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EFFECT OF FARMYARD MANURE AND TOWN REFUSE APPLICATION ON SOME SOIL PROPERTIES AND GROWTH, YIELD AND FRUIT ELEMENTAL COMPOSITION OF PEPPER

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ABSTRACT

Pot experiments were conducted during the early summer seasons of 1998 and 1999. Farmyard manure (FYM) and town refuse (TR) were applied to the soil in order to study their effects on improving some soil properties and also on growth, yield and elemental composition of bell pepper (*Capsicum annum* L.) plants. The treatments included the recommended NPK as control in addition to FYM or TR at the rates of 120, 240, or 360 g/pot which contained 12 kg of soil (ca. 10, 20 or 30 tons/fed., respectively, with or without the recommended NPK, and a 1:1 mixture of both amendments at the same rates with added NPK.

Soil pH slightly decreased and organic matter (OM) significantly increased with increasing the rate of the different applications of both amendments compared to the control, while soil electrical conductivity (EC) increased, only, at the medium and high rates of different applications. Sodium adsorption ratio (SAR) decreased with increasing the application rate of FYM (whether with or without NPK), but the opposite occurred, generally, with the remaining treatments. FYM at medium and high rate, and the mixture of both amendments at the medium rate with added NPK improved the aggregation parameters of the soil in most cases where mean weight diameter (MWD), water stable aggregates (WSA), optimum size of aggregates and structure coefficient (SC) increased compared to the control.

The different applications of both amendments significantly increased the total N and available P, K, Fe, Zn and Cu compared to the control. However, no significant trend was observed between the increase in the amendment application rate and the soil elements content values. Soil Cd content was not significantly affected by the different applications in both years.

The different applications of both amendments significantly increased stem length, number of leaves and leaf fresh and dry weights, compared to the control. However, no constant trend was observed between the increase in application rate and the values of these parameters. The largest vegetative growth was obtained with TR at the medium rate with added NPK or the mixture of both amendments at the medium rate with added NPK with slight differences between the two treatments in most measured parameters. Fruit yield per plant and average fruit weight increased with the different applications of both amendments. The yield response was similar to those of growth parameters. TSS % and vitamin C content in fruits were not significantly affected in both seasons.

Fruit content of N, P and K increased with most applications of organic amendments compared to the control. The highest contents of these elements were obtained with FYM at the high rate (without NPK). Concerning the concentration of micro elements in fruits, no constant response was observed. The lowest values were obtained with the mixture of both amendments at the medium rate with added NPK.

INTRODUCTION

Soil productivity is greatly improved by its content of organic matter, due to its beneficial effects on both soil and plants.

Organic wastes such as farmyard manure, town refuse and sewage sludge (SS) have been applied to the soil by some investigators as soil amendments (Fresquez *et al.*, 1990; Mbagwu and Piccolo, 1990 and Khalifa *et al.,* 1994). They reported that these amendments were rich in their content of organic matter and macro and micro nutrients, in addition to their efficiency in improving physical and chemical properties of the soil, thus leading to favorable conditions for better plant growth and greater yields. However, the application of a certain organic amendment is controlled by its ultimate content of plant nutrients and non-nutrients (heavy metals). Parsa (1970) reported that excessive micro nutrients may induce phytotoxicity. Also, excessive content of heavy metals (Cd, Pb and Ni) may produce toxic effects on biological process such as nitrification (Wilson, 1977). Furthermore, the preference of any kind of conditioners depends on its price and case of application.

Khalifa (1993), on broad bean, and Khalifa and Hassan (1993), on squash, found that increasing the rates of SS and FYM improved the aggregation parameters of clay soil viz., mean weight diameter, aggregation index and optimum size of aggregates. Also, a positive relationship was observed between application rate of the amendment and concentration of macro and micro nutrients in broad bean seeds and squash fruit, while the concentration of heavy metals obtained in seeds and fruits were increased but remained below the toxic limits. Khalifa *et al.* (1994) reported that the application of FYM and TR to wheat plants in sandy soil increased soil EC and the availability of Fe, Zn and Mn in soil, while the concentrations of Fe, Zn, Mn and Cu in wheat grain were also increased, but remained within the safe limits.

Sweet pepper is one of the important vegetable crops in Egypt. However, the total cultivated area, in 1999, was still low (65, 859 feddans) and so also was the average yield per unit area (5.90 tons/fed.) according to Central Administration of Agricultural Economics, Ministry of Agriculture, Egypt (2000). Egyptian soils are generally very low in OM content, which may contribute to low crop yields. Thus, more efforts should be involved in the direction of maximizing the soil productivity by OM amendments.

Therefore, the main objective of this work was to investigate the favorable effects of pepper fertilization with farmyard manure and town refuse on some soil properties and on plant growth, yield and fruit elemental composition.

MATERIALS AND METHODS

Pot experiments were conducted in the experimental station of Faculty of Agriculture, Kafr El-Sheikh, Tanta University during the early summer season of 1998 and 1999 to study the effects of FYM and TR applications on some soil properties and growth, yield and fruit elemental composition of pepper plants.

Sixteen treatments were used in this study. They included the recommended chemical NPK as control, in addition to FYM or TR at the rates of 120, 240, or 360 g/pot or nearly 10, 20 or 30 tons per fed., respectively, with or without the recommended NPK, and their 1:1 mixture at the same rates with the recommended NPK. The soil used in the study was obtained from one field in Eshaqa village, Kafr El-Sheikh District at 0-30 cm depth. FYM was collected from the experimental farm of Kafr El-Sheikh Faculty of Agriculture. TR was obtained from Kafr El-Sheikh City. The main characteristics of soil and both amendments, before starting the study, are shown in Tables (1 and 2).

The soil, FYM and TR were each air dried, ground and passed through a 2 mm sieve, then the soil was mixed with the amendment(s) according to the determined rates, and uniformly packed in 30 cm plastic pots having a capacity of 12 kg of amended soil/pot. Chemical NPK fertilizers, at the recommended rates, were applied to the pots at three doses. The commercial fertilizers used were ammonium sulphate (20.5% N), superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) at the rates of 4.8, 3.6, and 2.4 g/pot or nearly 400, 300 and 200 kg/fed. for the three fertilizers, respectively.

