J. Agric. Sci. Mansoura Univ., 25 (6): 3541 - 3558, 2000.

EFFECT OF ORGANIC MANURES IN COMBINATION WITH ELEMENTAL SULPHUR ON SOIL PHYSICAL AND CHEMICAL CHARACTERISTICS, YIELD, FRUIT QUALITY, LEAF WATER CONTENTS AND NUTRITIONAL STATUS OF FLAME SEEDLESS GRAPEVINES

I- SOIL PHYSICAL AND CHEMICAL CHARACTERISTICS

Abdel-Nasser* , G. and M. M. Harhash**

*** Soil and Agricultural Chemistry Dept.**

**** Plant Production (Pomology) Dept. Faculty of Agriculture (Saba Bacha) -Alexandria University**

ABSTRACT

The present study was carried out during 1998 and 1999 growing seasons of Flame seedless grapevines in the orchard of Experiment Station, Faculty of Agriculture, Saba Bacha, Alexandria University .The aim of the present study was to investigate the combined effects of elemental sulphur and organic manures on physical and chemical characteristics of experimental soil. The experimental Soil has a clay texture. All vines received the same N requirements (60 kg N/fed.), as recommended, but with replacement of one third and two third of the N requirements by organic manures namely Town refuse (TR1 and TR2), Farmyard manure (FYM1 and FYM2) and Bio Treasure (BT1 amd BT2) according to their N content. Two rates of elemental sulphur (S) were applied i.e., zero and 250 g sulphur/vine. All vines were received the same recommended practices. The obtained results revealed that application of organic manures significantly decreases the soil bulk density and medium pores, but increased the total porosity, large and small pores. The same trends were noticed with Sulphur application but without a significant effect. Organic manures significantly increased the soil moisture contents at 0.0, 0.33 and 15.0 bars, but sulphur application has not a significant effect. Mean weight diameter (MWD), optimum size of particles (OP) and Basic infiltration rate or field saturation conductivity were found to be significantly increased as a result of both sulphur and organic ;manures applications. The data indicated that both TR and FYM were more effective than BT in improving soil physical characteristics without significant differences in both seasons. The results also showed that available soil nutrients i.e. N, P, K, Fe, Mn, Cu and Zn were found to be significantly increased due to both sulphur and organic manure applications. Also, the data revealed that both TR and FYM produced more available N than BT as indicated by Apparent Net N Release (ANNR). Both soil organic matter content (OM) and electrical conductivity (EC) were found to be increased, while the soil pH and exchangeable sodium percentage (ESP) decreased as a results of organic manure applications. Sulphur application has a significant effect in decreasing both of soil pH and ESP in both seasons. A general, the; most outcome of the present study is clarifying the important role of organic manures such as Farmyard manure and Town refuse in modifying the soil physical and chemical behaviors that enhancing the plant production (growth, yield and fruit quality) that will be illustrated in the part II of this study.

INTRODUCTION

In Egypt, the grapevines (*Vitis vinifera*, L.) are one of the most important fruit crops mainly consumed as fresh grape. Grapevines are growing under different environmental conditions and soil types. One of the important tools in increasing crop yield is fertilization, especially nitrogenous fertilization. The role of nitrogen in crop production has been a major concern of agronomists, but the efficiency of fertilizer nitrogen practically under field condition and surface irrigated fields rarely exceeds 50% and is usually only 30-40% (Englestad and Russel, 1975 and Sahrawat, 1979), such low efficiency may be due to losses of N from soil by leaching of nitrate and nitrite, or reduction of nitrate resulting in the formation of nitrogen gas that loss by volatilization (Goring, 1962). Leaching of NO^{-}_{3} and downward movement below the rooting zone with flowing water causes many problems such as nitrate pollution of ground water and growing crops (Gambrell *et al.*, 1975). One of the practical solutions of N pollution is organic farming or eco-agriculture (USDA, 1980 and Blake, 1990). The organic farming was applied after increasing the objections against the present or chemical agriculture as a main source of soil and water pollution as well as food products.

Using organic manures could improve soil porosity, infiltration rate and soil water retention (Sabrah, 1993; Asker *et al.* 1994; Abdel-Sabour *et al.*, 1997; El-Sersawy, 1997 and 1998; and Nassar, 1998).

Organic manures, also considered as a source of essential nutrients for plant growth (Yagodin, 1984). Also, sulphur as a major element is needed in relatively large amounts for optimal plant growth and important metabolic functions. It was used for many years in reclamation and improvement of sodic soils (Stromberg and Tisdale, 1979). Sulphur is oxidized by soil microorganisms to sulfuric acid, which in turn lowers soil pH and improves the availability of most soil nutrients (Hassan and Olsen, 1966).

Many investigators reported the importance of sulphur for increasing growth and yield of fruit trees (Cummings *et al.*, 1981; Peterson *et al.*, 1987; Abo-Rady *et al.*, 1988; Hening *et al.*, 1991 and Kassem *et al.*, 1995).

The present study was carried out to clarify the combined effects of elemental sulphur and organic manures as a source of N requirements on: 1) soil physical and chemical properties and 2) growth, yield, fruit quality and nutrients status of Flame seedless grapevines grown on sodic clay soil (part II).

MATERIALS AND METHODS

The present study was carried out during two successive growing seasons, 1998 and 1999 in the orchard of Experimental Station, Faculty of Agriculture (Saba Bacha), Alexandria University. The aim of the present part of study was to investigate the combined effects of elemental sulphur and organic manures on soil physical and chemical characteristics. The 8 years old Flame seedless grapevines (*Vitis vinifer*a, L.) grown in a clay soil, planted at 2 x 3 m apart and spur-pruned at about 48 buds each season (double cordon, 16 spurs, 3 buds each). Some physical and chemical characteristic of experimental site were determined at the beginning of each season according to the methods outlined in Carter (1993) and presented in Table (1). Seventy grapevines, as uniform as possible were selected for the present study. Two rates of elemental sulphur were used i.e., zero and 250 g/vine. Three types of organic manures were used i.e. Town refuse (TR), Farmyard manure (FYM) and Bio Treasure (BT).

