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Evaluation of Some Soil Conditioners by Tetra-Factorial Computer Model and Their Effects on Some Soil Chemical Properties and its Productivity.

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Abstract: Field experiments were undertaken to evaluate the effect and residual effects of some natural soil amendments, i.e., farmyard manure, sheep manure, rabbit manure and pigeon manure and their combinations on improving some soil chemical properties, availability of some macronutrients as well as the productivity of maize and wheat crops. Furthermore, economical analysis was done by calculating the net income and investment ratios for every treatment to determine the economical treatment. The experiments were conducted at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate, during two consecutive growing seasons. The first season was during summer 2012 where zea mays (three- way cross 321) were grown. Wheat grains (Sakha 93 variety) were planted during the next season, winter 2012/2013. The experiments were conducted in a randomized complete block design with three replicates. Nineteen treatments having different (FYM), (SM), (RM) and (PM) ratios were used to cover all possible combinations of these amendments as well as control (untreated soil). The results were shown in tetrahedron forms using tetra-factorial computer model.

1- Organic natural soil amendments had slightly decreases in soil reaction (pH) and progressive increases in soil salinity (EC) with all added organic amendments for the two soil depths (0-15 and 15-30cm) in the two growing seasons. Also, soluble cations and anions slightly increased with all added treatments, except soluble Na decreased in some cases. SAR values were decreased while TSS values were increased compared with the control for the two soil depths in the two growing seasons.

2- Exchangeable Ca, Mg, K and CEC were increased with all added amendments while, Ex. Na and ESP were decreased.

3- Generally, the application of organic amendments clearly enhanced the nutrients statues of the investigated soil.

4- Organic carbon (OC, %) and C/N ratio were increased as a result of the four amendments and its combinations.

5- All added amendments gave increases in values of maize and wheat studied characters compared with the control. The highest values of yield and its components for maize and wheat plants were obtained by mixing the four used amendments of (FYM), (SM), (RM) and (PM) each by 1/4 or 2.5 : 2.5 : 2.5 : 0.25 ton/ fed., respectively.

6- According to the economical analysis, the combination consists of 2.5: 2.5: 2.5: 0.25 ton/ fed. of (FYM), (SM), (RM) and (PM), respectively was the most valuable compared with other treatments, since it gave the highest net income (14277.67 LE/ fed.). While, the lowest values were always incorporated with control (without organic manure application). The same trend was observed for investment ratio values.

7- From the above results its more useful to use combinations of these natural amendments in the presence of half recommended dose of mineral fertilizers to get markedly improved of both chemical properties and nutrients which reflect on higher yield incorporated with higher net income and investment ratio.
Key words: Tetrahydron, natural soil conditioners, farmyard manure(FYM), sheep manure (SM), rabbits manure (RM), and pigeon manure(PM).

Introduction

The use of organic materials causes a reduce of application chemical fertilizers in farm fields and decrease yield differences between conventional and less consumption of agricultural inputs farming [1].

It has been found that application of organic amendments can improve physical and chemical properties of soil and increase soil nutrient and water-holding ability and crop production [2, 3].

Some of the primary effects of use organic fertilizers are increased soil organic matter (SOM) and improved soil properties for crop growth [4]. Since most animal manures are land-applied for their nutrient values [5]. Manure can serve as a source of important plant nutrients including phosphorus (P) and nitrogen (N) [6]. Short-term experiments show that in chemical fertilizers a higher percentage of nitrogen can be absorbed by plants in compared to organic fertilizers. This is due to slowly release of nitrogen in organic fertilizers [7]. Long-term experiments have shown that neither the chemical fertilizer nor organic manure alone can help achieve sustainable crop production[8]. Organic manures are slow release nitrogen fertilizers where natural organic materials are broken down slowly by the soil microorganisms [9]. Moreover, organic fertilizer is considered as an important source of humus, macro and micro elements carrier, and at the same time it increases the activity of the useful microorganisms[10].

Soil pH, soil total organic C, and total N increased due to application of organic fertilizers with or without inorganic fertilizers [11]. Soil electrical conductivity and organic matter were increased by increasing organic fertilizer dose, but soil pH was not affected by different fertilizer doses [12]. Successive application of Chicken, pig and pigeon manures in dry seasons after three crops resulted in an increase in soil TSS, a decrease in pH, and favored secondary soil salinization. Except for Ca^{2+}, the contents of K^+, Na^+, Mg^{2+}, SO_4^{-2} and Cl^- significantly or positively increased with the application rate of CM and PM. Ionic composition of soil salinity changed with types and rates of fertilizers and their combinations applied. Results also showed that potential risk of secondary soil salinization exists with successive application of animal manure even in the humid region like Guangzhou south China[13]. Chemical properties improved by manure application include cation exchange capacity and soil buffering potential [14]. Sheep manure application increased soil organic matter and soil cation exchange capacity, and therefore the soil nutrient retention capacity was increased[15]. The application of different types of organic manures reduced the acidic levels of both the soils and enhanced soil organic C, total N, available P, exchangeable K and CEC better than NPK fertilizer in both soils[16]. Organic matter content and the concentration of macronutrients (N. K and P) were increased significantly with increasing the application rate of farmyard manure[17]. Chicken manure (CM) was more effective for all the studied traits than FYM when either the organic manures applied singly or in combination with chemical NPK fertilizers[18]. Organic fertilizers can neutralize or decreases the soil acidity and supply some micronutrients such as zinc, and copper [19].

Using organic manure fertilizers was found to improve plant growth, yield and yield quality on pea [20] and sweet pepper [21].

The effect of organic manures fertilizer on growth and yield of cowpea (*Vigna unguiculata*) plants. The obtained results indicated that, application of chicken manure combined with cattle manure or pigeon manure combined with chicken manure, cattle manure or rabbit manure were superior and significantly increased plant height, number of leaves, number of branches, leaf area, number of pods, seed index, seeds total yield and contents of P and K in seeds and P in leaves [22].

Flax growth parameters and the yield as well as chemical composition of seeds were increased with increasing FYM rate. In general application of either FYM at the rate of 30 m^3 fed^{-1} with 50% of the recommended dose of N and P or bio-fertilizers significantly increased plant growth parameters, i.e., plant height, fruiting zone length and total fiber length. Also, marked increments in yield components, i.e., No. of capsules plant^{-1}. No. of seed capsule^{-1}, seed index and weight of seed plant^{-1} were obtained [23]. The application of sheep manure produced significant increase in number of fruits of chilli pepper (Capsicum frutescence L.) by more than 203% and seeds per plant were increased by over 270%. dry fruit yields (Kg ha^{-1}) recorded 229% increase [24]. There was no significant difference in yield of onion bulbs due to chicken manure in both years, but in general the yield increased significantly with sheep manure and inorganic fertilizer. In general the yield of onion bulbs was higher in the second year compared with the first year [25]. Soil application of chicken manure and olive mills waste- water increased the plant yield of cowpea plant (Vigna sinensis)[26].

The objective of the present work is to investigate the effect and residual effects of farmyard manure, sheep manure, rabbits manure and pigeon manure and its combinations as natural soil conditioners for clayey soils of Nile delta on some soil chemical properties and its productivity

Materials and Methods

Tetra factorial computer model by [27] was applied using farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM) as natural soil conditioners at the experimental farm of El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate during two consecutive growing seasons 2012 and 2013. The initial properties of the experimental soil at the depths 0-15 and 15-30 cm are presented in Table (1-a) and analysis results of the investigated organic manures are shown in Table (1-b). The experiment was initiated in summer season 2012 using maize plants (*Zea mays*) and lasted for winter season 2012/2013 using wheat plants (*Hordum vulgare*), to evaluate the effect and residual effects of natural soil conditioners on improving some chemical properties of clay loam soil.

The investigated materials in the experiment, farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM) were designated as X_1, X_2, X_3, and X_4 respectively, which placed on the soil surface before sowing, during seed bed preparation in the first season. They were applied at levels ranging from zero to a maximum. The maximum doses per feddan of FYM, SM, RM and PM were (10, 10, 10, and 1 ton feddan^{-1}) respectively. There were 19 treatments, which cover all the possible combinations of different organic manure (Table 1- c). The maximum dose of each factor was assigned 8-points score, where the maximum dose of each manure was 100% graduated on a tetrahedron shape into 8 levels. The four organic manure were allocated on the four head of the tetrahedron on which sites they were equal to the maximum 100 % or 8 points graduated to be 0% on the opposite base (Fig. l).

Table (1- a) : Initial soil properties before sowing

Soil depth, cm	0 – 15	15 – 30	Soil depth, cm	0 – 15	15 – 30
Physical properties					
Particle size distribution			Texture class	Clay loam	Clay loam
Coarse sand, %	5.28	4.73	Bulk density (Db, g cm^{-3})	1.28	1.34
Fine sand, %	18.79	17.72	Total porosity (E, %)	51.70	49.43
Silt, %	39.06	38.98	Hydraulic conductivity (Kh, cm hr^{-1})	0.52	0.50
Clay, %	36.87	38.57	$CaCO_3$, %	3.55	3.49
Chemical properties					
pH 1 : 2.5 (Suspension)	7.84	7.95	Organic matter (O.M., %)	2.31	1.92
EC *, dSm^{-1}	2.06	2.31	Organic carbon (O.C., %)	1.340	1.114
Soluble cations *, meq l^{-1}			Soluble anions *, meq l^{-1}		
Ca^{2+}	5.53	5.76	CO_3^{2-}	0.00	0.00
Mg^{2+}	5.18	6.44	HCO_3^-	4.92	5.62
Na^+	9.66	10.70	Cl^-	8.48	10.13
K^+	0.23	0.20	SO_4^{2-}	7.20	7.35

* In soil paste extract.

The intersection between the graduated planes results in different combinations of the investigated factors which lie either on the surface of the tetrahedron or inside it. These combinations are illustrated in Table (1- c) in which treatments 1 to 4 and 6 to 11 lie on the surface of the tetrahedron while treatments 12 to 19 lie inside it, whereas treatment 5 lies exactly on the tetrahedron center and consists of the four organic manure such that the level of each organic manure equal 25% of each or 2 units of each with the sum being 8 units. The sum of any treatment is 8 units or 100% as shown in Table. (1- c).

Table (1-b): Some chemical characteristics of the investigated organic manures.

Properties	farmyard manure (FYM)	Sheep manure (SM)	Rabbit manure (RM)	Pigeon manure (PM)
pH (1:10 manure: water)	7.42	7.15	9.25	6.85
EC, dS m^{-1}(1:10 manure:water)	1.34	7.92	6.07	4.60
Organic matter, %	29.92	34.22	33.57	32.52
Organic carbon, %	17.35	19.85	19.47	18.86
Total N, %	0.78	1.94	2.69	3.97
C/N ratio	22.24	10.23	7.24	4.75
P, %	0.041	0.820	0.590	0.790
K, %	0.514	2.042	1.386	1.267
Ca, %	0.98	2.26	2.08	1.14
Mg, %	0.40	2.44	2.89	2.57
Na, %	0.28	1.18	1.08	0.80
Fe, ppm	36.00	26.00	43.50	58.00
Mn, ppm	51.83	3.85	5.20	7.95
Zn, ppm	20.55	5.70	10.50	15.00
Cu, ppm	10.63	6.95	10.50	12.15

Table (1-c) : The chosen combinations of farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM)

Treatment No.	Relative concentration percentages				Amount of amendments, Ton/fed			
	(FYM) (X_1)	(SM) (X_2)	(RM) (X_3)	(PM) (X 4)	(FYM)	(SM)	(RM)	(PM)
1	100.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00
2	0.00	100.00	0.00	0.00	0.00	10.00	0.00	0.00
3	0.00	0.00	100.00	0.00	0.00	0.00	10.00	0.00
4	0.00	0.00	0.00	100.00	0.00	0.00	0.00	1.00
5	25.00	25.00	25.00	25.00	2.50	2.50	2.50	0.25
6	50.00	50.00	0.00	0.00	5.00	5.00	0.00	0.00
7	50.00	0.00	50.00	0.00	5.00	0.00	5.00	0.00
8	50.00	0.00	0.00	50.00	5.00	0.00	0.00	0.50
9	0.00	50.00	50.00	0.00	0.00	5.00	5.00	0.00
10	0.00	50.00	0.00	50.00	0.00	5.00	0.00	0.50
11	0.00	0.00	50.00	50.00	0.00	0.00	5.00	0.50
12	62.50	12.50	12.50	12.50	6.25	1.25	1.25	0.13
13	12.50	62.50	12.50	12.50	1.25	6.25	1.25	0.13
14	12.50	12.50	62.50	12.50	1.25	1.25	6.25	0.13
15	12.50	12.50	12.50	62.50	1.25	1.25	1.25	0.63
16	31.25	31.25	31.25	6.25	3.13	3.13	3.13	0.06
17	31.25	31.25	6.25	31.25	3.13	3.13	0.63	0.31
18	31.25	6.25	31.25	31.25	3.13	0.63	3.13	0.31
19	6.25	31.25	31.25	31.25	0.63	3.13	3.13	0.31

The experimental fields consisted of 19 plots with three replicates, each plot was done in 2.5 m length and 2.0 m width. Treatments were prepared according to Table (1- c).