Transformations of the amendments and NPK fertilizers' rates to weights per pot were calculated considering that one fed. contains 1 million kg of top soil.

Seeds of pepper, cv. California Wonder, were sown on 15 January, under plastic cover, in both seasons. Seven weeks later, seedlings were transplanted into the pots (one seedling per pot) in the open. Pots of the different treatments were completely randomized. Each experimental unit consisted of 12 pots.

Seven weeks after transplanting, random samples of five plants per experimental unit were taken. The following parameters were determined: Stem length, number of leaves per plant and leaf fresh and dry weight.

At harvest, total plant fruit yield, average fruit weight and fruit content of total soluble solids (T.S.S.) and vitamin C were determined. T.S.S.% was determined by a hand refractometer. vitamin C (ascorbic acid as mg/100 g fresh fruit) was determined according to Cox and Pearson (1962). Pepper fruit content of some macro and micro elements were determined. A wet ashing technique, using sulphoric and perchloric acids was used for digesting 0.2 g of oven dried material at 70°C according to Piper (1950), then N, P and K concentrations in fruits were determined according to Black (1965), and Fe, Zn, Cu, Ni and Cd concentrations were determined by an atomic absorption spectrophotometer.

At the end of harvesting period, random samples of soil were taken from each experimental unit, then air dried and divided into two parts. The first was assigned to chemical analysis where EC, OM% and soluble Na, Ca and Mg were determined, then SAR was calculated. Soil pH was determined in a 1: 2.5 soil-water extract. All chemical properties of the soil were determined according to Black (1965). Total N and available P and K of the soil were determined according to Jackson (1958). Available Fe, Zn, Cu, Ni and Cd were extracted by the DTPA method according to Lindsay and Norvell (1978), then determined using an atomic absorption spectrophotometer.

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The second part of soil samples was undisturbed and used in a wet sieving technique (Yoder, 1963) for the determinations of aggregation parameters, viz., MWD, percentage of WSA, optimum size of aggregates (2.0 - 0.5 mm) and SC. SC was calculated according to the following formula:

$$SC = \frac{\text{WSA \%} > 0.25 \text{ mm diameter}}{\text{WSA \%} < 0.25 \text{ mm diameter}}$$

Aggregation parameters were determined and SC was calculated according to Baver *et al.* (1972).

Data were statistically analyzed. A complete randomized design with four replications was applied. Duncan's multiple range test was used for the comparisons among treatment means (Duncan, 1965).

RESULTS AND DISCUSSION

1. Soil Chemical properties:

Data on soil chemical properties are shown in Tables (3 and 4). The results indicate that pH slightly decreased with the different applications of both amendments (FYM or TR with or without NPK or their mixture with NPK) compared with the control in both seasons. The decrease in pH was, mostly, correlated with the increase in rate of application. Such decreases in pH values may be due to: a) decomposition of organic materials and the production of organic acids, (b) mineralization and nitrification of the added organic N and/or (c) increased partial pressure of CO_2 of the soil atmosphere due to increased microbiological activity (O'comer *et al*., 1986).

EC increased at the medium and high application rates of both amendments in the different treatments compared to the control. However these increases were not significantly different from the control's value in the first season. The increases in EC were greater with TR at the high rate whether with or without NPK; and such increases in EC were higher than those obtained with FYM at the same rate. However, EC at the higher application rates of both amendments did not reach the hazardous limits to the growing plant. These results agree with those obtained by Heggi and Abu El-Ezz (1988), Fresquez and Dennis (1990) and Khalifa *et al*. (1994).

Increasing the rate of FYM, whether with or without NPK, decreased SAR values. To the contrary, increasing the application rate of the remaining treatments (TR with or without NPK or mixture of both amendments with added NPK), mostly increased SAR value compared to the control in both seasons. The mixture of both amendments caused a slight increase in SAR values at the low rate of application when compared with the control.

Soil OM% significantly increased with increasing the application rate of both amendments in the different treatments compared with the control in both seasons. The highest OM contents were obtained with FYM at the high rate whether with or without NPK. These results are in agreement with those reported by Fresquez *et al*. (1990) and Khalifa *et al*. (1994).

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2. Soil physical properties:

Physical properties of the soil were obviously improved with the application of some treatments compared to the control in both seasons as shown in Tables (3 and 4). MWD increased with the application of TR at the high rate with added NPK, followed by the mixture of both amendments at the medium rate with added NPK. However, MWD values were not significantly affected in the second season. This increase in MWD may be due to the lower values of SAR and higher OM ones obtained under conditions of these treatments. WSA and SC increased with the application of FYM at the high rate, followed by the mixture of both amendments at the medium rate with added NPK. Optimum size of aggregates increased with FYM at the medium rate, followed by the mixture of both amendments at the medium rate with added NPK. However, the increases in the above-mentioned soil physical properties were insignificantly different from the control's value in most cases in both seasons. These results agree with those previously reported by Mbagwu and Piccolo (1990), Khalifa and Hassan (1993) and Khalifa *et al*. (1994).

3.Soil content of macro nutrients:

Data in Tables (5 and 6) indicate that the different applications of both amendments generally increased total N and available P and K in soil compared to the control in both seasons. These results are compatible with the higher contents of N and P in both amendments than in the used soil. The increases in N and K contents were, mostly, correlated with the rate of application. However, the differences of N values were not significant in the second season. As for available P, no obvious trend was observed between the increase in amendment application rate and P content values. Meantime, the highest values of available P were obtained with TR at the medium rate with added NPK followed by the mixture of both amendments at the medium rate with NPK.

4.Soil content of micro element:

Data in Tables (5 and 6) show that the different applications of both amendments generally increased the DTPA-extractable Fe, Zn, Cu and Ni compared to the recommended NPK (control). Meanwhile, no constant trend was observed between the increase in amendment application rate and micro elements content values; and the soil content of Cu in the second season and Cd content in both seasons were not significantly affected by the different treatments. The highest significant contents of Fe, Zn, Cu and Ni were obtained with TR at the high rate, FYM at the low rate, FYM at the high rate and the mixture of amendments at the high rate with added NPK, respectively, compared to the control in both seasons. The increases in soil micro element contents were mainly due to the higher content of such elements released from the used amendments. These results agree with those previously reported by Khalifa (1993), Khalifa and Hassan (1993) and Khalifa *et al*. (1994).

