
K-humate	Without	0.18B	8.6B	499B	902A	136A	3.5A	1.1A	0.7B
	With	0.19B	12.6A	624A	906A	129A	3.5A	1.2A	0.9A
N forms X Rates									
Mineral X 150		0.16A	3.5D	309C	896BC	154A	4.0AB	1.3A	0.6DE
Mineral X 300		0.16A	4.1D	353C	864C	133B	2.8B	0.9B	0.5E
Organic X 150		0.18A	13.2B	490C	901BC	114C	3.7AB	1.2A	1.4A
Organic X 300		0.23A	22.5A	1002A	888BC	132BC	4.6A	1.2A	0.8BC
Mixed X 150		0.17A	7.6CD	483C	920AB	123BC	3.1B	0.9B	0.7CD
Mixed X 300		0.20A	12.8BC	735B	955A	140AB	2.7B	1.1AB	0.9B
N forms X K-humate									
Mineral X Without		0.17A	3.7C	335C	860D	151A	3.5A	1.2AB	0.6D
Mineral X With		0.16A	3.8C	327C	900BC	136AB	3.2A	1.1B	0.5D
Organic X Without		0.19A	12.1B	480BC	920AB	125B	3.8A	1.1B	0.9B
Organic X With		0.22A	23.6A	1011A	869CD	121B	4.5A	1.3A	1.4A
Mixed X Without		0.19A	10.0B	683B	926AB	132B	3.1A	1.1B	0.7C
Mixed X With		0.19A	10.4B	535BC	949A	131B	2.7A	1.1B	0.9B
Rates X K-humate									
150 X without		0.17A	7.4B	422B	916A	139A	3.7A	1.2A	0.8B
150 X with		0.17A	8.8B	432B	895AB	122B	3.5A	1.2A	1.1A
300 X Without		0.18A	9.8B	577B	888B	133AB	3.2A	1.1A	0.7B
300 X With		0.21A	16.4A	817A	917A	137A	3.5A	1.2A	0.8B
N forms X Rates X K-humate									
Mineral X 150 X without		0.17A	3.3D	289C	874CD	161A	4.3A	1.3A	0.7CDE
Mineral X 150 X with		0.15A	3.8D	329C	918ABC	148AB	3.8A	1.2A	0.5EF
Mineral X 300 X Without		0.16A	4.2CD	382C	846D	142ABC	2.8A	1.0A	0.4F
Mineral X 300 X With		0.16A	3.9D	325C	883BCD	124BCD	2.7A	0.9A	0.5EF
Organic X 150 X without		0.18A	12.8BC	516BC	961A	127BCD	3.5A	1.1A	0.9BC
Organic X 150 X with		0.18A	13.7B	464C	841D	102D	3.8A	1.3A	1.9A
Organic X 300 X Without		0.19A	11.5BCD	445C	880BCD	123BCD	4.1A	1.1A	0.9BC
Organic X 300 X With		0.26A	33.6A	1559A	897BCD	141ABC	5.1A	1.4A	0.8BCD
Mixed X 150 X without		0.17A	6.3BCD	463C	914ABC	129BCD	3.4A	1.0A	0.6DEF
Mixed X 150 X with		0.18A	8.9BCD	504BC	926ABC	117CD	2.7A	0.9A	0.8BCD
Mixed X 300 X Without		0.20A	13.8B	903B	938AB	135ABC	2.7A	1.1A	0.8BCD
Mixed X 300 X With		0.20A	11.9BCD	567BC	972A	145ABC	2.7A	1.2A	1.0B

*, ** and *** significant effect at $P < 0.05$, 0.01 and 0.001, respectively, NS = not significant.*
The same streaks within factors are not different but a value A > B > C …etc at 5% level.

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References:

Caballero, R.; J. Ordovas; P. Pajuelo; E. Carmona and A. Delgado, 2007. Iron chlorosis in gerber as related to properties of various types of compost used as growing media, Commune. Soil Sci. plant Anal., 38: 2357-2369.

Canali, S.; A. Trinchera; F. Intrigliolo; L. Pompili; L. Nisini; S. Mocali and B. Torrisi, 2004. Effect of long term addition of composts and poultry manure on soil quality of citrus orchards in Southern Italy. Biology and Fertility of Soils, 40 (3): 206-210.

Caravaca, F.; G. Masciandaro and B. Ceccanti, 2002. Land use in relation to soil chemical and biochemical properties in a semiarid Mediterranean environment. Soil Till., Res. 68: 23-30.

Fernandez, J.M.; N. Senesi; C. Plaza; G. Brunetti and A. Polo, 2009. Effects of composted and thermally dried sewage sludge on soil and soil humic acid properties. Pedosphere, 19(3): 281-291.

Landon, J.R. 1991. Booker Tropical Soil Manual. pp. 106-156. Booker agriculture international limited Longman. Inc., New York, U.S.A.

Madejon, E.; R. Lopez; J. Murillo and F. Cabrera, 2001. Agricultural use of three (sugar-beet) vinasse composts: effect on crops and chemical proportes of a Cambisol soil in the Guadalquivir river vally (SW Spain). Ecosystems and Environment, 84: 55-65.

Melero, S.; E. Madejon; J. Ruiz and J. Herencia, 2007. Chemical and biochemical properties of a clay soil under dry land agriculture system as affected by organic fertilization. European Journal of Agronomy, 26(3): 327-334.

Mylonas, V.A. and C.B. McCants, 1980. Effect of humic and fulvic acids on growth of tobacco. I. Root initiation and elongation. Plant and soil, 54: 485-490.

Page, A.R.; R.H. Miller and J. Keeney, 1982. Methods of Soil Analysis, Part 2, 2nd ed. Amer. Soc. Agron. Inc. Soil. Sci. Soc. Amer. Inc.

Roan, S.; W. Nee and S. Cheng, 2006. Effects of organic fertilizer dosage and sod culture on soil reaction, organic matter and available nutrients content of a 'Tankan' (*Citrus Tankan*) orchard. Acta Horticulturae, 773: xx-xx.

Senesi, N.; C. Plaza; G. Brunetti and A. Polo, 2006. A comparative survey of recent result on humic-like fractions in organic amendment and effects on native soil humic substances. Soil Biol. Biochem., 39(6): 1244-1262.

Shiralipour, A.; D. McConnell and W. Smith, 1992. Physical and chemical properties of soils as affected by municipal solid waste compost application. Biomass and Bioenergy, 3: 261-266.

Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods. 7th ed. 507-529 pp. Iowa State Univ. Press, Ames . Iowa , U.S.A.

Warman, P.R.; J.C. Burham and L.J. Eaton, 2009. Effects of repeated application of municipal solid waste compost and fertilizers to three lowbush blueberry fields. Scienta Horticulturae, 122: 393-398.

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