Maize grains (*Zea mays*, three-way cross-321) were planted in the first season (summer 2012) at the rate of 15 kg/fed. during the first week of June 2012. While wheat grains (Sakha 93 variety) were planted in the second season (winter 2012/2013) at the rate of 60 Kg/fed. during the third week of November 2012.

The addition of organic manure were done before maize planting in the first season only and the residual effects of these manures were studied on wheat crop in the second one, where the same experimental plots were left without application of any soil conditioners to study the residual effects of applied soil conditioners in the first season. During the two seasons, half of the basal doses of N, P and K were applied according to the recommendations for each crop, for maize 60 Kg N/fed in the form of ammonium nitrate (33.5 % N), 31 Kg P_2O_5/fed in the form of supper phosphate (15.5 % P_2O_5) and 24 Kg K_2O /fed in the form of potassium sulphate (48% K_2O), for wheat 35 Kg N/fed as ammonium nitrate, 7.5 Kg P_2O_5/fed as supper phosphate and 24 Kg K_2O /fed as potassium sulphate). All other necessary operations except those under study were kept normal and uniform for all the treatments according to the recommendations of El-Gemmeiza Research Station.

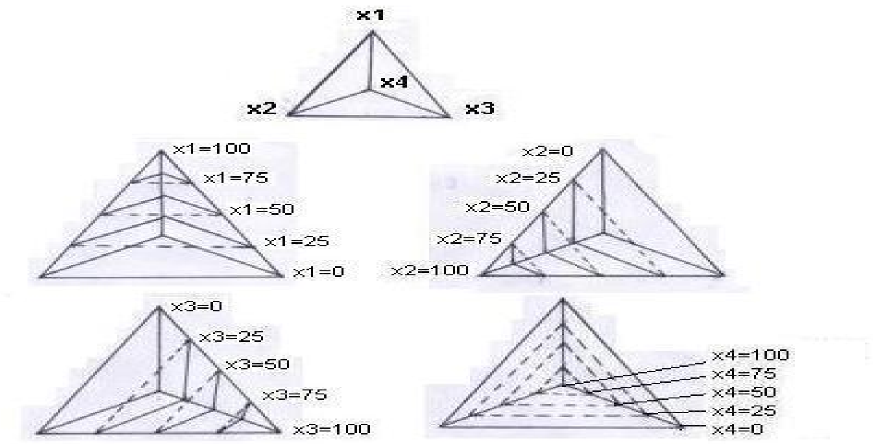

Fig. (1): The location of the four factors on the tetrahedron in which x = 100 % in the top and zero % in the oppesite base

At harvesting time, total yield of maize and wheat for each plot was weighed and related to Ton/fed. Also, wheat straw Ton/fed., 100 corn seed and 1000 wheat seed weight were determined for each treatment, besides ten random plants per plot were chosen at the harvest of each crop to determine the following growth characters.

Maize growth characters:

1- Plant height, cm 2- Ear length, cm
3- Ear diameter, cm 4- No. of rows per ear.
5- No. of kernels per row 6-Dry matter after 80 days of sowing, g/plant

-Wheat growth characters.

1- Plant height, cm 2- Spike length, cm
3- Harvest index 4- Dry matter after 90 days of sowing, g/10 plants

Soil samples (0-15 and 15-30 cm depths) were collected from each plot in each season after crop harvesting. The collected soil samples were air-dried, ground in a ceramic mortar and passed through 2 mm sieve and stored for chemical analysis. Soil chemical analyses were done according to the standard methods reported by [28]**.**

Soil pH in soil water suspension (1:2.5) and Soil electrical conductivity (EC, dSm^{-1}) in soil paste extract were measured. Soluble cations and anions were determined in soil paste extract using the methods described by [28], Sodium Adsorption Ratio (SAR) was calculated as :-

$$SAR = \frac{Na^{+} \ meq/l}{\sqrt{\frac{Ca^{++} + Mg^{++} \ meq/l}{2}}}$$

Total soluble salts, % were calculated according to the following equation :

$$T.S.S., \ \% = \frac{EC \ dSm^{-1} \ x \ 0.064 \ x \ SP}{100} \quad ,$$

where : SP = Saturation percentage

Cation exchange capacity (CEC, meq/100g soil) was determined using sodium acetate solution 1.0 N with pH 8.2, exchangeable cations (meq/100g soil) were displaced using 1.0 N ammonium acetate solution. Exchangeable sodium percentage (ESP, %) was calculated according to the following equation :-

$$ESP, \ \% = \frac{Ex. \ Na \ meq/100 \, g.soil}{CEC \ meq/100 \, g.soil} \times 100$$

Organic matter was determined by **Walkely and Black** method according to [29]**.** Total NPK of the two soil depths (0-15 and 15-30 cm) were determined according to [30]**.** Nitrogen by macro-kjeldahel method, phosphorus by ascorbic acid molybdenum blue method and potassium by flame photometer method.

Economic evaluation was done to compare between different treatments to state which one is the best. The test was executed according to the price of the yield (1500 LE/Ton) maize in the first season and (2500 LE/Ton) grain of wheat and (1000 LE/Ton) straw of wheat in the second season, as well as the cost of different treatments were calculated considering conventional method of both fixed and variable costs.

Each of determined parameters was passed through the tetra factorial computer program model of [27] in which the results of certain parameter (Y) of all the possible combination were printed. The location of Y value lies either on the surface of the tetrahedron or inside it. Each value refers to a specific combination of X_1, X_2, X_3 and X_4 according to its position on or inside the tetrahedron influencing this value. The values on the surface tetrahedron can be drown with the aid of the program as large triangles representing the four bases of the principal tetrahedron (open structure).

The three vertices of the large triangle represent the top of the tetrahedron X4, while its three mid points represent X_1, X_2 and X_3. Smaller interior tetrahedral can be visualized with specific X maxima and X minima. The value of X maximum or X minimum of the interior tetrahedra can be taken as 12.5, 25, 37.5, 50, 62.5, 75, 87.5 % of the X -maximum of the principal tetrahedron. Also the surface area of the interior tetrahedron will be given by the computer program as a whole planar triangle consisting of four smaller ones with the three main vertices of this triangle as the top of the interior tetrahedron. The total number of the output values will be 165 corresponding to the same number of single or combined treatments located either on the surface area of the principal tetrahedron or of the interior ones. The values located on the surface area of the principle tetrahedron amount to 130 corresponding to 4 single, 21 double and 105 triple factorial treatments. The other values located inside the principal tetrahedron amount to 35 tetra factorial combined treatments.

To facilitate interpreting the obtained results, equivalent transparent diagrams may used showing the intersections points between X_1, X_2, X_3 and X_4 as defined by their equivalent real values of the actual used conditioners. Moreover, the average value, general mean error, correlation coefficient, Fisher criterion, adequacy test of the model through the treatments 15 to 19 and the optimum combination of each parameter were of the program output.

Results and Discussion

I- Effect of different treatments on some soil chemical properties.

1- Soil reaction (pH).

Data in Tables (2 and 3) indicate that all different treatments caused a slightly decreases in soil reaction (pH) at the two seasons of (0-15 and 15-30 cm) depths compared with the control. The decrease in soil pH was ranged between 7.57 and 7.73, 7.67 and 7.83 in the first season and between 7.55 and 7.74, 7.62 and 7.81 in the second one for 0-15 and 15-30 cm depths, respectively. The results reveal that the effect of natural soil conditioners on soil pH may be more clearly in the second season. The decrease in soil pH values by these organic amendments application may have been caused by soil microbial activity that produces CO_2 and organic acids.

Values in Tables (2 and 3) and Fig. (2) show soil pH at soil depth (0-15cm) in the first season as affected by FYM, SM, RM and PM, it can be noticed from Fig. (2a) that soil pH was decreased to a minimum of 7.60 corresponding to an interpolated combined treatment consisting of [2:6:0:0], [3:5:0:0], [4:4:0:0] (of the 8 points score) of X_1, X_2, X_3 and X_4 respectively. In other words, farmyard manure with sheep manure played an important role in pH reduction. Whereas rabbits manure and pigeon manure resulting less role on decreasing soil pH. Comparing the values located on the sites of the four single treatments (the four head of the tctrachedron) X_1, X_2, X_3 and X_4 reveal that sheep manure (SM) single treatment was more effective on decreasing soil pH 7.64 than rabbits manure (RM) 7.63, farmyard manure (FYM) 7.69 or pigeon manure (PM) 7.70. The order of effect is SM > RM > FYM > PM. These results could be explained from the point of view that sheep manure may have improved the soil pH, on the other hand pigeon manure gave the maximum pH value. The combinations between FYM, SM, RM and PM gave the weak effect on soil pH where r = 0.19, 0.31 in the first season, and 0.33, 0.28 in the second one of (0-15 and 15-30 cm depths), respectively.

The other intersecting points inside the tetrahedron (Fig 2b) show the lowest pH value was 7.57 located in the small tetrahedron corresponding to combination treatment of [2: 4: 1: 1], [3: 3: 1: 1] of (the 8 points score), or in other words, the actual composition can be detected as [2.5: 5: 1.25: 0.13], [3.75: 3.75: 1.25: 0.13] ton feddan^{-1} of FYM, SM, RM and PM, respectively, emphasizing the role of SM in decreasing soil pH. Moreover, Fig. (3c) indicates that, the central point of the tetrahedron has a pH of 7.61 corresponds to a treatment of [2: 2: 2: 2], i.e, equivalent mixture of the four amendments used.

The results reveal that there is no wide variation between the different treatments on soil pH values. Similar results were obtained by [31], they reported that the magnitude of pH change depends on many soil properties, including buffering capacity and length of time after the application organic materials.

2- Soil salinity (EC) and soluble ions.

Data in Tables (2 and 3) show that all different treatments led to significant affects on soil EC values. Generally, the results reveal that application of natural soil conditioners led to significant increases in soil EC values at the two seasons of (0-15 and 15-30 cm) depths, respectively as compared with the control.

The highest EC values were 3.56 and 3.98 dSm^{-1} for the two soil depths (0-15 and 15-30 cm) respectively, which attained by added sheep manure only at the second season compared with the control (2.21 and 2.49 dSm^{-1}). This means that the EC values at this treatment were increased by 61.09 and 59.84 % over the control (at zero treatment application amendment in the first season). Also, the EC values were slightly increased as soil depth increased and in the second season. Similar results was obtained by [32], who reported that the addition of sewage sludge to the soil can increase the amounts of soluble salts, SAR and ESP to the hazard limits which affect the soil and plant growth. These results are in agreement with those reported by [33].

The results in Tables (2 and 3) and Fig. (3) reveal that the SM single treatment gave the maximum EC (3.41 dSm^{-1}) over all the other three ones, while the FYM gave the minimum EC (2.47 dSm^{-1}). The order of effect is SM > RM > PM > FYM, in other words the FYM should be preferred due to its less effect on rising soil salinity. The combination effect between FYM, SM, RM and PM gave the highly effect on soil EC where r = 0.96, 0.96 in the first season, and 0.92, 0.94 in the second one for (0-15 and 15-30 cm) depths, respectively. Scanning the different values of Fig (3a) show a minimum value of 2.47 dSm^{-1} corresponding to [8: 0: 0: 0], [7: 0: 0: 1], [6: 0: 0:2] of (the 8 point score) i.e [10: 0: 0: 0], [8.75: 0: 0: 0.13], [7.50: 0: 0: 0.25] ton $feddan^{-1}$ of FYM, SM, RM and PM, respectively. This is considered as absolute minimum.

Scanning the other values inside the tetrahedron Fig (3b), it can be concluded that the FYM gave the lowest EC values (2.61 dSm^{-1}). This value was obtained by using the addition of FYM, SM, RM and PM at the rate [5: 1: 1: 1] (of the 8 points score) of X_1, X_2, X_3 and X_4 respectively. In other words, [6.25: 1.25: 1.25: 0.13] ton $feddan^{-1}$ of them, respectively. On the other hand, the SM gave the highest EC values, where it increased to 3.32 dSm^{-1} by the application of FYM, SM, RM and PM at the rate [1: 5: 1: 1] (of the 8 points score) of X_1, X_2, X_3 and X_4 respectively. In other words, [1.25: 6.25: 1.25: 0.13] ton $feddan^{-1}$ of FYM, SM, RM and PM, respectively. Fig. (3c) indicates that the center point of the tetrahedron has an EC of 3.01 dSm^{-1} corresponding to treatment of [2: 2: 2: 2] of the equivalent mixture of the four amendments used.