5.Plant growth and fruit yield:

Data in Tables (7 and 8) show that vegetative growth parameters viz., stem length, number of leaves per plant and leaf fresh and dry weights were significantly increased with the different applications of both amendments in both years. However, no obvious trend was noticed between the increase in amendment application rate and the values of these parameters. These increases in growth parameters were mainly due to the increases in availability of nutrients released from the organic amendments used, and to the efficiency of the latter in improving soil properties. Similar conclusions were reported by Zaid (1989) and Khalifa *et al*. (1994).

From the obtained data, it was generally noticed that the increases in vegetative growth parameters were more pronounced in the following cases: (a) with TR rates with or without added NPK more than FYM rates with or without NPK, respectively. (b) with TR or FYM with added NPK more than their applications without NPK and (c) with the mixture of both amendments specially at the medium rate with added NPK more the individual application of each whether with or without NPK. Meantime, the highest stem length was obtained with FYM at the medium rate in the first season and FYM at the high rate with added NPK in the second season. Concerning the number of leaves per plant and leaf fresh and dry weights, the highest values were obtained with TR at the medium rate with added NPK or the mixture of both amendments at the medium rate with added NPK (with slight differences between the two treatments in most cases) in both years.

Data on fruit yield (Tables 7 and 8) show that fruit yield per plant and average fruit weight were significantly increased with the different applications of both amendments. They showed similar responses as those of growth parameters. The highest values were obtained with TR at the medium rate with added NPK or the mixture of both amendments at the medium rate with NPK (with slight differences between the two treatments) in both years. These increases in yield were expected since better plant productivity is a function of better plant growth. Furthermore, the higher content of available P found in soil of the two mentioned treatments was an important factor responsible for the increased yield.

Concerning some fruit characteristics, data show that T.S.S. % and vitamin C content were not significantly affected by the different treatments in both seasons.

6.Fruit content of macro nutrients:

From the data in Tables (9 and 10), it was generally noticed that concentrations of N, P and K in fruits were significantly increased with the different application rates of most treatments in both seasons except those of TR at all rates with added NPK and the mixture of both amendments at the medium rate. The increases in fruit macro nutrients were mainly due to the higher contents of such elements released from the used amendments. FYM alone was more efficient in increasing the content of these elements in fruits. The highest concentrations of N, P and K were obtained with FYM at the high rate in both seasons except that of K content in the second season, which was insignificantly different from the control value.

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On the other hand, the lowest values were obtained with TR at the low rate with added NPK. Meantime, P content in fruits was not significantly affected by the different treatments in the second season.

7.Fruit content of micro nutrients:

Data in Tables (9 and 10) show that fruit content of Fe, Zn, Cu and Ni mostly increased with increasing the rate of FYM alone, while the opposite occurred when applying FYM with added NPK. Meanwhile, fruit content of Fe, Ni and Cd decreased and Zn increased with increasing the rate of TR (alone) up to 20 ton/fed., while the opposite occurred when applying TR with added NPK. These contradictory levels of micro elements in fruits may be attributed to soil or plant relating factors i.e., antagonism, inhibition or binding in or out of plants. On the other hand, the lowest contents of these elements were mostly obtained with applying the mixture of both amendments at the medium rate with added NPK. Similar conclusions were reported by some researchers (El-Gala *et al*., 1990; Khalifa *et al*., 1994 and Mehana and Mataloub, 1997).

From the obtained data, concerning fruit contents of heavy metals, it is concluded that all the application rates of both amendments in the different treatments of the study did not reach the toxic limits for growing plants as outlined by Cottonie *et al*. (1976).

It is generally concluded that the different applications of both amendments resulted in favorable effects on both soil and plant. Such effects may be due to the amendments' high content of plant nutrients and to their efficiency in improving soil chemical and physical properties, thus, leading to higher plant growth and productivity. The highest growth and yield of pepper plants were obtained with TR at the medium rate with added NPK or the mixture of both amendments at the medium rate with added NPK (with slight differences between the two treatments in most parameters). However, the latter treatment was more preferable since it resulted in better soil physical and chemical properties than the former treatment. It also, lowered the DTPA-extractable heavy metals in the soil and lowered their concentrations in fruits. So, application of the mixture of both amendments at the medium rate with added NPK is considered more safe and feasible, for a long period, from the agronomic and economic point of view.

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تأثير إضافة سماد المزرعة العضوى ومخلفات المدن على بعض خواص التربة والنمو والمحصول والتركيب المعدنى لثمار الفلفل

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أجريت تجربة أصص فى الموسم الصيفى المبكر لعامى 1998 ، 1999 ، استخدم فيها سماد المزرعة العضوى ، ومخلفات المدن وذلك لدراسة تأثيرهما على تحسين بعض خواص التربة ، وكذلك على النمو والمحصول والتركيب المعدنى للثمار فى نبات الفلفل.

اشتملت المعاملات على السماد الكيماوى (الموصى به) كمعاملة مقارنة ، بالإضافة إلى سماد المزرعة العضوى أو مخلفات المدن بمعدل120 أو 240 أو 360 جم/أصيص أو ما يوازى 10 أو 20 أو 30 طن/فدان ـ مع إضافة أو عدم إضافة السماد الكيماوى، وكذلك استخدام خليط من مصدرى المخلفات العضوية بنفس المعدلات المذكورة (نصف المعدل من كل منهما) ـ مع إضافة السماد الكيماوى.