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

Parameters	Soil depth, cm	
	0-30	30-60
Particle-size distribution, %		
Sand	27.0	26.5
Silt	31.8	33.0
Clay	41.1	40.5
Textural class	Clay	Clay
Bulk density, Mg/m^3	1.28	1.27
Saturation water content, m^3/m^3	0.52	0.52
Field capacity, m^3/m^3	0.37	0.37
Permanent wilting point, m^3/m^3	0.23	0.23
Available water, m^3/m^3	0.14	0.14
saturated hydraulic conductivity, cm/hr	0.22	0.22
Organic matter, %	1.92	1.87
$CaCO_3$, %	6.61	6.84
Cation Exchange Capacity, cmol(+)/kg	42.7	41.8
Exchangeable Cations, %		
Ca	25.3	24.7
Mg	37.8	39.9
Na	32.1	30.8
K	4.8	4.6
pH (1 : 1 soil : water suspension)	8.3	8.2
Electrical conductivity (EC), dS/m (1:1 soil : water extract)	2.62	2.35
Soluble Cations, meq/100 g soil		
Ca	0.63	0.60
Mg	0.50	0.52
Na	1.38	1.15
K	0.06	0.07
Soluble Anions, meq/100 g soil		
$CO_3 + HCO_3$	0.60	0.55
Cl	1.60	1.29
SO_4	0.38	0.40
Available Nutrients, mg/kg		
N	365	389
P	25	27
K	480	462
Fe	5.2	4.8
Mn	3.8	4.2
Cu	1.1	1.2
Zn	2.1	2.5

All vines received the same N requirements i.e. 60 kg N/fed., but with replacement of one third (TR1, FYM1 and BT1) or two third (TR2, FYM2 and BT2) of the N requirements by organic manures previously mentioned according to their content of N. Table (2) shows some characteristics of organic manures used in the present study and Table (3) shows the experimental treatments. The amount of N requirements was added at three equal doses at 1st of March, April and May in both seasons. All vines received the organic manures at December of 1997 and 1998. In the same time, all vines received their requirements of phosphorus with organic manure. A 20 Kg P/fed was applied in the form of calcium super-phosphate (6.67% P). Potassium sulfate (38.9% K) was added to all vines at rate of 70 kg K/fed. at two equal doses in April and June for both seasons.

All fertilizers and organic manures were mixed with the 30-cm surface layer of soil under the foliage of vines, about 0.5 m around the vine trunk. The control treatment was fertilized with 60 kg N/fed in the form of ammonium nitrate (33.5% N).

The experiment was arranged in split-plot technique in randomized complete block design. The sulphur application was assigned to the main plot and organic manures were devoted to the subplots. Each treatment was replicated 5 times, one vine for each.

Table (2): Some physical and chemical characteristics of the organic manures used in the present experiment.

Parameter	Town refuse (TR)	Farmyard manure (FYM)	Bio Treasure (BT)
Fraction fineness , %			
> 2 mm	27.13	38.23	1.65
2-1	37.54	30.66	27.75
1-0.5	15.41	11.13	25.58
0.5-0.25	12.13	10.99	27.25
0.25-0.1	6.81	7.79	16.30
0.1-0.05	0.29	0.09	0.64
< 0.05	0.69	1.11	0.83
Bulk density, Mg/m^3	0.47	0.61	0.30
Moisture content, %	17.00	8.80	14.00
Organic carbon, %	30.10	23.60	20.35
Total nitrogen, %	1.49	1.98	1.10
C/N ratio	20.20	11.92	18.50
Organic matter, %	51.89	40.69	35.10
EC, dS/m (1 : 10)	10.05	6.90	5.00
PH (1 : 10)	7.70	7.00	6.50
Total Macro-nutrients , %			
P	0.45	0.9	1.05
K	0.76	1.34	1.7
Ca	0.76	1.9	2.2
Mg	0.11	0.9	2.2
Total Micro-nutrients , mg/Kg soil			
Fe	995	2190	830
Mn	203	454	382
Cu	249	95	60
Zn	267	88	77

Table (3): Experimental treatments of organic manures used in the present study.

Treatment	Description	Rate of organic manure kg/vine
Check	60 kg N-mineral/fed.	-
Town refuse (TR1)	40 kg N-mineral/fed. + 20 kg N-organic/fed.	2.0
Town refuse (TR2)	20 kg N-mineral/fed. + 40 kg N-organic/fed.	4.0
Farmyard manure (FYM1)	40 kg N-mineral/fed. + 20 kg N-organic/fed.	1.5
Farmyard manure (FYM2)	20 kg N-mineral/fed. + 40 kg N-organic/fed.	3.0
Bio Treasure (BT1)	40 kg N-mineral/fed. + 20 kg N-organic/fed.	3.0
Bio Treasure (BT2)	20 kg N-mineral/fed. + 40 kg N-organic/fed.	6.0

At the end of both experimental seasons after harvesting, the undisturbed and disturbed soil samples were collected from 30-cm soil surface layer for physical and chemical soil characterization. Physical properties including bulk density (BD), total porosity (TP), soil water relations (such as field capacity (FC), permanent wilting point (PWP) and available water capacity (AW) were determined according to the methods outlined in Klute (1986). The pore-size distribution (PSD) as percentage of total porosity was calculated and differentiated to large, medium and small pores as recommended by Richards (1972), Kohnke (1982) and Klute (1986). The basic infiltration rate was determined with single-ring infiltrometer according to Elrick *et al.* (1995). Mean weight diameter (MWD) was determined according to the method described in Carter (1993). Chemical soil properties including soil pH, total soluble salts (EC) and available soil nutrient (N, P, K, Fe, Mn, Cu and Zn) were determined as illustrated by Carter (1993). All collected data were subjected to statistical analysis according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

I- Soil physical characteristics.

1. Bulk density (BD)

Data presented in Table (4 and 5) illustrate the effects of sulphur application and organic manures in reducing BD. It has been noticed that sulphur application led to slight decrease in the BD and consequently increases total porosity (TP) at the end of the growing seasons. The reduction in BD may be attributed to the exchangeable Ca^{+2} ions produced from the solubility of $CaCO_3$ presented in soil, resulted from sulphur oxidation (McLean, 1971). The exchangeable Ca^{2+} enhanced the formation of large soil aggregates and increasing the solid volume (Abo-Soliman *et al.*, 1992).

4

5

Regarding to the effect of organic manures, the data clearly indicated that soil BD values were declined. Such reduction in soil BD may be due to the homogenous distribution of the manure constituents between soil particles, and also the decomposition activity, which produces many essential cementing materials that link soil particles and forming soil aggregates. The high rates of TR and FYM caused high reduction effect on BD (Stewart *et al*, 1998). It is account as 5.38 and 4.61% as compared with the check treatment (mineral-N only), respectively. The related values for the second season were 5.3 and 6.15%, respectively

As general, application of organic manures plus mineral N significantly decreased the soil BD and consequently increased total porosity in which led to improve the water movement in soil profile. Similar results were obtained by Ahmed (1981), Pagliai *et al.* (1981), Mostafa (1986) and El-Sersawy (1997 and 1998).

2. Total porosity (TP)

Tables (4 and 5) clearly indicate the importance of sulphur and organic manures in altering the total pore space and pore-size distribution (PSD) as compared with check treatment.

Sulphur application led to slight increase in total porosity (TP) by about 1.50 and 1.76% for both seasons, respectively.

Organic manures significantly increased TP, the highest values were attained with TR and FYM at highest rates. Such increases were 5.1 and 4.31%, respectively for the first season. The corresponding values for the second season were 4.72 and 5.91%, respectively. Organic materials, such as TR, FYM and BT were able to modify the soil porosity (Pagliai *et al.*, 1981).