Concerning the soluble cations and anions, the results in Tables (2 and 3) indicate that the soluble calcium, magnesium, potassium, chloride and sulphate increased by the application of natural soil conditioners as compared with the control treatment, which take the same trend as soil EC values.

Table (2): Effect of different treatments on some soil chemical properties in the first season (summer 2012).

Treatment No.	pH, 1:2.5 (susp.)		EC *, dSm-1		Cations *, meq/l								Anions *, meq/l						SAR		TSS, %	
					Ca^{++}		Mg^{++}		Na^{+}		K^{+}		HCO_3^-		Cl^-		SO_4^{--}					
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1	7.69	7.78	2.47	2.68	8.23	9.01	7.79	9.34	8.45	8.12	0.26	0.22	4.14	4.55	11.93	13.67	8.66	8.47	2.99	2.68	0.12	0.12
2	7.64	7.75	3.41	3.78	10.64	11.90	9.97	11.25	13.28	14.46	0.36	0.35	5.06	5.75	16.21	18.69	12.98	13.52	4.14	4.25	0.16	0.18
3	7.63	7.72	3.29	3.62	10.39	11.76	9.77	10.81	12.55	13.48	0.34	0.33	4.94	5.63	15.35	17.93	12.76	12.82	3.95	4.01	0.16	0.17
4	7.70	7.80	2.58	2.81	8.59	9.69	8.11	9.50	8.92	8.77	0.27	0.24	4.30	5.01	12.49	13.88	9.10	9.31	3.09	2.83	0.12	0.13
5	7.61	7.70	3.01	3.30	9.44	11.11	9.32	10.24	11.13	11.49	0.31	0.30	4.69	5.39	13.89	16.00	11.62	11.75	3.63	3.52	0.16	0.17
6	7.60	7.68	3.04	3.34	9.52	11.15	9.40	10.26	11.29	11.83	0.32	0.30	4.72	5.41	14.11	16.34	11.70	11.79	3.67	3.62	0.15	0.16
7	7.67	7.77	2.85	3.11	9.00	10.57	8.94	9.90	10.33	10.46	0.29	0.28	4.46	5.13	13.22	15.29	10.88	10.79	3.45	3.27	0.14	0.15
8	7.69	7.79	2.49	2.70	8.28	9.07	7.85	9.38	8.55	8.43	0.26	0.23	4.23	4.87	11.95	13.73	8.76	8.51	3.01	2.78	0.12	0.13
9	7.68	7.78	3.37	3.74	10.56	11.86	9.91	11.23	13.02	14.04	0.35	0.34	5.02	5.69	15.98	18.36	12.84	13.42	4.07	4.13	0.17	0.19
10	7.66	7.76	3.15	3.48	9.86	11.51	9.61	10.54	11.77	12.60	0.33	0.31	4.81	5.53	14.60	16.83	12.16	12.60	3.77	3.79	0.16	0.17
11	7.66	7.76	2.95	3.21	9.22	10.74	9.29	10.08	10.82	11.12	0.31	0.29	4.63	5.36	13.74	15.60	11.27	11.27	3.56	3.45	0.15	0.16
12	7.60	7.70	2.61	2.84	8.65	9.72	8.17	9.52	9.07	9.06	0.27	0.24	4.34	5.04	12.51	14.07	9.31	9.43	3.13	2.92	0.13	0.14
13	7.58	7.67	3.32	3.66	10.44	11.82	9.84	10.88	12.70	13.72	0.34	0.33	4.96	5.67	15.55	18.13	12.81	12.95	3.99	4.07	0.17	0.18
14	7.64	7.74	3.27	3.57	10.36	11.68	9.73	10.73	12.36	13.13	0.34	0.32	4.91	5.61	15.14	17.47	12.74	12.78	3.90	3.92	0.17	0.18
15	7.62	7.71	2.81	3.04	8.98	10.26	8.91	9.68	9.82	10.07	0.28	0.26	4.41	5.09	12.81	14.80	10.77	10.38	3.28	3.19	0.14	0.15
16	7.71	7.81	3.10	3.39	9.77	11.25	9.48	10.29	11.54	12.21	0.32	0.31	4.79	5.52	14.17	16.55	12.15	11.99	3.72	3.72	0.16	0.17
17	7.73	7.83	2.91	3.18	9.13	10.71	9.11	10.04	10.55	10.83	0.30	0.28	4.47	5.18	13.50	15.55	11.12	11.13	3.49	3.36	0.15	0.16
18	7.73	7.82	2.71	2.94	8.81	10.11	8.65	9.64	9.48	9.45	0.28	0.25	4.36	5.07	12.72	14.72	10.14	9.66	3.21	3.01	0.14	0.14
19	7.70	7.81	3.21	3.53	10.08	11.59	9.69	10.60	12.13	12.89	0.33	0.32	4.90	5.59	14.78	17.08	12.55	12.73	3.86	3.87	0.16	0.17
Control	7.84	7.95	2.06	2.31	5.53	5.76	5.18	6.44	9.66	10.7	0.23	0.20	4.92	5.62	8.48	10.13	7.2	7.35	4.17	4.33	0.10	0.11
General mean	7.66	7.76	2.98	3.26															3.57	3.49	0.15	0.16
Correlation coefficient	0.19	0.31	0.96	0.96															0.91	0.93	0.92	0.89
Minimum value	7.57	7.66	2.47	2.68															2.99	2.68	0.12	0.13
Optimum combination	[2: 4: 1: 1], [3: 3: 1: 1]	[2: 4: 1: 1], [3: 3: 1: 1]	[8: 0: 0: 0]	[8: 0: 0: 0]…															[8: 0: 0: 0]…	[8: 0: 0: 0]	[8: 0: 0: 0]	[8: 0: 0: 0], [0: 0: 0: 8]
Maximum value	7.73	7.83	3.41	3.78															4.14	4.25	0.18	0.19
Optimum combination	[2.5: 2.5: 0.5: 2.5], [2.5: 0.5: 2.5: 2.5]	[2.5: 2.5: 0.5: 2.5]	[0: 8: 0: 0]	[0: 8: 0: 0]															[0: 8: 0: 0]	[0: 8: 0: 0]	[0: 4: 4: 0], [0: 5: 3: 0]	[0: 4: 4: 0], [0: 5: 3: 0]

* In soil paste extract.

Table (3): Effect of different treatments on some soil chemical properties in the second season (winter 2012/2013).

Treatment No.	pH, 1:2.5 (susp.)		EC *, dSm-1		Cations *, meq/l								Anions *, meq/l						SAR		TSS, %	
					Ca^{++}		Mg^{++}		Na^{+}		K^{+}		HCO_3^{-}		Cl^{-}		SO_4^{--}					
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1	7.67	7.74	2.61	2.85	9.42	10.64	8.79	10.30	7.60	7.21	0.24	0.24	4.03	4.58	10.81	12.13	11.21	11.68	2.52	2.23	0.12	0.13
2	7.63	7.71	3.56	3.98	11.28	13.02	11.09	12.63	12.78	13.66	0.33	0.32	5.10	5.66	16.12	17.60	14.26	16.37	3.82	3.81	0.17	0.19
3	7.61	7.69	3.32	3.67	10.79	12.38	10.31	12.14	11.83	12.01	0.32	0.30	4.95	5.57	15.26	16.63	13.04	14.63	3.64	3.43	0.16	0.17
4	7.69	7.76	2.69	2.95	9.51	10.93	8.87	10.45	8.23	7.84	0.25	0.24	4.28	4.88	11.17	12.71	11.41	11.87	2.71	2.40	0.13	0.14
5	7.59	7.66	3.05	3.39	10.26	11.82	9.82	11.43	10.12	10.37	0.29	0.28	4.71	5.31	13.58	15.00	12.20	13.59	3.19	3.04	0.16	0.17
6	7.56	7.64	3.10	3.44	10.37	11.85	9.91	11.52	10.32	10.63	0.30	0.29	4.72	5.32	13.94	15.12	12.24	13.85	3.24	3.11	0.16	0.17
7	7.66	7.73	2.91	3.23	10.12	11.63	9.63	11.26	9.14	9.12	0.27	0.26	4.46	5.18	12.39	14.04	12.31	13.05	2.91	2.70	0.15	0.16
8	7.69	7.76	2.64	2.88	9.47	10.72	8.83	10.36	7.99	7.43	0.24	0.24	4.06	4.60	10.99	12.35	11.48	11.80	2.64	2.29	0.13	0.14
9	7.67	7.74	3.41	3.79	10.93	12.64	10.55	12.31	12.26	12.53	0.33	0.31	5.04	5.61	15.85	17.13	13.18	15.05	3.74	3.55	0.18	0.19
10	7.65	7.72	3.20	3.54	10.70	12.11	10.11	11.83	10.86	11.02	0.31	0.29	4.82	5.45	14.55	15.85	12.61	13.95	3.37	3.19	0.16	0.17
11	7.64	7.72	3.01	3.34	10.22	11.77	9.72	11.38	9.91	9.81	0.29	0.28	4.63	5.27	13.30	14.75	12.21	13.22	3.14	2.88	0.15	0.16
12	7.58	7.65	2.76	3.06	9.76	11.30	9.15	10.69	8.47	8.27	0.26	0.25	4.34	4.90	11.29	13.02	12.01	12.59	2.75	2.49	0.13	0.15
13	7.55	7.62	3.36	3.72	10.86	12.58	10.36	12.25	12.04	12.23	0.33	0.31	4.98	5.59	15.50	16.91	13.11	14.87	3.70	3.47	0.17	0.19
14	7.62	7.69	3.27	3.62	10.75	12.24	10.17	12.03	11.35	11.57	0.32	0.30	4.91	5.52	15.13	16.54	12.55	14.08	3.51	3.32	0.17	0.18
15	7.59	7.67	2.86	3.18	10.07	11.57	9.46	11.17	8.94	8.91	0.26	0.26	4.41	4.95	12.01	13.81	12.31	13.15	2.86	2.64	0.14	0.15
16	7.71	7.78	3.16	3.51	10.52	12.07	10.08	11.73	10.71	10.88	0.31	0.29	4.80	5.42	14.27	15.37	12.55	14.18	3.34	3.15	0.16	0.18
17	7.74	7.81	2.95	3.28	10.16	11.67	9.61	11.29	9.41	9.65	0.28	0.27	4.50	5.25	12.98	14.69	11.98	12.94	2.99	2.85	0.15	0.16
18	7.73	7.80	2.80	3.10	9.80	11.39	9.19	10.73	8.72	8.57	0.26	0.25	4.38	4.93	11.72	13.55	11.87	12.46	2.83	2.58	0.14	0.15
19	7.71	7.77	3.24	3.58	10.73	12.16	10.20	11.94	11.06	11.31	0.31	0.30	4.87	5.49	14.79	16.31	12.64	13.91	3.42	3.26	0.16	0.18
Control	7.81	7.92	2.21	2.49	6.42	6.64	5.86	7.72	9.61	10.32	0.21	0.22	4.81	5.65	8.07	9.67	9.22	9.58	3.88	3.85	0.11	0.12
General mean	7.65	7.72	3.05	3.37															3.18	2.97	0.15	0.17
Correlation coefficient	0.33	0.28	0.92	0.94															0.85	0.56	0.83	0.84
Minimum value	7.54	7.61	2.61	2.85															2.52	2.23	0.12	0.13
Optimum combination	[2: 4: 1: 1], [3: 3: 1: 1]	[2: 4: 1: 1], [3: 3: 1: 1]	[8: 0: 0: 0]	[8: 0: 0: 0]…															[8: 0: 0: 0]	[8: 0: 0: 0]	[8: 0: 0: 0]	[8: 0: 0: 0]
Maximum value	7.74	7.81	3.56	3.98															3.82	3.81	0.18	0.20
Optimum combination	[2.5: 2.5: 0.5: 2.5]	[2.5: 2.5: 0.5: 2.5]	[0: 8: 0: 0]	[0: 8: 0: 0]															[0: 8: 0: 0]	[0: 8: 0: 0]	[0: 5: 3: 0]	[0: 6: 2: 0], [0: 5: 3: 0]

* In soil paste extract.