ويمكن تلخيص النتائج المتحصل عليها فيما يلى:

- حدث نقص طفيف فى رقم حموضة التربة (pH) وزيادة معنوية فى النسبة المئوية للمادة العضوية (DM%) بزيادة المعدل من الإضافات المختلفة لمصدرى المخلفات العضوية ، مقارنة بالكنترول ، بينما زاد التوصيل الكهربى للتربة (EC) عند المعدل المتوسط والعالى من الإضافات المختلفة. أما نسبة الصوديوم المدمص (SAR) فقد قلت بزيادة معدل الإضافة من سماد المزرعة (مع إضافة أو عدم إضافة السماد الكيماوى) ، ولكن حدث العكس عند زيادة معدل الإضافة فى باقى المعاملات عموما.
- أدت إضافة سماد المزرعة العضوى عند المعدل المتوسط والعالى بدون إضافة السماد الكيماوى ، وكذلك الخليط من مصدرى المخلفات العضوية عند المعدل المتوسط مع إضافة السماد الكيماوى إلى حدوث تحسن فى خصائص التحبب للتربة ـ فى معظم الحالات ـ حيث زاد كل من متوسط القطر الموزون (MWD) ، ونسبة الحبيبات المجمعة (WSA) ، ونسبة المجمعات ذات الحجم الأمثل (Opt. Size) ، ومعامل البناء للتربة (SC) مقارنة بالكنترول.
- أدت الإضافات المختلفة من مصدرى المخلفات العضوية إلى زيادة معنوية فى قيم كل من النيتروجين الكلى والعناصر المتيسرة بالتربة (الفوسفور ، البوتاسيوم ، الحديد ، الزنك والنحاس) مقارنة بالكنترول، ولكن لم يكن هناك إتجاها محددا لقيم هذه العناصر مع الزيادة فى معدلات الإضافة ـ هذا ولم يتأثر المحتوى من الكادميوم معنويا بالإضافات المختلفة فى كلا الموسمين.
- أدت الإضافات المختلفة من مصدرى المخلفات العضوية إلى زيادة معنوية فى كل من طول النبات ، وعدد الأوراق ، والوزن الطازج والجاف للأوراق مقارنة بالكنترول ، ولكن لم يكن هناك إتجاها محددا لقيم هذه الصفات مع الزيادة فى معدلات الإضافة ـ هذا وقد نتج أحسن نمو خضرى عند استخدام مخلفات المدن عند المعدل المتوسط مع إضافة السماد الكيماوى أو خليط من مصدرى المخلفات العضوية عند المعدل المتوسط مع إضافة السماد الكيماوى (مع وجود فارق بسيط بين هاتين المعاملتين فى قيم الصفات المختلفة) ، هذا وقد أزداد المحصول الثمرى للنبات ومتوسط وزن الثمره مع الاضافات المختلفة للمخلفات العضوية حيث أظهرا أستجابة مماثلة لاستجابة النمو الخضرى فيما يتعلق بأعلى القيم (أعلى محصول) ، بينما لم يتأثر معنويا كل من النسبة المئوية للمواد الصلبة الذائبة الكلية ومحتوى الثمار من فيتامين ج فى كلا الموسمين.

- زاد محتوى الثمار من كل من النيتروجين والفوسفور والبوتاسيوم مع معظم الإضافات من المخلفات العضوية مقارنة بالكنترول ، وقد نتج أعلى تركيز من العناصر الثلاثة باستخدام سماد المزرعة العضوى عند المعدل العالى (بدون إضافة السماد الكيماوى) ،ومن ناحية اخرى ، لم يكن هناك استجابة ثابتة لمحتوى الثمار من العناصر الدقيقة ، وقد نتج أقل تركيز من غالبية هذه العناصر باستخدام خليط من مصدرى المخلفات العضوية عند المعدل المتوسط مع إضافة السماد الكيماوى.

Table (1): Some chemical and physical properties of the soil used in the study.

EC*, dS/m	PH (1: 2.5)	Soluble cations and anions (meq/L*)								SAR	OM %	Macro and micro elements								Particle size distribution		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	CO^{--}_3	HCO^{-}_3	SO^{--}_4			Total N(%)	Available (µg/g)		DTPA extractable (µg/g)					Clay (%)	Silt (%)	Sand (%)
													P	K	Fe	Zn	Cu	Ni	Cd			
0.38	8.04	1.20	1.80	2.20	0.20	1.10	0.00	1.50	2.80	1.80	1.96	0.098	3.1	562	17.5	1.56	0.24	0.84	0.11	57.2	26.5	16.3

* Determinations were made on a 1: 5 soil water extract.

Table (2): Some chemical properties of the organic manures used in the study.

EC*, dS/m	PH *	Soluble cations and anions (meq/L*)								SAR	OM %	Macro and micro elements							
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	CO^{--}_3	HCO^{-}_3	SO^{--}_4			Total N(%)	Available(µg/g)		DTPA extractable(µg/g)				
													P	K	Fe	Zn	Cu	Ni	Cd
Farmyard manure (FYM)																			
5.80	7.35	6.40	2.80	28.8	2.70	28.5	0.00	7.20	4.30	18.70	13.30	1.82	32.0	255	43.4	39.2	0.50	1.90	0.11
Town refuse (TR)																			
4.26	7.08	8.60	2.60	25.2	2.40	25.0	0.00	6.60	4.20	10.55	11.06	1.05	38.6	386	47.6	134.0	1.40	3.90	0.68

* Determinations were made on a 1: 10 soil water extract

Table (3): Soil chemical and physical properties as affected by farmyard manure and town refuse application to soil prior to pepper transplanting (first season, 1998).