3. Pore-size distribution (PSD)

Regarding the effect of sulphur and organic manures on PSD, the data presented in Tables (4 and 5) showed different trends. Sulphur application has a slight effect in modifying the PSD. Large pores increased by about 9.52 and 7.51%, respectively for both seasons. Medium pores were decreased by about 6.45 and 5.23%, respectively for both seasons. Fine pores were found to be increased due to sulphur application. Such pores were account as 3.34 and 2.68%, for both seasons, respectively.

Regarding the effect of organic manures, on PSD, Large pores > 60 µm (aeration porosity) were significantly increased in both seasons. The increasing percent in such macro (large) pores over the check treatment were 150.0, 229.2, 345.8, 427.1, 164.6 and 235.4% for TR1, TR2, FYM1, FYM2, BT1 and BT2, respectively in the first season. The corresponding values for the second season were 137.3, 193.2, 177.9, 220.3, 94.9 and 115.3%, respectively. This improvement in large pores is considered of great importance for air exchange and reducing water losses through evaporation and their reflection on plant growth (Kohnke ,1982 and Russell, 1989).

As regard to the medium pores (60-10 µm), the data revealed that organic manures significantly decreased such pore type by about 17.3, 26.0, 38.8, 49.3, 16.1 and 22.9%, respectively in the first season, while the reduction in the second season were 23.9, 36.9, 37.9, 55.4, 11.9 and 15.8%, respectively. This reduction may be attributed to migration of fine fraction during wetting soil causing a partially clogging of such pores.

The third class of pores is small pores (< 10 µm), which mainly responsible for soil moisture retention. The data clearly indicated a pronounced increasing in their values by about 6.0, 8.5, 12.3, 17.1, 2.5 and 3.5%, respectively in the first season, while the increasing were 13.1, 23.1, 26.7, 45.2, 2.6 and 4.9%, respectively in the second season. The superiority of increase was found with large pores compared with the other pore classes. Also, FYM was superior in increasing of both followed by TR. The higher rates were more effective than lower rates in both seasons.

4- Soil water retention

The data presented in Tables (4 and 5) showed the response of soil moisture contents at different tensions, i.e. 0.0, 0.33 and 15.0 bars due to sulphur and organic manures applications.

Sulphur application slightly increased saturation water content (SWC) field capacity (FC), permanent wilting point (PWP) and available water capacity (AW) in both seasons. But these increments have not a significant effect.

As regard to organic manure applications, soil moisture contents i.e. SWC, FC and PWP besides of AW were significantly increased as compared with the check treatment (without organic manure). Saturation water content (SWC) as indicated by (TP) was increased by about 2.2, 5.1, 2.9, 4.3, 1.4 and 3.3% in the first season for TR1, TR2, FYM1, FYM2, BT1 and BT2, respectively. The corresponding values for the second season were 1.4, 4.7, 2.6, 5.5, 1.0 and 2.2%, respectively.

Field capacity (FC) was increased by about 7.4, 9.6, 10.4, 11.5, 4.4 and 6% in the first season and 6.5, 9.2, 8.9, 11.4, 4.1 and 6.5%, respectively in the second season. The corresponding values for the PWP were 6.4, 9.9, 8.6, 12.4, 2.1 and 4.7% in the first season and 5.1, 9.3, 8.9, 12.2, 2.1 and 5.5%, respectively in the second season.

The increases in the available water capacity (AW) were 7.5, 9.0, 12.8, 9.8, 7.5 and 7.5% in the first season and 9.0, 9.8, 9.0, 9.8, 7.5, and 8.3%, respectively in the second season.

Generally TR and FYM introduced higher values of moisture retention as compared with check treatment, that is in agreement with (Serra-Wittling *et al*, 1996). The superiority of TR and FYM rather than BT for retains more moisture may be due to increasing the small pores (Gouda, 1984). Also, the obtained results could be due to that the organic manure particles can retain more water due to their large surface area that absorb water as films held at relatively high tensions (Change *et al.*, 1983). Such results are in agreement with those obtained by Epstein (1975), Change *et al.* (1983), Sabrah (1993), El-Sersawy (1997 and 1998). Change *et al.* (1983) reported that conditioning soils by using sewage sludge resulted in a reduction of soil bulk density and an increase in water holding capacity. Gouda (1984) and Zeid and Asker (1987) also obtained the same results.

The proper modification of pore-size distribution is a key for improving the status of water availability in fine-textured soils, which are characterized by less water movement as a result of low macro pores content. Management of such soils must, therefore aim to increase relative proportion of macro pores (drainable pores).

5- Mean weight diameter (MWD) and Optimum size (OP).

The mean weight diameter (MWD) and optimum size of soil particles (OP) of the organic manure-treated soil were shown in Tables (4 and 5).

Sulphur application positively affected MWD. The application of organic manure also significantly increased MWD as compared with the check treatment. Such effects were more pronounced with TR and FYM. (Nassar, 1998). The decomposition of organic manure and enhancement of microorganisms' activity led to producing materials capable to link soil particles and create large aggregates (Marshall and Holmes, 1979).As reported by Kohnke (1982), the optimum size (OP) of peds for good plant growth lies between 0.5 and 2.0 mm. The present data confirmed this concept (Tables 4 and 5).

Sulphur and organic manure applications significantly increased the percent of optimum size. Such increases were more pronounced with TR and FYM, because of their content of fine particles which led to link soil particles to a larger aggregates.

6- Basic infiltration rate (I_b).

Data in Tables (4 and 5) show the effect of sulphur and organic manures on basic infiltration rate (I_b) of soil.

As general, sulphur application slightly increased I_b. The I_b increased from 0.235 to 0.237 cm/hr in the first season and from 0.242 to 0.248 cm/hr in the second season as sulphur application increased from zero to 250 g/vine, respectively. Such result may be attributed to the aggregation effects. (Abo-Soliman *et al*, 1992).

Regarding to organic manure applications, the data revealed that I_b significantly increased and improved as a result of organic manure treatment (Al-Lami *et al.*, 1990 and Ismail, 1996). Such effects may be attributed to the modification in PSD i.e., increasing the large pores (drainable pores) and consequently increasing the water movement rate. The high rates of organic manure were correlated with high I_b, this is confirmed by the modification of soil aggregation. The organic matter in soil, provides the material needed for formation and stabilization of soil aggregates and improves the water holding and water-conducting capacity of soil (Kohnke, 1982).

II- Soil chemical properties:

The data presented in Tables (6 and 7) show the effects of sulphur application and organic manures on some chemical properties of experimental soil at the end of both seasons.