NUMBER OF TREATMENTS = 19; NUMBER OF REPLICATES= 3
EXPRIMENTAL DATA AND (MEAN)

1. 7.89 7.91 7.27 (7.69)	8. 7.90 7.91 7.26 (7.69)	15. 7.73 7.68 7.45 (7.62)
2. 7.78 7.73 7.41 (7.64)	9. 7.83 7.78 7.43 (7.68)	16. 7.95 7.96 7.22 (7.71)
3. 7.73 7.68 7.48 (7.63)	10. 7.80 7.76 7.42 (7.66)	17. 7.98 8.00 7.21 (7.73)
4. 7.92 7.94 7.24 (7.70)	11. 7.80 7.75 7.43 (7.66)	18. 7.95 7.97 7.27 (7.73)
5. 7.69 7.66 7.48 (7.61)	12. 7.68 7.65 7.47 (7.60)	19. 7.93 7.94 7.23 (7.70)
6. 7.65 7.62 7.53 (7.60)	13. 7.64 7.61 7.49 (7.58)	
7. 7.83 7.78 7.40 (7.67)	14. 7.78 7.73 7.41 (7.64)	

GENERAL MEAN = 7.660001
MEAN ERROR = .1315895

CORRELATION COEFFICIENT= .1905806
KERETRIO FISHER F(18 38)= 7.956755E-02

REALITY ADEQUATE TEST OF THE MODEL THROUGH THE LAST FOUR TREATMENTS

EXPRIMENTAL TREATMENT - TABULAR =DIFFERENCE KER.STUDENT
16 7.71 -7.62 = 0.09 0.56
17 7.73 -7.61 = 0.12 0.78
18 7.73 -7.64 = 0.09 0.56
19 7.70 -7.64 = 0.06 0.40
THE SIGNIFICANT ADEQUATE SECTOR OF THE SQUARE TEST FOR THE CALCULATED VALUE , MULTIPLY BY 100

Maximum combination (fon) - 0 ; MAXIMUM - 1

X1
X4 X4
770 770 769 769 769 769 769 769 769 769 769 769 769 769 769 770 770
769 768 768 767 767 766 766 766 769 769 768 768 768 769 769 769
768 767 766 765 764 764 763 766 768 768 768 768 768 768 768
767 766 764 763 762 761 764 766 768 767 767 767 767 767
766 764 763 761 760 763 765 766 767 767 766 766 766
765 763 762 760 762 764 765 766 766 766 765 765
765 763 760 763 764 765 766 766 765 765 764
764 762 764 765 766 767 766 766 764 764
X2 764 766 767 768 768 768 767 765 763 X3
764 766 767 767 767 767 765 764 Fig. (2a)
765 766 767 767 767 766 764
765 766 767 767 766 765
766 767 767 767 766
767 767 767 767
768 768 768
769 769
770
X4

Maximum combination (fon) - .125 ; MAXIMUM - .625

X1
X4 X4
762 761 761 760 760 760 761 761 762
761 760 759 758 761 762 762 762
760 759 757 760 762 763 763
759 757 760 762 763 763
X2 758 760 762 763 764 X3
759 761 762 763 Fig. (2b)
760 762 763
761 762
762
X4

Maximum combination (fon) - .25 ; MAXIMUM - .25

X1
X4 X4
761 Fig. (2c)
X2 X3
X4

MINIMUM VALUE YR = 7.57
OPTIMUM COMBINATION: (2: 4: 1: 1), (3: 3: 1: 1)

Fig. (2): Computer output of soil reaction (pH) of (0-15cm) soil depth at the first season in response to all the possible combination of farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM).

NUMBER OF TREATMENTS = 19; NUMBER OF REPLICATES= 3
EXPRIMENTAL DATA AND (MEAN)

---

1. 2.45 2.30 2.66 (2.47)	8. 2.50 2.48 2.49 (2.49)	15. 2.75 2.73 2.95 (2.81)
2. 3.47 3.57 3.19 (3.41)	9. 3.41 3.51 3.19 (3.37)	16. 3.09 3.12 3.09 (3.10)
3. 3.36 3.36 3.15 (3.29)	10. 3.20 3.23 3.02 (3.15)	17. 2.85 2.85 3.03 (2.91)
4. 2.59 2.52 2.63 (2.58)	11. 2.97 2.88 3.00 (2.95)	18. 2.73 2.65 2.75 (2.71)
5. 3.01 2.98 3.04 (3.01)	12. 2.64 2.63 2.56 (2.61)	19. 3.21 3.26 3.16 (3.21)
6. 3.06 3.11 2.95 (3.04)	13. 3.39 3.44 3.13 (3.32)	
7. 2.82 2.75 2.98 (2.85)	14. 3.33 3.34 3.14 (3.27)	

GENERAL MEAN = 2.976316	CORRELATION COEFFICIENT= .9570138
MEAN ERROR = 5.163978E-02	KERETRIO FISHER F(18 38)= 22.98391

REALITY ADEQUATE TEST OF THE MODEL THROUGH THE LAST FOUR TREATMENTS

EXPRIMENTAL TREATMENT - TABULAR =DIFFERENCE KER.STUDENT 16 3.10 -3.09 = 0.01 0.12 17 2.91 -2.92 = -0.01 -0.18	18 2.71 -2.83 = -0.12 -1.88 19 3.21 -3.18 = 0.03 0.46 THE SIGNIFICANT ADEQUATE SECTOR OF THE	SQUARE TEST FOR THE CALCULATED VALUE , MULTIPLY BY 100

Maximum combination (fon) - 0 ; MAXIMUM - 1

X1
X4 X4
258 255 253 251 249 248 247 247 247 247 247 248 249 251 253 255 258
275 272 270 267 266 264 264 263 256 256 257 258 260 262 265 268
290 287 285 282 280 279 278 272 265 266 267 269 271 274 277
304 300 298 295 293 292 286 281 275 276 278 280 283 286
315 312 309 306 304 300 295 290 285 287 289 292 295
324 321 318 315 312 308 304 300 295 298 301 304
332 328 325 323 320 317 313 310 306 309 312
337 334 332 330 328 326 323 321 317 321
X2 341 340 340 338 337 335 334 331 329 X3
337 336 334 332 329 327 324 321 **Fig. (3a)**
332 329 326 323 320 316 312
324 321 317 313 308 304
315 310 306 300 295
304 298 292 286
290 284 277
275 268
258
X4

Maximum combination (fon) - .125 ; MAXIMUM - .625

X1
X4 X4
281 275 270 265 261 265 270 275 281
297 291 286 281 277 282 287 293
310 304 299 296 293 299 304
322 316 314 312 310 316
X2 332 331 330 329 327 X3
322 320 318 316 **Fig. (3b)**
310 308 304
297 293
281
X4

Maximum combination (fon) - .25 ; MAXIMUM - .25

X1
X4 X4
301 **Fig. (3c)**
X2 X3
X4

MINIMUM VALUE YR = 2.47
OPTIMUM COMBINATION: (8: 0: 0: 0), (7: 0: 0: 1),(6: 0: 0:2)

Fig. (3): Computer output of soil electrical conductivity (EC, dSm^{-1}) of (0-15cm) soil depth at the first season in response to all the possible combination of farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM).

The increases percent were differed between 48.82 and 92.41, 56.42 and 106.60% of Ca^{++}, 50.39 and 92.47, 45.03 and 74.69% of Mg^{++}, 13.04 and 56.52, 10.00 and 75.00% of K^{+}, 40.68 and 91.16, 34.95 and 84.50% of Cl^{-} and 20.28 and 80.28, 15.24 and 83.95% of SO_4^{--} in the first season for (0-15 and 15-30 cm depths), respectively over the control. While, in the second one, the increases percent were differed between 46.73 and 75.70, 60.24 and 96.08% of Ca^{++}, 50.00 and 89.25, 33.42 and 63.60% of Mg^{++}, 14.29 and 57.14, 9.09 and 45.45% of K^{+}, 33.95 and 99.75, 25.44 and 82.01% of Cl^{-} and 21.58 and 54.66, 21.92 and 70.88% of SO_4^{--} for (0-15 and 15-30 cm depths), respectively over the control. As for the soluble Na^{+} and HCO_3^{-}, there was no marked trend where the values sometimes decreased under the control and others increased over it. These results reveal that the SM gave the highest values of soluble Ca, Mg, Na, K, Cl and SO_4, while FYM gave the lowest one, where the order effect on increasing soluble Ca, Mg, Na, K, Cl and SO_4 is SM > RM > PM > FYM

3- Sodium adsorption ratio (SAR) and total soluble salts (TSS).

Data in Tables (2 and 3) and Fig. (4) indicate that sodium adsorption ratio (SAR) and total soluble salts (TSS) markedly affected by the application of natural soil conditioners. Generally, the results show that the natural soil conditioners caused a significant decreases in SAR values and a significant increases in TSS in the two seasons at (0-15 and 15-30 cm depths) as compared with the control (untreated soil). The decreases in SAR were ranged between 28.30 and 0.72 %, 38.11 and 1.85 % in the first season and between 35.05 and 1.55 %, 42.08 and 1.04 % in the second one for the two soil depths (0-15 and 15-30 cm), respectively under the control. Also, the increases in TSS over the control were ranged between 20.00 and 70.31 %, 9.09 and 63.64 % in the first season and 9.09 and 54.55 %, 8.33 and 58.33 % in the second one for the same depths, respectively. These mean that the values of SAR were generally decreased with all different treatments in the first and second seasons. Similar conlusion was obtained by [34]**.** The combinations effect between FYM, SM, RM and PM gave a high significant correlation on SAR and TSS where r = 0.91, 0.93 and 0.92, 0.89 in the first season, and 0.85, 0.56 and 0.83, 0.84 in the second one at the two soil depths, respectively.

The results in Tables (2) and Fig. (4) show the values of SAR at the surface layer (0-15 cm) in the first season as affected by FYM, SM, RM and PM, where the single treatment recorded 2.99, 4.14, 3.95, 3.09 for the principal tetrahedron (Fig. 4a) and 3.13, 3.99, 3.90, 3.28 for the smaller interior tetrahedral (Fig. 4b), respectively. The effectiveness take the order: FYM > PM > RM > SM on decreasing SAR values. Scanning the different values of (Fig. 4a) indicate that the number of 2.99 as a minimum one, which corresponding to a combination of [8: 0: 0: 0], [7: 0: 0: 1], [6: 0: 0: 2] (of the 8 point score) or in other words, [10: 0: 0: 0], [8.75: 0: 0: 0.13], [7.50: 0: 0: 0.25] ton feddan^{-1} of FYM, SM, RM and PM, respectively. Scanning the other intersecting inside the tetrahedron (Fig 4b) shows 3.13 as a minimum SAR value, corresponding to [5: 1: 1: 1] or in other words, [6.25: 1.25: 1.25: 0.13] ton feddan^{-1} of FYM, SM, RM and PM, respectively. The central point has SAR value of 3.63 (Fig. 4c) corresponds to a treatment of [2: 2: 2: 2], i.e. [2.5: 2.5: 2.5: 0.25] ton feddan^{-1} of the previous treatments, respectively.

II- Effect of different treatments on exchangeable cations, cation exchange capacity and exchangeable sodium percentage.

Data in Tables (4 and 5) indicate that exchangeable cations (meq/100g soil), cation exchange capacity (CEC, meq/100g soil) and exchangeable sodium percentage (ESP, %) were markedly affected by the addition of natural soil conditioners. The results reveal that the Ex. Ca, Mg, K and CEC values were significantly increased with all added natural soil conditioners as compared with the control, the increases percent were ranged from 0.30 to 2.11, 0.30 to 2.42 % and 1.51 to 7.05, 1.52 to 3.75 % for Ex. Ca, 32.68 to 36.20, 28.35 to 31.61 % and 30.80 to 34.57, 28.15 to 31.66 % for Ex. Mg, 1.69 to 78.81, 2.36 to 73.23% and 3.70 to 143.21, 1.71 to 41.03 % for Ex. K and from 0.98 to 5.85, 0.15 to 5.33 % and 0.95 to 8.43, 0.50 to 5.03 % for CEC for the first and second seasons at (0-15 and 15-30 cm depths), respectively over the control. These results suggest that the SM gave the highest values of Ex. Ca, Mg, K and CEC values, while FYM gave the lowest one, where the effectiveness take the order SM > RM > PM > FYM on increasing these parameters. The combinations effect between FYM, SM, RM and PM gave a high significant correlation of Ex. Ca where r = 0.39, 0.93 and 0.99, 0.83, Ex. Mg where r = 0.85, 0.67 and 0.93, 0.76, Ex. K where r = 0.93, 0.72 and 0.91, 0.68 and CEC where r = 0.85, 0.93 and 0.94, 0.93 in the first and second seasons of the two soil depths, respectively.