No.	Treatments	Chemical properties[@] pH (1: 2.5)	EC, dS/m (1: 5)	SAR	OM %	Physical properties[#] MWD (mm.)	WSA %	Opt. Size %	SC
1	Recommended NPK	7.24	0.89 abc	2.13	1.87 a	0.47 abc	57.83 ef	43.92 def	1.37 de
2	FYM (10 ton/fed.)	7.17	0.99 abc	2.34	2.34 cde	0.52 abc	57.85 ef	43.14 c-f	1.37 de
3	FYM (20 ton/fed.)	7.03	0.88 abc	2.20	2.32 cd	0.62 cde	56.88 ef	50.14 f	1.33 de
4	FYM (30 ton/fed.)	7.00	0.93 abc	1.98	2.64 f	0.53 abc	60.63 f	46.12 ef	1.54 e
5	TR (10 ton/fed.)	7.16	0.72 a	1.92	2.23 bc	0.44 a	50.27 ab	38.77 a-d	1.02 ab
6	TR (20 ton/fed.)	7.11	0.97 abc	2.79	2.47 e	0.48 abc	56.71 def	44.08 def	1.28 cd
7	TR (30 ton/fed.)	7.12	1.32 c	4.67	2.41 de	0.52 abc	55.17 b-e	42.02 b-c	1.23 bcd
8	FYM (10 ton/fed.) + NPK	7.15	0.78 ab	2.79	2.12 b	0.47 abc	51.38 bc	38.35 a-d	1.07 abc
9	FYM (20 ton/fed.) + NPK	7.10	0.73 a	2.26	2.31 cd	0.47 abc	53.87 b-e	35.52 ab	1.17 bcd
10	FYM (30 ton/fed.) + NPK	7.11	1.21 bc	2.12	2.72 f	0.43 a	51.81 bc	35.81 ab	1.07 abc
11	TR (10 ton/fed.) + NPK	7.14	0.68 a	1.93	1.83 a	0.49 abc	46.08 a	33.02 a	0.87 a
12	TR (20 ton/fed.) + NPK	7.02	1.00 abc	2.55	1.89 a	0.46 ab	50.82 b	38.71 a-d	1.04 ab
13	TR (30 ton/fed.) + NPK	7.09	1.27 c	2.85	2.18 b	0.75 e	57.10 ef	43.42 c-f	1.36 de
14	FYM (5 ton/fed.) TR (5 ton/fed.) + NPK	7.19	0.72 a	2.19	2.15 b	0.52 abc	51.92 bcd	42.33 b-e	1.10 bc
15	FYM (10 ton/fed.) TR (10 ton/fed.) + NPK	7.19	0.98 abc	2.22	2.37 de	0.69 de	58.09 ef	47.06 ef	1.40 de
16	FYM (15 ton/fed.) TR (15 ton/fed.) + NPK	7.13	0.99 abc	2.53	2.41 de	0.47 abc	51.72 bc	37.25 a-d	1.07 abc
	F-test	---	*	---	**	**	**	**	**

[@] SAR : Sodium adsorption ratio, OM : Organic matter
[#] MWD : Mean weight diameter, WSA : Water stable aggregates
Opt. size : Optimum size of aggregates, SC : Structure coefficient.
*** and** indicate P < 0.05 and P < 0.01, respectively, according to F. test.**
Means followed by a letter in common are not significantly different at the 5% level according to Duncan's test.

Table (4): Soil chemical and physical properties as affected by farmyard manure and town refuse application to soil prior to pepper transplanting (second season, 1999).

No.	Treatments	Chemical properties@				Physical properties#			
		pH (1: 2.5)	EC, dS/m (1: 5)	SAR	OM %	MWD (mm.)	WSA %	Opt. Size %	SC
1	Recommended NPK	7.23	0.83 ab	2.20	1.85 a	0.48	52.30 bc	37.12 c	1.42 fg
2	FYM (10 ton/fed.)	7.13	0.85 ab	2.60	1.90 a	0.49	57.00 de	34.60 b	1.43 fg
3	FYM (20 ton/fed.)	7.06	0.84 ab	2.60	2.10 b	0.48	54.18 cd	45.18 g	1.39 efg
4	FYM (30 ton/fed.)	7.02	0.82 ab	2.15	2.58 e	0.58	58.22 e	39.80 ef	1.45 fg
5	TR (10 ton/fed.)	7.13	0.80 a	2.00	1.90 a	0.42	50.00 ab	35.42 b	1.10 bc
6	TR (20 ton/fed.)	7.12	0.92 b	3.00	2.26 c	0.52	54.20 cd	40.12 f	1.27 c-f
7	TR (30 ton/fed.)	7.16	1.25 d	4.10	2.40 d	0.50	53.10 bcd	35.52 b	1.10 bc
8	FYM (10 ton/fed.) + NPK	7.20	1.10 c	3.10	1.93 a	0.50	53.10 bcd	37.12 c	1.22 cde
9	FYM (20 ton/fed.) + NPK	7.13	1.81 e	2.35	2.12 bc	0.52	54.12 cd	34.32 b	1.22 cde
10	FYM (30 ton/fed.) + NPK	7.13	1.18 cd	2.30	2.60 e	0.40	54.10 cd	32.00 a	0.89 a
11	TR (10 ton/fed.) + NPK	7.14	0.75 a	2.00	1.80 a	0.52	48.00 a	34.34 b	1.28 def
12	TR (20 ton/fed.) + NPK	7.10	1.02 bc	2.55	2.10 b	0.45	52.20 bc	35.12 b	1.00 ab
13	TR (30 ton/fed.) + NPK	7.13	1.20 cd	3.28	1.93 a	0.60	55.83 cde	38.20 cd	1.12 bcd
14	FYM (5 ton/fed.) + TR (5 ton/fed.) + NPK	7.15	0.80 a	2.13	2.10 b	0.50	54.18 cd	38.80 de	1.30 ef
15	FYM (10 ton/fed.) + TR (10 ton/fed.) + NPK	7.17	0.85 ab	2.28	2.23 bc	0.60	58.22 e	48.10 h	1.50 g
16	FYM (15 ton/fed.) + TR (15 ton/fed.) + NPK	7.15	0.85 ab	2.35	2.25 c	0.52	53.21 bcd	37.14 c	1.39 efg
F-test		---	*	---	*	N.S	**	**	*

@ SAR : Sodium adsorption ratio, OM : Organic matter
 # MWD : Mean weight diameter, WSA : Water stable aggregates
Opt. size : Optimum size of aggregates, SC : Structure coefficient.
***, ** and N.S indicate $P < 0.05$, $P < 0.01$ and not significant, respectively, according to F. test.**
Means followed by a letter in common are not significantly different at the 5% level according to Duncan's test.

Table (5): Soil content of some macro and micro elements as affected by farmyard manure and town refuse application to soil prior to pepper transplanting (first season, 1998).