Soil organic matter content (OM) significantly increased at the end of both seasons as a result of organic manures application .The maximum value of OM content was attained with the application of high rate of FYM and TR in both seasons. Organic matter content increased from 2.2 to 2.8 % related to

N-mineral fertilizer and 3 Kg FYM/vine treatment in the 1998 season .The corresponding values for 1999 season were 2.14 and 2.78%, respectively. Such results may be due to the decay of organic manure materials that increasing the OM content in soil .The high content of OM with FYM and TR application may be attributed to the less C/N ratio that responsible for organic matter decomposition (Yagodin , 1984 and Hyaletedinov ,1988).

The data clearly indicate that pH values significantly decreased as a result of sulphur application in both seasons. The reduction in soil pH may be due to the acidification resulted from sulphur oxidation (Wainwright , 1984). Similar trend was noticed with organic manures, in which soil pH significantly decreased. The reduction in pH was more pronounced at high rate of organic manures in both seasons. Such reduction in soil pH due organic manures may be attributed to the organic acids i.e. humic, fluvic and carbonic acids produced by organic material decomposition (Zaid and Kriem, 1992).

Soluble salts (EC) in soil solution were significantly increased as a result of sulphur application. The relatively higher values of EC for soil received sulphur could be attributed to the acidity produced through sulphur oxidation by microorganisms, this acidity was an efficient solvent on soil calcium carbonates (Zaid and Kriem, 1992). Organic manures significantly increased the soil EC values in both seasons. Such increase may be due to the organic acids produced by organic materials decomposition by microorganisms and its effect on calcium carbonate solubility.

Regarding the exchangeable sodium percentage (ESP, calculated as adsorbed Na* 100/CEC), it is clear that both sulphur application and organic manures significantly reduced the ESP values. Such reduction, may be attributed to the acidity produced by sulphur oxidation and organic materials decomposition. This acidity is effective in solubilizing soil calcium carbonate that produced free Ca^{2+} ions. The Ca^{2+} ions replaced the Na adsorbed on soil complex, thus reduced the ESP values (Richards, 1972). The higher reduction in ESP was noticed with FYM (Tables, 6 and 7) in both seasons.

Concerning the available soil nutrients, the data presented in Tables (6 and 7) revealed that both sulphur and organic manures have a significant effect on increasing the availability of soil macro-and micro-nutrients, i.e. N, P, K, Fe, Mn, Cu and Zn in both seasons. Such increases in available soil nutrient due to sulphur application may be due to acidification resulted by sulphur oxidation to $SO^{=}_4$ ion. The $SO^{=}_4$ ions can dissolve some soil minerals and released these nutrients or due to the reduction in soil pH and its effects on increasing the availability of such nutrients (Mengel and Kirkby, 1987).

In the same time, the more availability of soil nutrients resulted by organic manures may be attributed to the acidity produced by organic materials decomposition and its effects on solubility of soil minerals or releasing the nutrients through organic materials decay. Also, the increasing of the soil nutrients level may be due to the high content of such element in organic materials used. However, the magnitude of increases in soil nutrients due to organic manures differed according to source of organic manure and elemental composition. The high levels of soil nutrients were associated with the addition of TR and FYM especially at higher rates. It is may be due to the high content of TR and FYM in such elements (Tables, 6 and 7).

6

7

There is a significant effect between organic and inorganic N sources on the availability of soil N. The beneficial effect was greatest when organic N was applied with inorganic N than in the case of inorganic N was applied alone (Tables 6 and 7).

The results also show that available soil N increased gradually with the increase of the applying rate of organic N compared with inorganic N (Tables, 6 and 7). Azam (1990) attributed the enhanced soil N mineralization to the biological interchange of applied N with soil-N. The soil micro-organisms will react to the addition of energy-rich materials and the increased microbial activity will involve mineralization of the native soil organic matter, thus increased availability of nutrients including N. Application of such organic manures with chemical fertilizers may be helpful in conserving the fertilizer N and in assuring its continued availability to subsequent crops since microbial biomass is a potentially available N source whereas humic compounds may prove to be an important source of N supply over an extended period of time (Azam *et al* , 1985).

The Apparent Net N Release (ANNR) as a result of organic manure application can be described by the following formula:

$$ANNR(\%) = \frac{\text{Available-N (organic-N treated soil) - available-N (mineral-N treated soil)}}{\text{Available-N (mineral-N treated soil)}} \times 100$$

The present results revealed that both TR and FYM produced more available N than BT .The available -N was more pronounced with high level of organic manure in both seasons. The data indicated a superiority of FYM in producing available-N and then increased ANNR (Table, 8). In other words, there was an effective mineralization of soil organic matter due to FYM application that provides a continuous supply of N to grapevines resulted in more vegetative growth and grape yield (Jokela , 1992).

Table (8): Apparent Net N Release (ANNR) as influenced by sulphur application and organic manures during 1998 and 1999 growing season.

S rate g/vine	Organic manure	ANNR, %		Mean %
		1998	1999	
0	Control	-	-	-
	TR1	39.62	8.09	8.86
	TR2	12.69	12.13	12.41
	FYM1	12.30	11.40	11.85
	FYM2	17.31	14.71	16.01
	BT1	4.23	4.78	4.51
	BT2	8.46	7.72	8.09
250	Control	-	-	-
	TR1	6.25	5.30	5.78
	TR2	9.56	8.48	9.02
	FYM1	9.19	9.19	9.19
	FYM2	14.71	14.13	14.42
	BT1	4.41	4.59	4.50
	BT2	6.98	7.42	7.20

As general, application of organic manures such as compost town refuse (TR), farmyard manure (FYM) and Bio Treasure (BT) by mixing them with upper 30-cm soil layer could improves soil porosity and infiltration rate, while they reduced soil bulk density. The combination of elemental sulphur with such manures also improves physical properties and help plants to grow more.

The organic manure is a good amendment to increase the ability of soil to retain more water and increase water storage efficiency (Donahue *et al*, 1983 and Gouda, 1984). These effects may be due to linking materials resulted from decomposition of organic manure by micro-organisms (Marshall and Holmes, 1979 and Russell, 1989). The positive effects of organic manures in solubilizing some soil minerals , making them more readily available to growing plants. Thus, high crop production may be attained (Alexander, 1977 and Mervat, 1994).

The most outcome from the present study is clarifying the important role of organic manures in modifying the soil physical and chemical behaviors that enhance the plant production. It is reflected in plant growth, yield and fruit quality. This point will be illustrated in the part II of the present study (Harhash and Abdel-Nasser, 2000).

REFERENCES

Abdel-Sabour, M.F.; C.B. Ogden and R.W. El-Gendi. (1997). Conditioning effect of organic waste composts on hydro-physical properties of Inshas Sandy Soil. Egypt. J. of Soil Sci. 37: 355-366.

Abo-Rady, M.D.K.; O. Duheash, M. Khalil and M.A. Turjoman. (1988). Effect of elemental sulphur on some properties of calcareous soil and growth of date palm seedlings. Arid Soil Research and Rehabilitation, 2 (2): 121-130.