NUMBER OF TREATMENTS = 19; NUMBER OF REPLICATES= 3
EXPRIMENTAL DATA AND (MEAN)

1. 2.93 3.02 3.01 (2.99)	8. 2.98 3.06 2.99 (3.01)	15. 3.28 3.35 3.22 (3.28)
2. 4.27 4.36 3.78 (4.14)	9. 4.25 4.30 3.66 (4.07)	16. 3.78 3.88 3.50 (3.72)
3. 4.01 4.08 3.77 (3.95)	10. 3.86 3.93 3.53 (3.77)	17. 3.40 3.53 3.55 (3.49)
4. 3.05 3.16 3.05 (3.09)	11. 3.68 3.75 3.24 (3.56)	18. 3.23 3.34 3.06 (3.21)
5. 3.71 3.77 3.42 (3.63)	12. 3.11 3.20 3.07 (3.13)	19. 3.91 3.95 3.71 (3.86)
6. 3.77 3.86 3.38 (3.67)	13. 4.21 4.24 3.51 (3.99)	
7. 3.39 3.49 3.47 (3.45)	14. 4.00 4.06 3.64 (3.90)	

GENERAL MEAN = 3.57386	CORRELATION COEFFICIENT= .9074193
MEAN ERROR = 9.653045E-02	KERETRIO FISHER F(18 38)= 9.843749

REALITY ADEQUATE TEST OF THE MODEL THROUGH THE LAST FOUR TREATMENTS

EXPRIMENTAL TREATMENT - TABULAR =DIFFERENCE KER.STUDENT	18 3.21 -3.37 = -0.16 -1.42	SQUARE TEST FOR THE CALCULATED VALUE , MULTIPLY BY 100
16 3.72 -3.71 = 0.01 0.07	19 3.86 -3.79 = 0.07 0.56	
17 3.49 -3.48 = 0.01 0.10	THE SIGNIFICANT ADEQUATE SECTOR OF THE	

Maximum combination (fon) - 0 ; MAXIMUM - 1

X1
X4 X4
309 306 304 302 301 300 299 299 299 299 299 300 301 302 304 306 309
329 326 324 322 321 319 318 318 310 310 311 313 314 316 319 321
347 344 342 340 338 337 336 329 321 322 324 326 328 330 333
363 360 358 355 354 352 346 340 333 335 337 339 342 345
377 374 372 369 367 362 357 351 345 347 350 353 356
389 386 383 381 377 372 368 363 357 360 363 366
400 396 393 390 387 383 379 374 370 373 376
408 404 402 399 397 394 390 386 382 386
X2 414 412 411 409 407 405 402 399 395 X3
408 405 403 400 397 394 390 386 Fig. (4a)
400 396 393 389 385 381 376
389 385 381 376 372 366
377 372 367 362 356
363 357 351 345
347 340 333
329 321
309
X4

Maximum combination (fon) - .125 ; MAXIMUM - .625

X1
X4 X4
328 324 320 316 313 316 320 324 328
349 344 340 336 332 336 340 344
368 363 358 355 351 355 360
384 379 377 374 370 375
X2 399 397 395 393 390 X3
384 381 379 375 Fig. (4b)
368 364 360
349 344
328
X4

Maximum combination (fon) - .25 ; MAXIMUM - .25

X1
X4 X4
363 Fig. (4c)
X2 X3
X4

MINIMUM VALUE YR = 2.99
OPTIMUM COMBINATION: (8: 0: 0: 0), (7: 0: 0: 1), (6: 0: 0: 2)

Fig. (4): Computer output of sodium adsorption ratio (SAR) of (0-15cm) soil depth at the first season in response to all the possible combination of farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM).

The values of Ex. Ca in the first season at (0-15cm) soil depth as affected by FYM, SM, RM and PM are shown in Table (4) and Fig. (5) which indicate that the SM single treatment gave the highest values of Ex. Ca. The effectiveness take the order SM > RM > PM > FYM, in other words the SM should be preferred if the target is increasing Ex. Ca. Scanning the different values of Fig. (5a) show the optimum combination for increasing of Ex. Ca was 24.20 meq/100g soil obtained by a mixture of FYM, SM, RM and PM at the ratio of [0: 8: 0: 0] of (the 8 point score) i.e [0: 10.00: 0: 0] ton feddan^{-1}, respectively.

The other intersecting points inside the tetrahedron, Figs. (5b) shows a value of 24.10 meq/100 g soil, as the maximum one located in the small tetrahedron corresponding to combination treatment of [1: 5: 1: 1] of (the 8 points score) of (FYM), (SM), (RM) and (PM), respectively, or in other words, [1.25: 6.25: 1.25: 0.13]. These results show the role of (SM) on increasing the values of Ex. Ca. Also, Fig. (5c) show that the center point of the tetrahedron has Ex. Ca in the first season was 23.90 meq/100 g soil, for the treatment of [2: 2: 2: 2]. This results show a marked effect of applying (FYM), (SM), (RM) and (PM) at a rate of [2.50: 2.50: 2.50: 0.25] ton feddan^{-1} on raising Ex. Ca.

Table (4): Effect of different treatments on exchangeable cations in the first season (summer 2012).

Treatment No.	Exchangeable cations, meq/100g soil								CEC, meq/100g soil		ESP, %	
	Ca		Mg		Na		K					
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1	23.72	23.22	19.57	19.33	2.09	1.81	1.20	1.30	46.58	45.66	4.49	3.96
2	24.15	23.71	20.09	19.82	2.48	2.29	2.11	2.20	48.83	48.02	5.08	4.77
3	24.08	23.63	20.00	19.71	2.41	2.17	2.02	2.03	48.51	47.54	4.97	4.56
4	23.76	23.27	19.61	19.37	2.13	1.84	1.37	1.47	46.87	45.95	4.54	4.00
5	23.95	23.45	19.79	19.50	2.31	2.00	1.80	1.84	47.85	46.79	4.83	4.27
6	23.97	23.47	19.81	19.54	2.33	2.03	1.86	1.86	47.97	46.90	4.86	4.33
7	23.86	23.37	19.70	19.44	2.25	1.92	1.70	1.74	47.51	46.47	4.74	4.13
8	23.73	23.24	19.60	19.35	2.11	1.82	1.23	1.31	46.67	45.72	4.52	3.98
9	24.13	23.68	20.06	19.78	2.47	2.25	2.06	2.14	48.72	47.85	5.07	4.70
10	24.01	23.51	19.89	19.61	2.37	2.09	1.93	1.93	48.20	47.14	4.92	4.43
11	23.92	23.42	19.76	19.47	2.29	1.98	1.74	1.82	47.71	46.69	4.80	4.24
12	23.78	23.28	19.63	19.39	2.16	1.86	1.41	1.48	46.98	46.01	4.60	4.04
13	24.11	23.66	20.03	19.76	2.44	2.21	2.04	2.10	48.62	47.73	5.02	4.63
14	24.07	23.59	19.97	19.67	2.39	2.14	2.00	2.01	48.43	47.41	4.93	4.51
15	23.84	23.35	19.68	19.43	2.24	1.90	1.62	1.65	47.38	46.33	4.73	4.10
16	23.98	23.48	19.85	19.59	2.35	2.07	1.88	1.89	48.06	47.03	4.89	4.40
17	23.89	23.40	19.73	19.46	2.27	1.95	1.71	1.79	47.60	46.60	4.77	4.18
18	23.81	23.31	19.65	19.41	2.20	1.89	1.59	1.60	47.25	46.21	4.66	4.09
19	24.04	23.55	19.92	19.65	2.38	2.11	1.96	1.96	48.30	47.27	4.93	4.46
Control	23.65	23.15	14.75	15.06	6.55	6.11	1.18	1.27	46.13	45.59	14.20	13.40
General mean	23.94	23.45	19.81	19.54	2.30	2.02	1.75	1.80	47.79	46.81	4.81	4.31
Correlation coefficient	0.39	0.93	0.85	0.67	0.86	0.95	0.93	0.72	0.84	0.93	0.85	0.91
Minimum value	23.72	23.23	19.57	19.30	2.09	1.81	1.20	1.29	46.58	45.66	4.49	3.97
Optimum combination	[8:0:0:0]	[8:0:0:0]	[8: 0:0:0]	[8: 0:0:0]…	[8:0:0:0]	[8:0:0:0]…	[8:0:0:0]…	[7:0:0:1]…	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	8:0:0:0]…
Maximum value	24.20	23.71	20.10	19.80	2.48	2.29	2.11	2.20	48.83	48.02	5.08	4.77
Optimum combination	[0:8:0:0]	[0:8:0:0]…	[0:8:0:0]…	[0:8:0:0]…	[0:8:0:0]…	[0:8:0:0]	[0:8:0:0]	[0:8:0:0]	[0:8:0:0]	[0:8:0:0]	[0:8:0:0]…	[0:8:0:0]

On the other hand, the results in Tables (4 and 5) show that the Ex. Na and ESP values were decreased, where the decreases were ranged from 68.09 to 62.14, 70.38 to 62.52 % and 71.25 to 64.45, 72.01 to 62.68 % for Ex. Na and from 68.38 to 64.23, 70.45 to 64.40 % and 71.55 to 67.19, 72.17 to 64.48 % for ESP in the first and second seasons at (0-15 and 15-30 cm depths), respectively under the control. These means that the SM gave the highest values of Ex. Na and ESP values, while FYM gave the lowest one, where the order effect on decreasing Ex. Na and ESP values were FYM > PM >. RM > SM The combinations effect between FYM, SM, RM and PM gave a high significant correlation on Ex. Na and ESP where r were 0.86, 0.95 and 0.85, 091 in the first season, and r were 0.54, 0.92 and 0.42, 090 in the second one for the two soil depths, respectively. Similar results were obtained by [35].

The results of ESP, % in the first season of (0-15cm) soil depth as affected by the four different amendments are shown in Table (4) and Fig. (6) which indicate that the FYM single treatment gave the minimum ESP values less of all the other three ones. The order effect is FYM > PM > RM > SM, in other words the FYM should be preferred if the target is decreasing ESP. Scanning the different values of Fig. (6a) show the optimum combination for decreasing ESP was 4.49% obtained by a mixture of FYM, SM, RM and PM at the ratio of [8: 0: 0: 0] of (the 8 point score) i.e [10.00: 0: 0: 0] ton feddan^{-1}, respectively.

The other intersecting points inside the tetrahedron, Fig. (6b) indicate that the value of 4.60 as the minimum one located in the small tetrahedron corresponding to combination treatment of [5: 1: 1: 1] of (the 8 points score) or in other words, [6.25: 1.25: 1.25: 0.13] ton feddan^{-1} of (FYM), (SM), (RM) and (PM), respectively. These results show the role of FYM on decreasing the values of ESP. Fig. (6c) show the center point of the tetrahedron has ESP in the first season was 4.83 % for the treatment of [2: 2: 2: 2]. This results shows a marked effect of applying (FYM), (SM), (RM) and (PM) at a rate of [2.50, 2.50, 2.50, 0.25] ton feddan^{-1}.

NUMBER OF TREATMENTS = 19; NUMBER OF REPLICATES= 3
EXPRIMENTAL DATA AND (MEAN)

1. 23.16 23.26 24.74 (23.72)	8. 23.26 23.36 24.57 (23.73)	15. 23.54 23.62 24.36 (23.84)
2. 24.31 24.26 23.88 (24.15)	9. 24.27 24.25 23.87 (24.13)	16. 24.05 23.95 23.94 (23.98)
3. 24.20 24.11 23.93 (24.08)	10. 24.06 23.99 23.98 (24.01)	17. 23.76 23.66 24.25 (23.89)
4. 23.34 23.44 24.50 (23.76)	11. 23.84 23.74 24.18 (23.92)	18. 23.51 23.57 24.35 (23.81)
5. 23.94 23.84 24.07 (23.95)	12. 23.44 23.54 24.36 (23.78)	19. 24.08 24.01 24.03 (24.04)
6. 23.98 23.88 24.05 (23.97)	13. 24.26 24.18 23.89 (24.11)	
7. 23.66 23.64 24.28 (23.86)	14. 24.18 24.08 23.95 (24.07)	

GENERAL MEAN = 23.93685	CORRELATION COEFFICIENT= .3915888
MEAN ERROR = .1840258	KERETRIO FISHER F(18 38)= .3823521

REALITY ADEQUATE TEST OF THE MODEL THROUGH THE LAST FOUR TREATMENTS

EXPRIMENTAL TREATMENT - TABULAR =DIFFERENCE KER.STUDENT 16 23.98 -23.99 = -0.01 -0.06 17 23.89 -23.91 = -0.02 -0.10	18 23.81 -23.86 = -0.05 -0.23 19 24.04 -24.03 = 0.01 0.06 THE SIGNIFICANT ADEQUATE SECTOR OF THE	SQUARE TEST FOR THE CALCULATED VALUE , MULTIPLY BY 10

Maximum combination (fon) - 0 ; MAXIMUM - 1

X1
X4 X4
238 238 237 237 237 237 237 237 237 237 237 237 237 237 237 238 238
238 238 238 238 238 238 238 238 237 238 238 238 238 238 238 238
239 239 239 239 239 239 239 238 238 238 238 238 238 238 238
240 239 239 239 239 239 239 239 238 238 238 239 239 239
240 240 240 240 240 239 239 239 239 239 239 239 239
241 240 240 240 240 240 240 239 239 239 239 240
241 241 241 241 240 240 240 240 240 240 240
241 241 241 241 241 241 241 240 240 240
X2 242 241 241 241 241 241 241 241 241 X3
241 241 241 241 241 241 241 240 Fig. (5a)
241 241 241 241 240 240 240
241 240 240 240 240 240
240 240 240 239 239
240 239 239 239
239 239 238
238 238
238
X4

Maximum combination (fon) - .125 ; MAXIMUM - .625

X1
X4 X4
238 238 238 238 238 238 238 238 238
239 239 239 239 238 239 239 239
240 240 240 239 239 239 240
241 240 240 240 240 240
X2 241 241 241 241 241 X3
241 240 240 240 Fig. (5b)
240 240 240
239 239
238
X4

Maximum combination (fon) - .25 ; MAXIMUM - .25

X1
X4 X4
239 Fig. (5c)
X2 X3
X4

MAXIMUM VALUE YR = 24.20
OPTIMUM COMBINATION: (0: 8: 0: 0)

Fig. (5): Computer output of exchangeable calsium (meq/100g soil) of (0-15cm) soil depth at the first season in response to all the possible combination of farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM).