No.	Treatments	Macro elements in soil			DTPA-extractable in soil (µg/g)				
		Total N%	Available P (µg/g)	Available K (µg/g)	Fe	Zn	Cu	Ni	Cd
1	Recommended NPK	0.126 ab	56.20 abc	519.2 ab	5.38 a	2.33 ab	0.26 a	0.80 ab	0.135
2	FYM (10 ton/fed.)	0.119 a	60.96 abc	605.4 cd	6.96 a-d	7.26 f	0.31 cde	0.93 bcd	0.139
3	FYM (20 ton/fed.)	0.126 ab	37.50 a	714.5 e	6.75a-d	3.60 abc	0.32 de	0.86 abc	0.112
4	FYM (30 ton/fed.)	0.168 cd	73.40 bcd	887.0 g	6.44 abc	4.20 cd	0.34 e	0.76 a	0.138
5	TR (10 ton/fed.)	0.133 a-d	54.75 abc	530.0 b	7.55 bcd	3.30 abc	0.30 bcd	0.98 cde	0.115
6	TR (20 ton/fed.)	0.165 bcd	61.46 abc	605.0 cd	10.06 ef	2.28 a	0.29 a-d	0.95 bcd	0.126
7	TR (30 ton/fed.)	0.154 a-d	55.40 abc	587.5 c	13.00 g	3.12 abc	0.32 de	1.10 e	0.107
8	FYM (10 ton/fed.) + NPK	0.161 bcd	73.20 bcd	702.0 e	10.61 f	4.56 de	0.28 abc	0.84 abc	0.115
9	FYM (20 ton/fed.) + NPK	0.168 cd	99.45 de	807.0 f	6.57 abc	4.55 de	0.30 bcd	1.08 de	0.105
10	FYM (30 ton/fed.) + NPK	0.182 d	118.00 e	938.5 g	8.78 de	3.66 abc	0.26 ab	1.10 de	0.112
11	TR (10 ton/fed.) + NPK	0.147 a-d	42.46 ab	484.0 a	7.39 a-d	4.93 e	0.27 ab	0.83 abc	0.106
12	TR (20 ton/fed.) + NPK	0.154 a-d	126.27 g	507.0 ab	6.96 ab	4.38 cde	0.32 de	1.04 de	0.104
13	TR (30 ton/fed.) + NPK	0.154 a-d	39.41 a	577.5 c	7.84 cde	3.46 abc	0.32 de	1.04 bcd	0.126
14	FYM (5 ton/fed.) TR (5 ton/fed.) + NPK	0.140 a-d	56.75 abc	577.5 c	6.54 abc	3.20 abc	0.28 a-d	1.02 de	0.120
15	FYM (10 ton/fed.) TR (10 ton/fed.) + NPK	0.154 a-d	120.20 f	644.5 d	5.91 ab	3.27 abc	0.29 a-d	1.03 de	0.132
16	FYM (15 ton/fed.) TR (15 ton/fed.) + NPK	0.168 cd	80.29 cd	780.0 f	6.99 a-d	3.54 abc	0.31 cde	1.31 f	0.132
F-test		*	**	**	**	*	**	**	N.S.

***, ** and N.S indicate P < 0.05, P < 0.01 and not significant, respectively, according to F. test.**
Means followed by a letter in common are not significantly different at the 5% level according to 's test.

Table (6): Soil content of some macro and micro elements as affected by farmyard manure and town refuse application to soil prior to pepper transplanting (second season, 1999).

No.	Treatments	Macro elements in soil			DTPA-extractable in soil (µg/g)				
		Total N%	Available P (µg/g)	Available K (µg/g)	Fe	Zn	Cu	Ni	Cd
1	Recommended NPK	0.135	52.30 b	522.0 b	6.50 ab	2.70 b	0.30	0.85 a	0.125
2	FYM (10 ton/fed.)	0.141	60.12 c	620.3 d	6.02 a	5.20 j	0.30	0.90 abc	0.110
3	FYM (20 ton/fed.)	0.142	60.33 c	702.3 f	6.52 ab	3.80 ef	0.34	0.90abc	0.115
4	FYM (30 ton/fed.)	0.163	68.40 d	890.0 i	6.50 ab	4.50 h	0.35	0.80 a	0.128
5	TR (10 ton/fed.)	0.151	50.12 b	612.5 cd	7.00 bc	3.55 d	0.28	1.01 bcd	0.110
6	TR (20 ton/fed.)	0.161	60.20 c	610.2 cd	9.80 e	2.42 a	0.29	1.02 bcd	0.110
7	TR (30 ton/fed.)	0.162	58.20 c	611.2 cd	12.05 f	3.25 c	0.29	1.05 cd	0.110
8	FYM (10 ton/fed.) + NPK	0.143	70.20 de	720.0 g	10.0 e	4.70 i	0.31	1.00 bcd	0.105
9	FYM (20 ton/fed.) + NPK	0.166	90.20 f	800.5 h	7.00 bc	4.66 hi	0.31	1.00 bcd	0.100
10	FYM (30 ton/fed.) + NPK	0.168	110.20 g	920.0 j	7.99 d	3.90 f	0.29	1.03 cd	0.116
11	TR (10 ton/fed.) + NPK	0.154	43.50 a	476.2 a	7.00 bc	5.10 j	0.29	0.87 ab	0.105
12	TR (20 ton/fed.) + NPK	0.143	120.88 h	602.2 c	7.05 bc	4.70 i	0.34	1.03 bcd	0.120
13	TR (30 ton/fed.) + NPK	0.142	90.26 f	610.3 cd	7.50 cd	4.10 g	0.31	1.02 bcd	0.105
14	FYM (5 ton/fed.) TR (5 ton/fed.) + NPK	0.152	60.33 c	610.2 cd	7.00 bc	3.50 d	0.29	1.00 bcd	0.110
15	FYM (10 ton/fed.) TR (10 ton/fed.) + NPK	0.152	114.12 g	650.03 e	6.50 ab	3.55 d	0.30	1.02 bcd	0.120
16	FYM (15 ton/fed.) TR (15 ton/fed.) + NPK	0.152	75.12 e	800.1 h	7.06 bc	3.65 de	0.29	1.10 d	0.118
F-test		N.S	*	*	**	*	N.S	*	N.S

***, ** and N.S indicate P < 0.05, P < 0.01 and not significant, respectively, according to F. test.**
Means followed by a letter in common are not significantly different at the 5% level according to Duncan's test.

Table (7): Effect of farmyard manure and town refuse application to soil prior to pepper transplanting on plant growth and fruit yield (first season, 1998).