Abo-Soliman, M.S.M.; M.A. Abou El-Soud; A.A. Amer and W.S.El-Sabry (1992). Effect of some reclamation and improvement processes on some physical properties of saline sodic soils in North Delta, Egypt. J. Agric. Sci. Mansoura Univ., 17 (1): 158-169.

Ahmed, M.T. (1981). Effect of soil conditioners on soil physical properties. M.Sc. Thesis, Fac. Agric., Ain Shams Univ., Cairo, Egypt.

Alexander, M. (1977). “Introduction to Soil Microbiology” .2nd ed. , John Wiley and Sons. Inc., New York.

Al-Lami, M.M.; A.S. Al-Janabi; and M.S. Suliman (1990). Estimation of saturated hydraulic conductivity from routine analysis and morphological properties of soil. Mesopotamia J. Agric., 22: 33-43.

Asker, F.A.; S. Marei and H. El-Zaher (1994). Sewage sludge as Natural Conditioner for Newly Reclaimed Soils. I. Effect on Soil Moisture Retention characteristics and Pore-size distribution. Egypt. J. Soil Sci., 34 (1): 67-77.

Azam, F. (1990). Comparative effects of organic and inorganic nitrogen sources applied to a flooded soil on rice yield and availability of N. Plant and Soil. 125: 255.

Azam, F.; K.A. Malik and M.L. Sujjad (1985). Transformation in soil and availability to plants of N^{15} applied as inorganic fertilizer and legume residues. Plant and Soil, 86: 3.

Blake, F. (1990). Organic Farming and Growing. The Crowood Press. New York.

Carter, M.R. (ed.) (1993). Soil Sampling and Methods of Analysis. Canadian society of Soil Science, Lewis Publishers.

Change, A.C.; A.L. Page and J.E. Warmeke. (1983). Soil conditioning effects of municipal sludge compost. J. Environ. Eng. ASCE, 109: 574.

Cummings, C.M.; I.P. Mainland and J.P.Lilly (1981). Influence of soil pH, S and Sawdusts on Blueberry survival, growth and yield. J. Amer. Soc. Hort. Sci., 106 (6): 783-785.

Danahue, R.L.; R.W. Miller and J.C. Shickuna (1983). Soils : An Introduction to Soil and Plant Growth. 5th ed. Prentice-Hall, Inc., Englewood Cliffs, New York.

Elrick, D.E.; G.W. Parkin, W.D. Reynolds and D.J. Fallow. (1995). Analysis of early-time and steady state single-ring infiltration under falling head conditions. Water Resour. Res., 31: 1883-1895.

El-Sersawy, M.M. (1997). Influence of organic farming on soil mechanical properties, pore-size distribution and maize productivity of Maryut calcareous soil. Egypt J. Appl. Sci., 12 (8): 278-297.

El-Sersawy, M.M. (1998). Hydrophysical and impedance properties of cultivated calcareous soil as affected by some tillage practices. Egypt. J. Appl. Sci. 13 (1): 284-299.

Engelstad, O.P. and S.A. Russel (1975). Fertilizers for use under tropical conditions. Adv. Agron., 27: 175-208.

Epstein, E. (1975). Effect of sewage sludge on some soil physical properties. J. Environ. Quali, 4: 139.

Gambrell, R.P.; J.W. Gilliam and S.B. Week (1975). Nitrogen losses from soils of the North Carolina coastal plain. J. Environ. Qual., 4: 317-322.

Goring, C.A.L. (1962). Control nitrification by 2-chloro-6-(trichloro-methyl) pyrine. Soil Sci., 93: 211-218.

Gouda, M.A.K. (1984). Soil and water management of sandy soil. Ph. D. Thesis, Fac. of Agric., Zagazig Univ., Egypt.

Harhash , M.M. and G. Abdel-Nasser (2000) .Effect of organic manures in combination with elemental sulphur on soil physical and chemical characteristics , yield , fruit quality , leaf water contents and nutritional status of Flame seedless grapevines. II- Yield , fruit quality ,leaf water contents and nutritional status .J. Agric. Res., Mansoura Univ., 25(4): (In press).

Hassan, N. and R.A. Olsen (1966). Influence of applied sulfur on availability of soil nutrients for corn (*Zea mays* L.) nutrition. Soil Sci. Soc. Amer. Proc., 30: 284-286.

Hening, H.; D. Sparks and J.J. Evans. (1991). Sulphur deficiency influences vegetative growth, chlorophyll and element concentrations and amino acids of pecan. J. Amer. Soc. Hort. Sci., 116 (6): 974-980.

Hyaletadinov, A. (1988). Microbiological Conversion of Nitrogen Compounds in the soil. Nauka publishers, Moscow.

Ismail, S.M. (1996). The effect of some sugar cane industry by-products on certain physical characteristics of soils. M.Sc. Thesis, Faculty of Agric., Assiut Univ., Assiut, Egypt.

Jokela, W.E. (1992). Nitrogen fertilizer and dairy manure effects on corn yield and soil nitrate. Soil Sci. Soc. Am. J. 56: 148-153.

Kassem, A.A., H.A. Kassem and H.M. Kamal (1995). The influence of source, levels of nitrogen fertilizers and for sulphur application on guava trees grown in alkaline sandy soil. Menofiya. J. Agric. Res., 20 (3): 1223-1235.

Klute, A. (ed.). (1986). "Methods of Soil Analysis", No. 9 Part 1. American Society of Agronomy. Inc. Madison, Wisconsin, USA. 2nd edition.

Kohnke, H. (1982). Soil Physics. TMH Edition. Reprinted in Indian by arrangement with McGraw-Hill, Inc., New York.

Marshall, T.J. and J.W. Holmes (1979). "Soil Physics". Cambridge University press, Cambridge London, New York.

McLean, E.O. (1971). Potentially beneficial effects from liming: chemical and physical. Soil crop Sci. Soc. Fla. Proc., 31: 189-196.

Mengel, K. and A. Kirkby. (1987). Principles of Plant Nutrition. 4th Ed. International Potash Institute, Norblafen-Bern/ Switzerland.

Mervat ,A.T. Amara (1994). Wheat response to rhizospheric bacterial inoculation under field conditions. Desert Ins. Bull. , Egypt , 44(2):315-329 .

Mostafa, M.M.F. (1986). Effect of soil conditioners on some physical and chemical properties in some Egyptian soils., Ph.D. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., Benha Branch, Egypt.

Nassar, I. N. (1998). Utilization of the municipal Garbage (MG). As a soil Amendment. Alex. J. Agric. Res., 43 (3): 317-332.

Pagliai, M; G. Guidi, M. La Marca; M. Giachetti and G. Lucamante (1981). Effect of sewage sludges and composts on soil porosity and aggregation. J. Environ. Qual., 10: 556-561.