NUMBER OF TREATMENTS = 19; NUMBER OF REPLICATES= 3
EXPRIMENTAL DATA AND (MEAN)

1. 4.44 4.37 4.65 (4.49)	8. 4.51 4.44 4.62 (4.52)	15. 4.66 4.68 4.84 (4.73)
2. 4.96 5.05 5.22 (5.08)	9. 4.95 4.94 5.31 (5.07)	16. 4.82 4.79 5.05 (4.89)
3. 4.92 4.93 5.06 (4.97)	10. 4.88 4.81 5.07 (4.92)	17. 4.69 4.71 4.90 (4.77)
4. 4.51 4.46 4.66 (4.54)	11. 4.70 4.72 4.98 (4.80)	18. 4.53 4.57 4.87 (4.66)
5. 4.77 4.74 4.98 (4.83)	12. 4.53 4.51 4.76 (4.60)	19. 4.89 4.82 5.07 (4.93)
6. 4.82 4.79 4.97 (4.86)	13. 4.92 4.94 5.20 (5.02)	
7. 4.67 4.70 4.84 (4.74)	14. 4.91 4.86 5.03 (4.93)	

GENERAL MEAN = 4.806843
MEAN ERROR = 6.224833E-02

CORRELATION COEFFICIENT= .8541654
KERETRIO FISHER F(18 38)= 5.696208

REALITY ADEQUATE TEST OF THE MODEL THROUGH THE LAST FOUR TREATMENTS

EXPRIMENTAL TREATMENT - TABULAR =DIFFERENCE KER.STUDENT
16 4.89 -4.88 = 0.00 0.04
17 4.77 -4.80 = -0.03 -0.38
18 4.66 -4.73 = -0.07 -0.93
19 4.93 -4.94 = -0.01 -0.17
THE SIGNIFICANT ADEQUATE SECTOR OF THE SQUARE TEST FOR THE CALCULATED VALUE , MULTIPLY BY 100

Maximum combination (fon) - 0 ; MAXIMUM - 1

X1
X4 X4
454 454 454 453 452 452 451 450 449 450 451 452 452 453 454 454 454
466 465 465 464 463 462 461 459 455 456 457 458 459 460 461 462
476 475 474 473 472 471 469 466 461 463 464 465 466 467 468
485 484 482 481 480 478 475 472 468 469 471 472 473 474
492 491 489 488 486 484 481 478 474 475 477 479 480
498 496 495 493 491 489 487 483 480 482 483 485
503 501 499 498 497 495 492 489 486 488 490
506 504 504 503 502 500 498 495 491 494
X2 508 508 508 508 507 505 503 500 497 X3
506 506 505 504 502 500 497 494
503 502 500 499 496 493 490
498 496 494 492 489 485
492 490 487 484 480
485 482 478 474
476 472 468
466 462
454
X4

Fig. (6a)

Maximum combination (fon) - .125 ; MAXIMUM - .625

X1
X4 X4
473 470 467 463 460 463 467 470 473
482 479 475 472 468 472 475 479
490 487 483 480 477 481 484
497 493 491 488 485 489
X2 502 501 499 496 493 X3
497 495 492 489
490 487 484
482 479
473
X4

Fig. (6b)

Maximum combination (fon) - .25 ; MAXIMUM - .25

X1
X4 X4
483
X2 X3
X4

Fig. (6c)

MINIMUM VALUE YR = 4.49
OPTIMUM COMBINATION: (8: 0: 0: 0)

Fig. (6): Computer output of exchangeable sodium percentage (ESP, %) of (0-15cm) soil depth at the first season in response to all the possible combination of farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM).

Table (5): Effect of different treatments on exchangeable cations in the second season (winter 2012/2013).

Treatment No.	Exchangeable cations, meq/100g soil								CEC, meq/100g soil		ESP, %	
	Ca		Mg		Na		K					
	0-15 cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
1	24.19	24.07	19.79	19.35	1.86	1.71	0.84	1.19	46.68	46.32	3.98	3.69
2	25.51	24.60	20.36	19.88	2.30	2.28	1.97	1.65	50.14	48.41	4.59	4.71
3	25.23	24.53	20.31	19.79	2.25	2.19	1.88	1.58	49.67	48.09	4.53	4.55
4	24.24	24.19	19.86	19.41	1.91	1.78	1.04	1.27	47.05	46.65	4.06	3.82
5	24.68	24.41	20.11	19.62	2.08	1.96	1.70	1.45	48.57	47.44	4.28	4.13
6	24.71	24.43	20.15	19.65	2.11	1.98	1.75	1.47	48.72	47.53	4.33	4.17
7	24.43	24.34	19.99	19.57	2.01	1.89	1.53	1.42	47.96	47.22	4.19	4.00
8	24.21	24.11	19.82	19.37	1.88	1.74	0.88	1.20	46.79	46.42	4.02	3.75
9	25.43	24.58	20.35	19.85	2.28	2.26	1.92	1.61	49.98	48.30	4.56	4.68
10	24.95	24.47	20.22	19.70	2.16	2.09	1.83	1.51	49.16	47.77	4.39	4.38
11	24.56	24.39	20.08	19.61	2.06	1.93	1.68	1.44	48.38	47.37	4.26	4.07
12	24.27	24.25	19.91	19.44	1.92	1.80	1.08	1.29	47.18	46.78	4.07	3.85
13	25.31	24.56	20.33	19.82	2.26	2.22	1.90	1.59	49.80	48.19	4.54	4.61
14	25.11	24.51	20.28	19.76	2.21	2.17	1.86	1.56	49.46	48.00	4.47	4.52
15	24.35	24.31	19.97	19.52	1.97	1.87	1.48	1.40	47.77	47.10	4.12	3.97
16	24.82	24.44	20.19	19.68	2.14	2.06	1.77	1.48	48.92	47.66	4.37	4.32
17	24.51	24.36	20.04	19.59	2.04	1.90	1.62	1.43	48.21	47.28	4.23	4.02
18	24.32	24.28	19.94	19.48	1.94	1.84	1.44	1.37	47.64	46.97	4.07	3.92
19	25.04	24.49	20.25	19.74	2.19	2.13	1.85	1.54	49.33	47.90	4.44	4.45
Control	23.83	23.71	15.13	15.10	6.47	6.11	0.81	1.17	46.24	46.09	13.99	13.26
General mean	24.73	24.38	20.10	19.62	2.08	1.99	1.58	1.44	48.50	47.44	4.29	4.19
Correlation coefficient	0.99	0.83	0.93	0.76	0.54	0.92	0.91	0.68	0.94	0.93	0.42	0.90
Minimum value	24.19	24.07	19.79	19.35	1.86	1.71	0.84	1.19	46.68	46.30	3.99	3.69
Optimum combination	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0] …	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0] …	[8:0:0:0]	[8:0:0:0] …	[8:0:0:0	[8:0:0:0]
Maximum value	25.51	24.60	20.40	19.90	2.30	2.28	1.98	1.65	50.14	48.41	4.59	4.71
Optimum combination	[0:8:0:0]	[0:8:0:0] …	[0:8:0:0]	[0:8:0:0] …	[0:8:0:0]	[0:8:0:0] …	[1:7:0:0]	[0:8:0:0]	[0:8:0:0]	[0:8:0:0] …	[0:8:0:0	[0:8:0:0] …

III- Effect of different treatments on soil macronutrients and C/N ratio.

1- Soil macronutrients.

Data in Tables (6 and 7) indicate that total soil N, P and K values were increased with all different treatments in the two soil depths (0-15 and 15-30 cm) at the end of the two growing seasons compared with the control. The maximum values of total soil N were obtained by using 10 ton/fed. of rabbit manure, where the increases were 19.85, 22.61 % in the first season and 20.15, 2017 % in the second one over the control at the two soil depths, respectively.

Regarding the phosphorus and potassium concentrations, they take the same trend as nitrogen where results indicate that the application natural amendments led to an increase in soil P and K concentrations at the two seasons compared with the control. The maximum values of them were 0.036, 0.514 % and 0.030, 0.496 % for the two soil depths, respectively at the end of the first season. While in the second season the values were 0.037, 0.521 % and 0.035, 0.514 %, respectively for the same depths. These values were obtained by using 10 ton/fed. of sheep manure where the increases were 71.43, 43.58 and 50.00, 47.18 % over the control for the two soil depths in the first season and were 60.87, 37.47 and 59.09, 38.92 % for the same depths, respectively in the second season. These results suggest that it may be practical to apply these soil conditioners to soil to increase NPK concentrations in the soil and thereby enhance its availability to crop. These results are in full agreement with those of [33,34] they reported that, the application of organic amendments clearly enhanced the nutrients statues of the investigated soil.

Table (6): Effect of different treatments on soil macronutrients and C/N ratio in the first season (summer 2012).

Treatment No.	Total macronutrients, %						Organic carbon, %		C / N ratio	
	N		P		K					
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
1	0.141	0.118	0.022	0.021	0.363	0.342	2.059	1.547	14.60	13.11
2	0.151	0.133	0.036	0.030	0.514	0.496	1.713	1.345	11.34	10.11
3	0.157	0.141	0.032	0.029	0.492	0.479	1.974	1.544	12.57	10.95
4	0.152	0.136	0.026	0.026	0.396	0.387	1.929	1.520	12.69	11.18
5	0.149	0.129	0.029	0.027	0.442	0.421	1.542	1.273	10.35	9.87
6	0.143	0.120	0.027	0.026	0.454	0.429	1.663	1.276	11.63	10.63
7	0.146	0.124	0.025	0.024	0.401	0.390	1.691	1.283	11.58	10.35
8	0.144	0.121	0.023	0.022	0.368	0.349	1.680	1.289	11.67	10.65
9	0.154	0.139	0.035	0.030	0.510	0.492	1.703	1.448	11.06	10.42
10	0.152	0.134	0.033	0.029	0.486	0.471	1.601	1.325	10.53	9.89
11	0.156	0.140	0.030	0.027	0.434	0.412	1.880	1.523	12.05	10.88
12	0.142	0.119	0.024	0.023	0.388	0.376	1.582	1.280	11.14	10.76
13	0.150	0.130	0.034	0.029	0.498	0.483	1.642	1.385	10.95	10.65
14	0.153	0.138	0.030	0.028	0.472	0.457	1.660	1.453	10.85	10.53
15	0.150	0.131	0.028	0.027	0.414	0.404	1.692	1.385	11.28	10.57
16	0.147	0.127	0.032	0.029	0.469	0.447	1.619	1.331	11.01	10.48
17	0.145	0.122	0.027	0.026	0.422	0.410	1.623	1.321	11.19	10.83
18	0.148	0.128	0.025	0.025	0.411	0.402	1.650	1.381	11.15	10.79
19	0.153	0.137	0.030	0.028	0.479	0.466	1.689	1.445	11.04	10.55
Control	0.131	0.115	0.021	0.02	0.358	0.337	1.340	1.112	10.23	9.67
General mean	0.149	0.130	0.029	0.027	0.443	0.427	1.715	1.387	11.51	10.69
Correlation coefficient	0.96	0.89	0.96	0.68	0.84	0.93	0.66	0.70	0.68	0.56
Minimum value	0.141	0.118	0.022	0.021	0.362	0.341	1.540	1.240	10.30	9.80
Optimum combination	[8:0:0:0]…	[8:0:0:0]…	[8:0:0:0]	[8:0:0:0]…	[7:0:0:1]	[7:0:0:1]	[2:2:2:2]	[3:4:0:1],..	[2:2:2:2]	[0:6:0:2],..
Maximum value	0.160	0.141	0.036	0.0301	0.514	0.496	2.060	1.550	14.60	13.11
Optimum combination	[0:0:8:0]…	[0:0:8:0]…	[0:8:0:0]	[0:7:1:0]…	[0:8:0:0]…	[0:8:0:0]…	[8:0:0:0]	[8:0:0:0]…	[8:0:0:0]	[8:0:0:0]…

The combinations effect between FYM, SM, RM and PM gave a high significant correlation on total soil N where r = 0.96, 0.89 and 0.89, 0.99 in the first and second seasons at (0-15 and 15-30 cm depths), respectively. Also, the combinations effect between FYM, SM, RM and PM gave a high significant correlation on total soil P and K where r were 0.96, 0.68 and 0.84, 0.93 in the first season and r were 0.91, 0.83 and 0.98, 0.92 in the second one, respectively.