No.	Treatments	Stem Length (cm)	No. of leaves/ plant	Leaf fresh weight (g)	Leaf dry weight (g)	Fruit yield/plant (g)	Average fruit weight (g)	Total soluble solids (%)	Vitamin C (mg/100 g fresh fruit)
1	Recommended NPK	32.5 a	40.7 a	24.97 b	3.93 ab	248.3 a	46.9 ab	4.2	156.2
2	FYM (10 ton/fed.)	39.7 bc	45.6 b	22.00 a	3.51 a	253.6 a	47.3 ab	4.4	156.2
3	FYM (20 ton/fed.)	43.3 f	46.5 b	25.07 bc	4.05 ab	277.5 b	47.6 ab	4.4	158.2
4	FYM (30 ton/fed.)	39.0 b	48.4 c	26.20 bcd	4.28 abc	267.0 ab	47.4 ab	4.3	160.4
5	TR (10 ton/fed.)	40.9 cd	48.2 c	26.07 bcd	4.25 abc	285.6 bc	45.5 a	4.4	160.4
6	TR (20 ton/fed.)	45.0 g	51.8 e	27.93 def	4.55 b-e	301.2 cd	48.2 bc	4.3	158.2
7	TR (30 ton/fed.)	44.0 fg	48.0 c	26.07 bcd	4.30 abc	275.3 b	46.8 ab	4.4	165.3
8	FYM (10 ton/fed.) + NPK	42.6 ef	53.3 f	28.97 efg	4.77 b-e	325.5 ef	48.3 bc	4.5	174.9
9	FYM (20 ton/fed.) + NPK	45.6 g	55.6 g	30.20 ghi	5.06 c-f	332.9 ef	50.5 c	4.5	175.3
10	FYM (30 ton/fed.) + NPK	44.1 fg	53.2 f	27.77 def	4.53 b-e	315.7 de	47.5 ab	4.5	170.6
11	TR (10 ton/fed.) + NPK	45.1 g	50.1 d	27.17 cde	4.43 a-d	302.7 cd	48.5 bc	4.6	175.2
12	TR (20 ton/fed.) + NPK	41.5 de	61.9 j	32.10 l	5.40 ef	360.7 g	59.4 f	4.5	175.1
13	TR (30 ton/fed.) + NPK	45.1 g	57.5 h	31.53 hi	5.29 def	340.9 fg	53.6 d	4.5	173.6
14	FYM (5 ton/fed.) TR (5 ton/fed.) + NPK	41.6 de	54.6 g	29.53 fgh	4.88 b-e	327.9 ef	50.6 c	4.5	174.3
15	FYM (10 ton/fed.) TR (10 ton/fed.) + NPK	41.6 de	59.7 I	34.20 j	5.80 f	360.8 g	56.2 e	4.5	175.2
16	FYM (15 ton/fed.) TR (15 ton/fed.) + NPK	45.3 g	52.6 ef	28.40 efg	4.70 b-e	287.4 bc	48.5 bc	4.4	170.5
	F-test	*	**	*	*	**	*	N.S	N.S.

***, ** and N.S indicate P < 0.05, P < 0.01 and not significant, respectively, according to F. test.**
Means followed by a letter in common are not significantly different at the 5% level according to Duncan's test.

Table (8): Effect of farmyard manure and town refuse application to soil prior to pepper transplanting on plant growth and fruit yield (second season, 1999).

No.	Treatments	Stem length (cm)	No. of leaves/ plant	Leaf fresh weight (g)	Leaf dry weight (g)	Fruit yield/plant (g)	Average fruit weight (g)	Total soluble solids (%)	Vitamin C (mg/100 g fresh fruit)
1	Recommended NPK	30.1 a	47.2 ab	21.17 a	3.56 a	328.3 ab	53.0 ab	4.3	155.5
2	FYM (10 ton/fed.)	35.6 b	44.1 a	25.50 b	4.34 b	312.9 a	56.6 c	4.5	145.8
3	FYM (20 ton/fed.)	35.5 b	51.5 cde	26.50 b	4.53 bc	341.6 bc	55.5 bc	4.5	159.3
4	FYM (30 ton/fed.)	40.2 c	48.2 bc	26.50 b	4.58 cd	345.3 bc	55.3 bc	4.2	162.6
5	TR (10 ton/fed.)	40.4 c	52.7 def	27.30 bc	4.75 de	350.7 c	56.2 c	4.2	165.5
6	TR (20 ton/fed.)	42.5 cd	51.9 cde	28.17 bcd	4.94 e	355.1 cd	58.4 cd	4.5	163.5
7	TR (30 ton/fed.)	44.0 de	51.8 cde	28.10 bcd	4.88 e	360.7 cde	58.5 cd	4.5	165.6
8	FYM (10 ton/fed.) + NPK	44.2 de	56.3 fg	30.10 cde	5.33 f	380.7 fg	61.2 de	4.5	172.8
9	FYM (20 ton/fed.) + NPK	46.7 e	54.6 ef	33.33 ef	5.52 fg	390.8 fgh	62.6 ef	4.6	174.0
10	FYM (30 ton/fed.) + NPK	48.6 f	54.6 ef	30.20 cde	5.37 f	375.2 ef	62.7 ef	4.5	174.0
11	TR (10 ton/fed.) + NPK	45.6 de	50.3 bcd	35.23 f	6.34 i	372.6 def	60.5 de	4.5	176.6
12	TR (20 ton/fed.) + NPK	42.5 cd	56.5 fg	35.23 f	6.38 i	405.5 h	65.2 f	4.6	175.7
13	TR (30 ton/fed.) + NPK	46.6 e	54.6 ef	31.40 de	5.60 g	395.5 gh	65.1 f	4.6	175.8
14	FYM (5 ton/fed.) TR (5 ton/fed.) + NPK	43.9 de	52.8 def	30.23 cde	5.35 f	388.2 fgh	60.2 de	4.5	175.3
15	FYM (10 ton/fed.) TR (10 ton/fed.) + NPK	41.5 cd	58.6 g	33.43 ef	6.00 h	401.3 h	65.2 f	4.7	179.8
16	FYM (15 ton/fed.) TR (15 ton/fed.) + NPK	43.5 cd	52.7 def	33.33 ef	5.51 ef	350.3 c	52.0 a	4.6	178.3
	F-test	*	*	**	*	*	*	N.S	N.S

***, ** and N.S indicate P < 0.05, P < 0.01 and not significant, respectively, according to F. test.**

Means followed by a letter in common are not significantly different at the 5% level according to Duncan's test.

Table (9): Effect of farmyard manure and town refuse application to soil prior to pepper transplanting on fruit content of some macro and micro elements (first season, 1998).