Peterson, P.V., C.A. Mullins, D.A. Lietzke and D.E. Deyton (1987). Effect of soil applied elemental sulphur, aluminum sulfate and sawdust on growth of rabbitege blueberries. J. Amer. Soc. Hort. Sci., 112: 612-616.

Richards, L.A. (ed.) (1972). Diagnosis and Improvement of Saline and Alkaline soils. U.S. Dept. of Agric., Agric. Handbook No. 60.

Russell, E.W. (1989). Soil conditions and plant Growth. ELBS edition of eleventh edition. " London-UK".

Sabrah, R.E.A. (1993). Improving water availability in some sandy soils using a petro-chemical soil conditioner. Egypt. J. Soil Sci., 33 (1): 63-72.

Sahrawat, K.L. (1979). Nitrogen losses in rice soils. Fert. News, 24: 38-48.

Serra-Wittling, C., C., Hout and E. Barriuso (1996). Modification of soil water retention and biological properties by municipal waste compost. Compost Science and utilization, 4: 44-52.

Steel, R.G. and J.H. Torrie. (1980). Principles and Procedures of Statistics. 2nd Ed., McGraw Hill Book Company, New York, USA.

Stewart, D.P.C.; K.C. Cameron, L.S. Cornforth and J.R. Sedcole. (1998). Effects of spent mushroom substrate on soil physical conditions and plant growth in an intensive horticultural system. Aust. J. Soil Sci., 36: 899-912.

Stromberg, L.K. and S.L. Tisdale. (1979). Treating irrigated arid-land soils with acid-forming sulphur compounds. The sulphur Institute Technical Bulletin, 24, p. 2.

U.S.D.A. (1980). "Report and Recommendations on Organic Farming". U.S. Dept. of Agriculture, U.S. Gov. Print Office, Washington D.C.

Wainwright, M. (1984). Sulphur oxidation in soils. Adv. Agron. 37, 349-396.

Yagodin, B.A. (ed.).(1984). "Agricultural Chemistry", English translation, Mir Publisher, Moscow.

Zaid, M.S. and H.M. Kriem (1992). Effect of sugar cane wastes and sulphur on some soil properties and nutrients uptake by *Zea maize* plants in sandy soil. J. Agric. Sci. Mansoura Univ., 17 (1): 181-188.

Zeid, H. and F.A. Asker (1987). Effect of sewage sludge applied to soil on crop yields and some soil chemical and physical properties. J. Agric. Res. Tanta Univ. 13, 479.

" التأثير المشترك للتسميد العضوي مع الكبريت العنصري علي خواص التربة الفيزيقية والكيماوية – المحصول – جودة الثمار – العلاقات المائية والحالة الغذائية لكرمات العنب صنف فليم سيدلس "

1 – الصفات الفيزيقية والكيماوية للتربة

جمال عبد الناصر محمد* و محمد محمد عبد الرحمن حرحش**

*** قسم الأراضي والكيمياء الزراعية و ** قسم الإنتاج النباتي (فاكهة)**

كلية الزراعة – سابا باشا – جامعة الإسكندرية .

تم تنفيذ الدراسة الحالية خلال موسمي 1998 و 1999 في مزرعة محطة التجارب الزراعية – كلية الزراعة (سابا باشا) – جامعة الإسكندرية . وقد كان الهدف الرئيس من هذه الدراسة هو توضيح التأثيرات المشتركة لكلا من الكبريت المعدني والأسمدة العضوية علي الخواص الفيزيقية والكيماوية للتربة المنزرعة بالعنب صنف فليم سيدلس بعمر 8 سنوات نامية في أرض طينية . جميع الكرمات أضيف لها نفس المقررات السمادية (60 كجم ن/فدان) ولكن مع استبدال ثلث أو ثلثي الكمية بالأسمدة العضوية وهي مخلفات المدن – سماد المزرعة والبيوتريجير تبعاً لمحتواها من النيتروجين . أضيف معدلين من الكبريت المعدني هي صفر ، 250 جم/كرمة . وقد تم اتباع المعاملات الزراعية الموصي بها مع كل الكرمات وقد كانت معاملة الكنترول هي إضافة السماد النيتروجيني المعدني (60 كجم ن/فدان) . النتائج المتحصل عليها أوضحت أن إضافة الأسمدة العضوية قد أدت إلى نقص معنوي في الكثافة الظاهرية للتربة والمسام المتوسطة لكنها أدت إلي زيادة معنوية في المسامية الكلية – المسام الدقيقة والكبيرة (الواسعة) . نفس الاتجاه لوحظ مع إضافة الكبريت المعدني لكن بدون تأثير معنوي . إضافة الأسمدة العضوية أدت إلي زيادة معنوية في محتوي التربة من الماء عند شد رطوبي صفر ، 0.33 ، و 15 بار لكن إضافة الكبريت لم يكن له تأثير معنوي . متوسط القسط الموزون وأنسب حجم محببات التربة وكذلك معدل التسرب الأساسي (التوصيل الهيدروليكي تحت الظروف الحقلية) وجد أنها تزداد معنويا كنتيجة لإضافة كلا من الكبريت والأسمدة العضوية . وقد أوضحت النتائج أن كلا من مخلفات المدن وسماد المزرعة كان لها تأثير واضح عن البيوتريجر في تحسين الخواص الفيزيقية للتربة بدون وجود فرق معنوي بينهما .

أيضا أوضحت النتائج أن عناصر التربة الميسرة (Zn, Cu, Mn, Fe, K, P, N) قد زادت معنوياً نتيجة إضافة كلا من الكبريت والأسمدة العضوية . وقد أشارت النتائج أن كلا من مخلفات المدن (TR) وسماد المزرعة (FYM) أدت إلي زيادة الكمية الميسرة من النيتروجين عن البيوتريجر كما يتضح ذلك من زيادة معدل انطلاق أو تحرر النيتروجين من التربة (ANNR) .

كلا من محتوي التربة من المادة العضوية والأملاح الذائبة قد زادت بينما pH التربة ونسبة الصوديوم المتبادل ESP قد انخفضت نتيجة إضافة كلا من الكبريت والأسمدة العضوية .

بصفة عامة فإن النتيجة النهائية للدراسة الحالية هي توضيح الدور الهام للأسمدة العضوية مثل سماد المزرعة ومخلفات المدن في تعديل وتحسين الخواص الفيزيقية والكيماوية للتربة والتي تؤدي إلي زيادة إنتاجية النبات (النمو – المحصول – وخواص جودة الثمار) والتي سوف توضح في الجزء الثاني من الدراسة .

Table (4). Some physical characteristics of experimental soil at the end of 1998 growing season as influenced by sulphur application and organic manures.