The results in Table (6) and Fig. (7a) show total soil N % of (0-15cm) soil depth in the first season as affected by FYM, SM, RM and PM. The results reveal that the RM single treatment gave the highest total soil N greater than all the other three ones, where it was 0.157 %, obtained by the addition of 100% RM or 10.00 ton feddan^{-1}, while the FYM gave the minimum one, where it was 0.141 %. The order effect is RM > PM > SM > FYM on increasing total soil N value, in other words the RM should be preferred if the target is increasing total soil N. Also, it can be noticed from Fig. (7a) that the highest total soil N values which was 0.157% obtained by the addition of FYM, SM, RM and PM at the rate [0: 0: 8: 0], [0: 0: 7: 1], [0: 0: 6: 2], [0: 0: 5: 3] (of the 8 points score) of X_1, X_2, X_3 and X_4 respectively. In other words, [0: 0: 10: 0], [0: 0: 8.75: 0.13], [0: 0: 7.50: 0.25], [0: 0: 6.25: 0.38] ton feddan^{-1} of FYM, SM, RM and PM, respectively.

Table (7): Effect of different treatments on soil macronutrients and C/N ratio in the second season (winter 2012/2013).

Treatment No.	Total macronutrients, %						Organic carbon, %		C / N ratio	
	N		P		K					
	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
1	0.144	0.122	0.024	0.023	0.384	0.375	1.812	1.408	12.58	11.54
2	0.155	0.137	0.037	0.035	0.521	0.514	1.699	1.333	10.96	9.73
3	0.161	0.143	0.034	0.033	0.498	0.493	1.803	1.406	11.20	9.83
4	0.156	0.139	0.028	0.027	0.405	0.407	1.809	1.402	11.60	10.09
5	0.153	0.133	0.031	0.029	0.451	0.442	1.574	1.271	10.29	9.56
6	0.148	0.125	0.028	0.028	0.459	0.451	1.625	1.295	10.98	10.36
7	0.149	0.128	0.026	0.025	0.417	0.414	1.627	1.299	10.92	10.15
8	0.148	0.125	0.025	0.023	0.387	0.376	1.626	1.272	10.99	10.18
9	0.158	0.141	0.037	0.035	0.514	0.506	1.711	1.444	10.83	10.24
10	0.156	0.139	0.035	0.033	0.492	0.489	1.608	1.351	10.31	9.72
11	0.160	0.142	0.031	0.030	0.450	0.441	1.794	1.392	11.21	9.80
12	0.145	0.122	0.026	0.025	0.400	0.403	1.579	1.273	10.89	10.43
13	0.153	0.134	0.036	0.034	0.503	0.499	1.584	1.391	10.35	10.38
14	0.158	0.141	0.032	0.031	0.471	0.464	1.632	1.359	10.33	9.64
15	0.154	0.135	0.030	0.028	0.429	0.427	1.677	1.400	10.89	10.37
16	0.150	0.131	0.033	0.032	0.466	0.459	1.608	1.353	10.72	10.33
17	0.149	0.127	0.029	0.028	0.435	0.434	1.620	1.294	10.87	10.19
18	0.150	0.132	0.027	0.027	0.422	0.420	1.617	1.342	10.78	10.17
19	0.157	0.140	0.032	0.031	0.481	0.476	1.696	1.349	10.80	9.64
Control	0.134	0.119	0.023	0.022	0.379	0.370	1.374	1.136	10.25	9.55
General mean	0.152	0.133	0.031	0.029	0.452	0.447	1.668	1.349	10.92	10.12
Correlation coefficient	0.89	0.99	0.91	0.83	0.98	0.92	0.66	0.48	0.61	0.54
Minimum value	0.144	0.122	0.024	0.0225	0.383	0.372	1.550	1.270	10.30	9.60
Optimum combination	[8:0:0:0]	[8:0:0:0]…	[8:0:0:0]	[6:0:0:2]	[7:0:0:1]	[7:0:0:1]…	[3:2:2:1] ..	[2:2:2:2], …	[2:2:2:2], …	[2:2:2:2], …
Maximum value	0.161	0.143	0.0374	0.0353	0.521	0.514	1.810	1.410	12.60	10.50
Optimum combination	[0:0:8:0]…	[0:0:8 0]…	[0:6:2:0]	[0:6:2:0]	[0:8:0:0]	[0:8:0:0]	[8:0:0:0], …	[8:0:0:0], …	[8:0:0:0]	[8:0:0:0]

Scanning the other values inside the tetrahedron, Fig (7b) show that the RM gave the highest total soil N values, where it increased to 0.153% by the application of FYM, SM, RM and PM at the rate [1: 1: 5: 1] or [1: 1: 4: 2] (of the 8 points score) of X_1, X_2, X_3 and X_4, respectively. In other words, [1.25: 1.25: 6.25: 0.13] or [1.25: 1.25: 5.00: 0.25] ton feddan^{-1} of FYM, SM, RM and PM, respectively. On the other hand, the FYM gave the lowest total soil N values, where it decreased to 0.142%. This value was obtained by using the addition of FYM, SM, RM and PM at the rate [5: 1: 1: 1] (of the 8 points score) of X_1, X_2, X_3 and X_4, respectively. In other words, [6.25: 1.25: 1.25: 0.13] ton feddan^{-1} of FYM, SM, RM and PM, respectively. Fig. (3c) indicates that the center point of the tetrahedron has a total soil N of 0.149% corresponding to treatment of [2: 2: 2: 2] of the equivalent mixture of the four used amendments.

2- Organic carbon (O.C) and C/N ratio.

Data in Tables (6 and 7) show that all applied amendments led to markedly affected in organic carbon (O.C) and C/N ratio of the soil at the end of the two seasons in the two soil depths (0-15 and 15-30 cm) compared with the control. The highest values of (O.C) and C/N ratio were recorded by using 10 ton/fed. of FYM where the increases were 53.66, 42.72 and 39.12, 35.57 %, respectively over the control in the two soil depths at the end of the first season. While, they were 31.88, 22.73 and 23.94, 20.84 %, respectively at the same depths in the second season. While, the lowest values were recorded by application of 2.50, 2.50, 2.50 and 0.25 ton/fed. of FYM, SM, RM and PM, respectively. Where the increases were 15.07, 1.17 and 14.48, 2.07 % over the control in the first season and they were 14.56, 0.39 and 11.88, 0.10 % in the second one at the two soil depths, respectively. The combination effects between FYM, SM, RM and PM gave significant correlation on

O.C and C/N ratio where r were 0.66, 0.70 and 0.68, 0.56 in the first season and were 0.66, 0.48 and 0.61, 0.54 in the second one at the two soil depths, respectively.

Thus, the decomposition of the added amendments will be decreased O.C, % values and increased total N, % values. Also, it can be noticed that the values of O.C, % and C/N ratio for all treatments were higher in the surface soil layer (0-15 cm) at the end of the two seasons due to the added amendments did not reach to the deeper depths with the same quantities of their arrangement in the surface layer. Similar results were obtained by [36,35].

NUMBER OF TREATMENTS = 19; NUMBER OF REPLICATES= 3
EXPRIMENTAL DATA AND (MEAN)

1. 0.14 0.14 0.14 (0.14)	8. 0.14 0.14 0.15 (0.14)	15. 0.15 0.15 0.15 (0.15)
2. 0.15 0.15 0.15 (0.15)	9. 0.16 0.16 0.15 (0.15)	16. 0.15 0.15 0.15 (0.15)
3. 0.16 0.16 0.15 (0.16)	10. 0.15 0.15 0.15 (0.15)	17. 0.15 0.14 0.15 (0.15)
4. 0.15 0.15 0.15 (0.15)	11. 0.16 0.16 0.16 (0.16)	18. 0.15 0.15 0.15 (0.15)
5. 0.15 0.15 0.15 (0.15)	12. 0.14 0.14 0.14 (0.14)	19. 0.15 0.15 0.15 (0.15)
6. 0.14 0.14 0.14 (0.14)	13. 0.15 0.15 0.15 (0.15)	
7. 0.15 0.15 0.15 (0.15)	14. 0.16 0.15 0.15 (0.15)	

GENERAL MEAN = .1491053
MEAN ERROR = 7.723286E-04
CORRELATION COEFFICIENT= .9598218
KERETRIO FISHER F(18 38)= 24.69932

REALITY ADEQUATE TEST OF THE MODEL THROUGH THE LAST FOUR TREATMENTS

EXPRIMENTAL TREATMENT - TABULAR =DIFFERENCE KER.STUDENT
16 0.15 -0.15 = -0.00 -0.27
17 0.15 -0.15 = -0.00 -1.21
18 0.15 -0.15 = 0.00 0.13
19 0.15 -0.15 = 0.00 0.40
THE SIGNIFICANT ADEQUATE SECTOR OF THE SQUARE TEST FOR THE CALCULATED VALUE , MULTIPLY BY 1000

Maximum combination (fon) -0 ; MAXIMUM -1

X1
X4 X4
152 150 147 146 144 143 142 141 141 141 142 143 144 146 147 150 152
152 150 147 145 144 143 142 141 142 142 143 145 146 148 151 153
152 150 147 145 144 142 141 142 143 144 145 147 149 152 154
152 149 147 145 143 142 143 143 144 146 148 150 152 155
152 149 147 145 143 144 145 145 146 148 150 153 156
152 149 147 144 145 146 147 147 148 151 153 157
152 149 146 147 148 149 149 150 151 154 157
151 148 149 150 151 151 152 153 154 157
X2 151 152 153 153 154 155 156 156 157 X3
151 152 153 154 155 155 156 157 Fig. (7a)
152 153 153 154 155 156 157
152 153 154 155 156 157
152 153 154 155 156
152 153 154 155
152 153 154
152 153
152
X4

Maximum combination (fon) -.125 ; MAXIMUM -.625

X1
X4 X4
150 148 145 144 142 144 145 148 150
150 148 145 143 144 146 148 151
150 148 145 146 147 149 152
150 147 148 149 150 153
X2 150 151 151 152 153 X3
150 151 152 153 Fig. (7b)
150 151 152
150 151
150
X4

Maximum combination (fon) -.25 ; MAXIMUM -.25

X1
X4 X4
149 Fig. (7c)
X2 X3
X4

MAXIMUM VALUE YR = 0.157
OPTIMUM COMBINATION: (0: 0: 8: 0), (0: 0: 7: 1), (0: 0: 6: 2), (0: 0: 5: 3)

Fig. (7): Computer output of total soil nitrogen (N, %) of (0-15cm) soil depth at the second season in response to all the possible combination of farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM).