No.	Treatments	Macro elements (% fruit dry weight)			Micro elements (µg/g fruit dry weight)				
		N	P	K	Fe	Zn	Cu	Ni	Cd
1	Recommended NPK	2.87 g	1.70 f	3.39 b	822.5 j	45.75 j	5.02 c	2.99 i	0.44 m
2	FYM (10 ton/fed.)	2.98 i	1.81 hi	4.10 f	636.1 d	54.62 m	5.00 c	2.56 d	0.31 d
3	FYM (20 ton/fed.)	3.36 k	2.04 l	4.25 h	645.1 e	63.50 n	5.13 d	2.60 e	0.34 g
4	FYM (30 ton/fed.)	4.41 m	2.06 l	7.70 l	840.0 k	54.00 l	5.03 c	3.14 i	0.39 k
5	TR (10 ton/fed.)	3.08 j	1.70 f	3.39 b	807.5 i	36.75 g	2.51 b	3.60 k	0.45 o
6	TR (20 ton/fed.)	2.74 e	1.94 k	4.25 h	780.3 h	52.90 k	2.51 b	1.47 a	0.18 b
7	TR (30 ton/fed.)	2.94 h	1.80 h	5.75 j	917.5 i	44.80 i	5.01 c	2.14 c	0.28 c
8	FYM (10 ton/fed.) + NPK	2.52 c	1.83 i	6.78 k	1188.0 n	65.12 o	2.51 b	3.42 j	0.38 j
9	FYM (20 ton/fed.) + NPK	2.94 h	1.77 g	4.61 i	546.1 c	34.25 f	2.50 b	2.99 h	0.33 f
10	FYM (30 ton/fed.) + NPK	3.72 l	1.81 hi	3.71 d	475.8 b	27.76 d	2.50 b	2.84 f	0.45 n
11	TR (10 ton/fed.) + NPK	2.40 a	1.30 a	3.02 a	727.6 g	41.50 h	2.50 b	2.70 e	0.36 h
12	TR (20 ton/fed.) + NPK	2.73 e	1.39 b	3.53 c	1215.0 o	31.50 e	2.50 b	3.14 i	0.41 l
13	TR (30 ton/fed.) + NPK	2.67 d	1.52 d	4.14 g	992.5 m	17.50 ab	2.50 b	2.90 g	0.37 i
14	FYM (5 ton/fed.) TR (5 ton/fed.) + NPK	2.95 h	1.89 j	3.85 e	807.5 i	24.25 a	2.50 b	2.25 cd	0.34 g
15	FYM (10 ton/fed.) TR (10 ton/fed.) + NPK	2.46 b	1.41 c	3.39 b	397.5 a	17.25 c	1.37 a	1.75 b	0.10 a
16	FYM (15 ton/fed.) TR (15 ton/fed.) + NPK	2.81 f	1.57 e	4.13 g	715.2 f	18.25 b	2.50 b	1.25 a	0.32 e
	F-test	**	**	*	**	**	**	**	**

*** and ** indicate P < 0.05 and P < 0.01, respectively, according to F. test.**
Means followed by a letter in common are not significantly different at the 5% level according to Duncan's test.

Table (10): Effect of farmyard manure and town refuse application to soil prior to pepper transplanting on fruit content of some macro and micro elements (second season, (1999).

No.	Treatments	Macro elements (% fruit dry weight)			Micro elements (µg/g fruit dry weight)				
		N	P	K	Fe	Zn	Cu	Ni	Cd
1	Recommended NPK	2.82 bc	1.68	6.45 g	812.5 fg	40.26 ef	4.50 f	2.75 f	0.40 g
2	FYM (10 ton/fed.)	2.80 bc	1.70	3.90 b	702.6 d	49.52 h	4.50 f	2.60 de	0.30 c
3	FYM (20 ton/fed.)	2.99 c	1.85	4.30 d	702.6 d	49.03 gh	4.50 f	2.60 de	0.31 c
4	FYM (30 ton/fed.)	3.98 e	1.86	6.50 g	810.4 fg	60.13 i	4.90 g	3.01 gh	0.35 f
5	TR (10 ton/fed.)	2.90 c	1.66	4.12 c	820.3 g	33.02 de	3.00 e	3.40 i	0.40 g
6	TR (20 ton/fed.)	2.50 b	1.65	4.12 c	802.2 f	50.23 h	2.80 c	1.60 a	0.15 a
7	TR (30 ton/fed.)	2.90 c	1.65	5.10 e	850.2 h	41.03 efg	4.40 f	2.00 b	0.30 c
8	FYM (10 ton/fed.) + NPK	2.80 bc	1.80	5.55 f	960.2 l	61.13 i	2.95 cde	3.10 h	0.34 e
9	FYM (20 ton/fed.) + NPK	2.76 bc	1.80	5.00 e	520.3 c	31.02 cd	2.80 c	2.50 d	0.30 c
10	FYM (30 ton/fed.) + NPK	3.47 d	1.69	5.00 e	490.3 b	30.02 bcd	3.00 e	2.51 d	0.40 g
11	TR (10 ton/fed.) + NPK	2.50 b	1.40	3.50 a	805.2 fg	42.03 fgh	2.96 de	2.50 d	0.30 c
12	TR (20 ton/fed.) + NPK	2.75 bc	1.40	4.05 c	1050.5 k	32.03 cd	2.83 cd	2.90 g	0.36 f
13	TR (30 ton/fed.) + NPK	2.91 c	1.40	3.60 a	1005.3 j	23.06 ab	2.85 cde	2.70 ef	0.33 d
14	FYM (5 ton/fed.) TR (5 ton/fed.) + NPK	2.90 c	1.75	3.80 b	820.2 g	20.05 a	2.82 cd	2.20 c	0.30 c
15	FYM (10 ton/fed.) TR (10 ton/fed.) + NPK	2.20 a	1.70	3.80 b	455.5 a	26.04 a-d	2.60 b	1.50 a	0.22 b
16	FYM (15 ton/fed.) TR (15 ton/fed.) + NPK	2.80 bc	1.50	3.85 b	750.3 e	24.03 abc	2.10 a	2.02 b	0.30 c
F-test		*	N.S	*	**	*	*	*	*

***, ** and N.S indicate P < 0.05, P < 0.01 and not significant, respectively, according to F. test.**
Means followed by a letter in common are not significantly different at the 5% level according to Duncan's test.