Sulphur rate g/vine	Organic manure	Bulk density Mg/m^3	Total porosity m^3/m^3	Pore-size distribution ,%			Soil water relations, m^3/m^3			MWD mm	Optimum size %	Basic infiltration rate cm/hr
				Large	Medium	Small	FC	PWP	AW			
0	Control	1.29	0.513	4.6	56.0	39.4	0.362	0.230	0.132	0.55	51.9	0.227
	TR1	1.26	0.525	11.6	47.0	41.4	0.387	0.248	0.139	0.68	54.4	0.236
	TR2	1.22	0540	15.2	42.4	42.4	0.392	0.253	0.139	0.77	59.8	0.246
	FYM1	1.25	0.534	20.4	36.5	43.1	0.398	0.256	0.142	0.68	57.5	0.234
	FYM2	1.21	0.543	23.8	30.4	45.8	0.402	0.261	0.141	0.81	67.3	0.240
	BT1	1.27	0.521	11.9	47.8	40.3	0.378	0.240	0.138	0.60	53.4	0.230
	BT2	1.25	0.528	15.4	43.8	40.8	0.384	0.246	0.138	0.68	56.1	0.233
250	Control	1.31	0.506	4.9	55.0	40.1	0.368	0.235	0.133	0.57	54.0	0.228
	TR1	1.28	0.517	12.4	44.7	42.9	0.396	0.249	0.147	0.76	59.8	0.239
	TR2	1.24	0.532	16.3	39.7	44.0	0.408	0.258	0.150	0.88	67.2	0.248
	FYM1	1.27	0.521	22.4	31.4	46.2	0.408	0.251	0.157	0.80	68.1	0.236
	FYM2	1.24	0.532	26.8	25.9	47.3	0.412	0.262	0.150	0.96	79.7	0.242
	BT1	1.29	0.513	13.4	45.3	41.3	0.384	0.236	0.148	0.66	57.5	0.231
	BT2	1.26	0.525	16.8	41.6	41.6	0.389	0.241	0.148	0.77	62.7	0.235
Mean effect of sulphur rate												
0		1.27	0.522	14.7	43.4	41.9	0.386	0.248	0.138	0.68	57.2	0.235
250		1.25	0.528	16.1	40.6	43.3	0.395	0.247	0.148	0.77	64.1	0.237
$L.S.D._{0.05}$		0.01**	N.S	1.03*	2.35*	1.3**	N.S	N.S	N.S	0.009**	1.25*	N.S
Mean effects of organic manures												
Control		1.30	0.510	4.8	55.4	39.8	0.365	0.233	0.133	0.56	53.0	0.227
TR1		1.27	0.521	12.0	45.8	42.2	0.392	0.248	0.143	0.72	57.1	0.238
TR2		1.23	0.536	15.8	41.0	43.2	0.400	0.256	0.145	0.83	63.5	0.247
FYM1		1.26	0.525	21.4	33.9	44.7	0.403	0.253	0.150	0.74	62.8	0.235
FYM2		1.24	0.532	25.3	28.1	46.6	0.407	0.262	0.146	0.89	73.5	0.241
BT1		1.28	0.517	12.7	46.5	40.8	0.381	0.238	0.143	0.63	55.4	0.231
BT2		1.26	0.527	16.1	42.7	41.2	0.387	0.244	0.143	0.73	59.4	0.234
$L.S.D._{0.05}$		0.026**	0.01**	1.49**	2.02**	2.63**	0.01**	0.008**	0.012*	0.007**	2.32**	0.006**

Table (5). Physical characteristics of experimental soil at the end of 1999 growing season as influenced by sulphur application and organic manures.

Sulphur rate g/vine	Organic manure	Bulk density Mg/m^3	Total porosity m^3/m^3	Pore-size distribution ,%			Soil water relations m^3/m^3			MWD mm	Optimum size mm	Basic infiltration rate cm/hr
				Large	Medium	Small	FC	PWP	AW			
0	Control	1.31	0.506	5.7	56.1	38.2	0.367	0.235	0.132	0.57	50.7	0.231
	TR1	1.28	0.517	13.4	42.6	44.0	0.385	0.246	0.139	0.72	53.9	0.241
	TR2	1.24	0.532	16.7	34.7	48.6	0.395	0.257	0.138	0.81	58.2	0.249
	FYM1	1.26	0.525	15.9	36.1	48.0	0.396	0.259	0.137	0.72	56.8	0.241
	FYM2	1.22	0.540	18.2	26.1	55.7	0.408	0.264	0.144	0.87	66.9	0.251
	BT1	1.28	0.513	10.8	50.8	38.4	0.382	0.243	0.139	0.64	53.0	0.238
	BT2	1.27	0.521	12.1	48.0	39.9	0.389	0.251	0.138	0.75	55.8	0.241
250	Control	1.29	0.509	6.1	54.4	39.5	0.372	0.238	0.134	0.61	53.2	0.235
	TR1	1.25	0.513	14.7	41.3	44.0	0.402	0.252	0.150	0.79	58.4	0.245
	TR2	1.22	0.532	17.8	35.1	47.1	0.412	0.261	0.151	0.92	66.3	0.252
	FYM1	1.27	0.517	16.9	32.6	50.5	0.410	0.257	0.153	0.85	67.9	0.246
	FYM2	1.22	0.536	19.5	23.3	57.2	0.416	0.268	0.148	0.99	78.5	0.256
	BT1	1.27	0.513	12.1	46.5	41.4	0.387	0.241	0.146	0.72	57.0	0.247
	BT2	1.25	0.517	13.2	45.2	41.6	0.398	0.249	0.149	0.81	62.0	0.252
Mean effect of sulphur rate												
0		1.27	0.512	13.3	42.0	44.7	0.389	0.251	0.138	0.73	56.5	0.242
250		1.25	0.521	14.3	39.8	45.9	0.400	0.252	0.147	0.81	63.3	0.248
$L.S.D._{0.05}$		N.S	N.S	0.29**	0.40**	0.42**	N.S	N.S	N.S	0.05*	1.23**	N.S
Mean effect of organic manures												
Control		1.30	0.508	5.9	55.2	38.9	0.370	0.237	0.133	0.59	52.0	2.330
TR1		1.27	0.515	14.0	42.0	44.0	0.394	0.249	0.145	0.76	56.2	0.243
TR2		1.23	0.532	17.3	34.8	47.9	0.404	0.259	0.145	0.87	62.3	0.251
FYM1		1.27	0.521	16.4	34.3	49.3	0.403	0.258	0.145	0.79	62.4	0.244
FYM2		1.22	0.538	18.9	24.6	56.5	0.412	0.266	0.146	0.93	72.7	0.253
BT1		1.29	0.513	11.5	48.6	39.9	0.385	0.242	0.143	0.68	55.0	0.243
BT2		1.26	0.519	12.7	46.5	40.8	0.394	0.250	0.144	0.78	58.9	0.247
$L.S.D._{0.05}$		0.025**	0.009**	1.45**	1.76**	0.72**	0.01**	0.009**	0.014*	0.068**	0.98**	0.0065**

Table (6). Chemical properties of experimental soil at the end of the 1998 growing season as influenced by sulphur application and organic manures.

Sulphur rate g/vine	Organic manure	OM %	PH	EC dS/m	ESP %	Available soil nutrients , mg/kg soil						
						N	P	K	Fe	Mn	Cu	Zn
0	Control	2.21	8.3	2.62	32.1	260	28.1	630	4.5	2.6	0.7	1.5
	TR1	2.52	8.1	2.78	26.2	285	34.2	671	5.8	3.6	1.3	2.2
	TR2	2.72	8.0	2.84	24.3	293	38.4	688	6.2	4.0	1.6	2.6
	FYM1	2.64	8.0	2.71	23.0	292	35.8	659	5.4	3.1	1.0	2.0
	FYM2	2.81	7.8	2.80	20.7	305	39.2	672	6.0	3.4	1.2	2.3
	BT1	2.45	8.1	2.68	28.1	271	31.2	641	4.8	2.7	0.8	1.7
	BT2	2.63	7.9	2.71	26.0	282	33.4	652	5.0	2.9	0.9	1.9
250	Control	2.22	8.2	2.65	29.0	272	30.2	642	4.9	2.8	0.8	1.8
	TR1	2.43	8.1	2.79	22.2	289	35.2	684	6.0	3.8	1.4	2.4
	TR2	2.74	8.0	2.85	18.8	298	39.8	698	6.6	4.3	1.8	2.7
	FYM1	2.55	8.0	2.72	17.8	297	36.4	668	5.8	3.4	1.2	2.2
	FYM2	2.84	7.8	2.83	16.2	312	40.3	684	6.4	3.9	1.5	2.5
	BT1	2.53	8.0	2.70	22.7	284	33.2	652	5.1	2.9	1.0	1.9
	BT2	2.72	7.8	2.75	20.10	291	35.6	664	5.4	3.2	1.1	2.2
Mean effect of sulphur rate												
0		2.50	8.0	2.73	25.8	284	34.3	659.0	5.4	3.2	1.1	2.0
250		2.50	7.9	2.77	21.0	292	35.8	670.3	5.7	3.5	1.3	2.2
$L.S.D._{0.05}$		N.S	0.017*	N.S	2.66*	4.57*	0.43**	6.7*	0.07**	0.14*	0.035**	0.03**
Mean effects of organic manures												
Control		2.20	8.3	2.64	30.6	266.0	29.2	636.0	4.7	2.7	0.8	1.7
TR1		2.50	8.1	2.79	24.2	287.0	34.7	677.5	5.9	3.7	1.4	2.3
TR2		2.70	8.0	2.85	21.5	295.5	39.1	693.0	6.4	4.2	1.7	2.7
FYM1		2.50	8.0	2.72	20.4	294.5	36.1	663.5	5.6	3.3	1.1	2.1
FYM2		2.80	7.8	2.83	18.4	308.5	39.8	687.0	6.2	3.7	1.4	2.4
BT1		2.40	8.0	2.70	25.4	277.5	32.2	646.5	5.0	2.8	0.9	1.8
BT2		2.70	7.8	2.75	23.1	286.5	34.5	658.0	5.2	3.1	1.0	2.1
$L.S.D._{0.05}$		0.11**	0.12**	0.087**	1.7**	5.55**	0.81**	3.43**	0.21**	0.14**	0.075**	0.058**

Table (7). Chemical properties of experimental soil at the end of the 1999 growing season as influenced by sulphur application and organic manures.

Sulphur rate g/vine	Organic manure	OM %	pH	EC dS/m	ESP %	Available soil nutrients , mg/kg soil						
						N	P	K	Fe	Mn	Cu	Zn
0	Control	2.12	8.4	2.73	30.2	272	30.2	642	4.8	2.8	0.6	1.7
	TR1	2.47	7.9	2.85	25.1	294	35.3	685	5.9	3.7	1.2	2.4
	TR2	2.68	7.7	2.89	21.3	305	40.2	397	6.4	4.0	1.5	2.8
	FYM1	2.59	8.0	2.80	22.7	303	37.8	668	5.4	3.2	0.9	2.3
	FYM2	2.74	7.9	2.84	20.1	312	41.2	687	5.8	3.6	1.2	2.6
	BT1	2.41	8.2	2.78	27.3	285	32.3	657	5.0	2.9	0.7	1.9
	BT2	2.58	8.1	2.83	24.5	293	34.5	669	5.4	3.3	0.9	2.2
250	Control	2.12	8.3	2.82	28.3	283	32.3	653	5.1	3.0	0.7	1.9
	TR1	2.51	7.8	2.78	23.2	298	36.9	694	6.2	3.8	1.3	2.6
	TR2	2.75	7.6	2.94	18.7	307	41.3	708	6.7	4.1	1.6	3.0
	FYM1	2.63	7.9	2.85	20.5	309	38.5	675	5.7	3.4	1.0	2.6
	FYM2	2.83	7.7	2.88	17.6	323	42.9	696	5.9	3.8	1.3	2.9
	BT1	2.50	8.0	2.83	24.2	296	33.4	668	5.3	3.1	0.8	2.3
	BT2	2.62	7.9	2.87	21.0	304	35.9	677	5.8	3.5	1.0	2.5
Mean effect of sulphur rate												
0		2.51	8.0	2.82	24.5	294.9	35.9	672.1	5.5	3.4	1.0	2.3
250		2.57	7.9	2.87	21.9	302.9	37.3	681.6	5.8	3.6	1.2	2.5
$L.S.D._{0.05}$		N.S	0.011	N.S	2.4*	3.73	1.15**	7.3**	0.04**	0.18*	0.14*	0.14*
Mean effects of organic manures												
Control		2.14	8.3	2.78	29.3	277.5	31.3	647.5	5.0	2.9	0.7	1.8
TR1		2.49	7.9	2.86	24.2	296.0	36.1	689.5	6.1	3.8	1.3	2.5
TR2		2.72	7.7	2.92	20.0	306.0	40.8	702.5	6.6	4.1	1.6	2.9
FYM1		2.61	8.0	2.83	21.6	306.0	38.1	671.5	5.6	3.4	1.0	2.5
FYM2		2.78	7.8	2.86	18.9	317.5	42.1	691.5	5.9	3.8	1.3	2.8
BT1		2.46	8.1	2.81	25.9	290.5	32.9	662.5	5.2	3.1	0.8	2.1
BT2		2.60	8.0	2.85	22.8	298.5	35.2	673.0	5.6	3.5	1.0	2.4
$L.S.D._{0.05}$		0.13**	0.14**	0.079*	0.8**	2.69**	0.91**	4.29**	0.16**	0.16**	0.09**	0.19*