NUMBER OF TREATMENTS = 19; NUMBER OF REPLICATES= 3
EXPRIMENTAL DATA AND (MEAN)

1. 12.93 13.27 11.54 (12.58)	8. 10.94 11.13 10.89 (10.99)	15. 10.67 10.70 11.30 (10.89)
2. 10.76 10.28 11.85 (10.96)	9. 10.63 10.69 11.17 (10.83)	16. 10.89 11.08 10.19 (10.72)
3. 11.32 11.46 10.82 (11.20)	10. 10.69 10.74 9.49 (10.31)	17. 10.70 11.18 10.74 (10.87)
4. 10.19 10.31 14.29 (11.60)	11. 10.51 10.66 12.46 (11.21)	18. 10.89 11.16 10.29 (10.78)
5. 9.94 9.88 11.04 (10.29)	12. 10.78 10.57 11.32 (10.89)	19. 10.25 10.40 11.76 (10.80)
6. 11.34 11.35 10.25 (10.98)	13. 9.95 9.95 11.16 (10.35)	
7. 10.62 10.95 11.20 (10.92)	14. 10.17 10.28 10.54 (10.33)	

GENERAL MEAN = 10.92123
MEAN ERROR = .3702157
CORRELATION COEFFICIENT= .6215333
KERETRIO FISHER F(18 38)= 1.328882

REALITY ADEQUATE TEST OF THE MODEL THROUGH THE LAST FOUR TREATMENTS

EXPRIMENTAL TREATMENT - TABULAR =DIFFERENCE KER.STUDENT
16 10.72 -10.45 = 0.27 0.61
17 10.87 -10.42 = 0.45 1.01
18 10.78 -10.60 = 0.18 0.41
19 10.80 -10.47 = 0.33 0.74
THE SIGNIFICANT ADEQUATE SECTOR OF THE SQUARE TEST FOR THE CALCULATED VALUE , MULTIPLY BY 10

Maximum combination (fon) - 0 ; MAXIMUM - 1
X1
X4 X4
116 112 110 109 110 112 115 120 126 120 115 112 110 109 110 112 116
111 108 107 107 108 111 115 120 120 115 111 109 109 109 111 115
107 105 104 105 107 111 116 115 115 111 109 108 109 110 114
104 103 103 105 108 112 112 111 112 109 108 108 110 113
103 103 104 106 110 109 109 109 109 108 108 109 112
103 103 105 108 108 107 107 108 108 108 109 112
104 105 108 107 107 107 107 107 108 109 112
106 108 107 107 107 107 108 108 109 112
X2 110 109 108 108 108 109 110 111 112 X3
106 106 106 107 107 109 110 112 **Fig. (8a)**
104 104 105 106 108 110 112
103 104 105 107 109 112
103 105 107 109 112
104 107 110 113
107 110 114
111 115
116
X4

Maximum combination (fon) - .125 ; MAXIMUM - .625
X1
X4 X4
109 107 106 107 109 107 106 107 109
106 104 105 106 106 105 105 107
104 103 104 104 104 104 106
103 103 103 103 103 104
X2 104 103 103 103 103 X3
103 103 104 104 **Fig. (8b)**
104 105 106
106 107
109
X4

Maximum combination (fon) - .25 ; MAXIMUM - .25
X1
X4 X4
103 **Fig. (8c)**
X2 X3
X4

MAXIMUM VALUE YR = 12.60
OPTIMUM COMBINATION: (8: 0: 0: 0)

Fig. (8): Computer output of C/N ratio of (0-15cm) soil depth at the second season in response to all the possible combination of farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM).

The results in Fig. (8a) show C/N ratio at 0-15 cm soil depth in the second season as affected by FYM, SM, RM and PM, it can be noticed that the four single treatments X_1, X_2, X_3 and X_4 reveal that FYM treatment gave the highest value of C/N ratio (12.60 : 1) and SM gave the lowest value, thus it can be arranged them in descending order : FYM > PM > RM > SM. Also, from the same figure it could be shown that the highest value of C/N ratio obtained by mixture of FYM, SM, RM and PM at the ratio of [8: 0: 0: 0] of (the 8 point score), i.e., [10: 0: 0: 0] ton/fed., respectively. While, the lowest values was 10.30 recorded by the addition of the previous amendments at the ratio of [0: 5: 0: 3], [0: 4: 0: 4], [1: 5: 0: 2], [1: 4: 0: 3], [1: 3: 0: 4] and [2: 3: 0: 3] of (the 8 point score) i.e [0: 6.25: 0: 0.38], [0: 5.00: 0: 0.50], [1.25: 6.25: 0: 0.25], [1.25: 5.00: 0: 0.38], [1.25: 3.75: 0: 0.50] and [2.50: 3.75: 0: 0.38] ton feddan^{-1}, respectively.

Also, the other intersecting points inside the tetrahedron (Fig 8b) show the highest value of C/N ratio was 10.90 located in the small tetrahedron corresponding to combination treatment of [5: 1: 1: 1] or [1: 1: 1: 5] of (the 8 points score), or in other words, the actual composition can be detected as [1.25: 1.25: 1.25: 0.63] ton feddan^{-1} of FYM, SM, RM and PM, respectively, while, the lowest one was 10.30 corresponding to combination treatment of [1: 1: 5: 1] of (the 8 points score), or [1.25: 1.25: 6.25: 0.13] ton feddan^{-1} of FYM, SM, RM and PM, respectively and the range numbers represent by 103. Moreover, Fig. (8c) show that, the central point of the tetrahedron has a C/N ratio of 10.30 corresponds to a treatment of [2: 2: 2: 2], i.e, equivalent mixture of the four amendments used.

IV- Effect of different treatments on yield and yield components.

Most of the recorded characters of maize and wheat plants were significantly affected by the application of natural soil conditioners. Results in Tables (8 and 9) represent the actual results of some maize and wheat growth characters in response to the original 19 treatments comprising some combinations of FYM, SM, RM and PM. Generally, most of different treatments exhibited significant differences on yield and yield component at the end of the two seasons compared with the control (untreated soil). The increases in maize grain yield ranged between 53.85 and 97.81 %, respectively (Table 8). While, the increases in wheat grain and straw yield were ranged between 51.98 and 91.01 % and between 66.67 and 112.96 %, respectively over the control in the second season (Table 9). Also, the same treatments led to significant increases in plant height, ear length, ear diameter, number of rows per ear, number of kernels per row and 100 seed weight for maize in the first season and in plant height, spike length, harvest index and 1000 seed weight for wheat in the second season.

It is quite clear from the output computed data, that maize grain yield and wheat straw yield were highly correlated with the other growth characters which gave similar trends i.e. the same maximum and minimum zone in the tetrahedron. So, each trait of the growth characters can be taken as a reliable index for maize grain yield and wheat straw yield. These results are in harmony with those obtained by [37,35]. From these results it can be noticed that the increases in yield and yield components as a result to added soil amendments, which led to improve soil physical, chemical and microbial properties. Also, the increases in macro-micronutrients, which led to release the elements in soil, consequently increase in yield.

Table (8): Effect of different treatments on yield and yield components of maize in the first season (summer 2012).

Treatment No.	Plant height, cm	Ear length, cm	Ear diameter, cm	No. of rows per ear	No. of kernels per row	100 seed weight, g	Grain yield, ton/fed	R.I.G.Y.	Dry matter, g/plant after 80 days
1	191.46	18.72	5.45	13.11	40.08	34.94	2.6679	53.85	175.41
2	193.39	18.83	5.49	13.24	40.52	35.29	2.7084	56.18	179.15
3	196.35	19.19	5.57	13.43	41.45	35.85	2.7809	60.36	187.44
4	195.30	19.05	5.55	13.33	41.02	35.63	2.7473	58.42	183.88
5	218.95	21.95	6.09	15.07	46.79	40.71	3.4303	97.81	247.93
6	210.39	20.53	5.86	14.37	44.66	39.09	3.1191	79.86	219.38
7	209.22	20.41	5.83	14.23	44.25	38.70	3.0921	78.31	215.11
8	205.02	20.01	5.73	13.97	43.24	37.81	2.9935	72.62	204.94
9	217.78	21.71	6.08	14.92	46.51	40.38	3.3733	94.52	242.08
10	206.22	20.11	5.76	14.06	43.62	38.10	3.0251	74.44	206.89
11	204.26	19.85	5.71	13.86	42.81	37.41	2.9504	70.14	200.50
12	198.34	19.31	5.61	13.53	41.73	36.23	2.8685	65.41	190.14
13	212.79	20.91	5.93	14.56	45.39	39.57	3.1824	83.52	229.80
14	216.12	21.50	6.02	14.79	46.06	40.02	3.2432	87.02	238.09
15	202.24	19.63	5.66	13.75	42.31	36.94	2.9186	68.30	197.44
16	214.03	21.12	5.97	14.67	45.79	39.74	3.2143	85.35	233.26
17	200.14	19.48	5.63	13.63	41.95	36.45	2.8870	66.48	192.53
18	208.09	20.27	5.81	14.16	43.99	38.42	3.0724	77.17	210.96
19	211.85	20.73	5.89	14.44	45.00	39.25	3.1530	81.82	225.46
Control	114.88	10.86	3.00	7.21	22.44	20.27	1.7341	0.00	101.74
General mean	205.89	20.17	5.77	14.06	43.54	37.92	3.0225	74.29	209.49
Correlation coefficient	0.16	0.81	0.19	0.85	0.73	0.66	0.6200	0.32	0.76
Minimum value	191.46	18.70	5.45	13.10	40.08	34.90	2.6700	53.80	175.00
Optimum combination	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]
Maximum value	220.00	21.95	6.11	15.10	47.10	41.00	3.4300	97.81	249.00
Optimum combination	[1:3:3:1]	[2:2:2:2]	[1:3:3:1]	[1:3:3:1]	[1:3:3:1]	[1:3:3:1]	[2:2:2:2]	[2:2:2:2]	[1:3:3:1]

The output of maize grain yield is shown in Fig (9) which exhibits an open view of the tetrahedron with X_4 being the top. Comparing the values located on the sites of the four single treatments (the four head of the tctrachedron) X_1, X_2, X_3 and X_4 reveal that RM single treatment was more effective on maize grain yield (2.7809) ton/fed than PM, SM or FYM, (2.7473), (2.7084) or (2.6679) ton/fed, respectively. Thus, the increase effectiveness took the following descending order: RM > PM > SM > FYM, So RM should be preferred. These results could be explained from the point of view that RM may a source of macro and micronutrients and also may have improved the soil physical properties, resulting in good soil moisture retention.

Scanning the different values of (Fig 9a) show the number 278 as the maximum one, this value represents maize grain yield of 2.78 ton/fed corresponding to an interpolated four combined treatment consisting of [0: 0: 8: 0] (of the 8 points score) of X_1, X_2, X_3 and X_4 respectively. The actual composition can be detected as [0: 0: 10: 0] ton/fed. of FYM, SM, RM and PM., respectively as concluded from matching the transparent guide with the computed results (Fig 9a). Scanning the other intersecting points inside the tetrahedron, smaller tetrahedra inside the principal one, (Fig 9b), it can be noticed a maximum value of 3.24 ton/fed. The corresponding combination treatment for this yield can be obtained with the transparent guide to be [1.25: 1.25: 6.25: 0.13] ton/fed. of FYM, SM, RM and PM., respectively. However (Fig 9c) illustrated the central point which lies in the central of the tetrahedron with maize grain yield of 3.43 ton/fed. corresponding to a treatment of [2: 2: 2: 2] (of the 8 points score) (i.e. 2.5: 2.5: 2.5: 0.25 ton/fed.) of FYM, SM, RM and PM., respectively.

Table (9): Effect of different treatments on yield and yield components of wheat in the second season (winter 2012/2013).

Treatment No.	Biological yield Ton/fed	Grain yield Ton/fed	Straw yield Ton/fed	* R.I.Y., %	* R.I.Y., %	Plant height, cm	Spike length, cm	Harvest Index,%	1000 Seed weight, g	Dry matter g/10 plants after 90 days
				Grain	Straw					
1	5.8810	2.3843	3.4617	51.98	66.67	92.74	9.13	40.54	41.52	18.92
2	5.9718	2.4155	3.5211	53.96	69.53	93.31	9.25	40.45	41.76	19.12
3	6.1626	2.4710	3.6778	57.50	77.07	93.93	9.41	40.10	42.34	19.66
4	6.0771	2.4615	3.6102	56.90	73.82	93.68	9.35	40.50	42.17	19.39
5	7.4259	2.9967	4.4233	91.01	112.96	98.67	10.83	40.35	46.08	24.00
6	6.8537	2.7333	4.1142	74.22	98.08	96.81	10.28	39.88	44.60	22.06
7	6.7559	2.6955	4.0463	71.81	94.81	96.47	10.18	39.90	44.21	21.81
8	6.5027	2.5869	3.9226	64.89	88.86	95.74	9.92	39.78	43.75	21.00
9	7.2913	2.9373	4.3472	87.22	109.30	98.30	10.73	40.28	45.93	23.70
10	6.5962	2.6139	3.9608	66.61	90.70	95.98	10.04	39.63	43.84	21.12
11	6.3839	2.5492	3.8352	62.49	84.65	95.37	9.79	39.93	43.50	20.77
12	6.2316	2.4960	3.7145	59.10	78.84	94.48	9.52	40.05	42.72	20.09
13	7.0425	2.7981	4.2409	78.35	104.18	97.31	10.44	39.73	45.02	22.73
14	7.2205	2.9129	4.3083	85.67	107.43	97.97	10.63	40.34	45.75	23.46
15	6.3519	2.5332	3.8135	61.47	83.60	94.99	9.68	39.88	43.32	20.41
16	7.1264	2.8457	4.2814	81.39	106.13	97.68	10.54	39.93	45.28	23.14
17	6.2951	2.5191	3.7725	60.57	81.63	94.79	9.59	40.02	43.01	20.23
18	6.6625	2.6639	3.9916	69.80	92.18	96.27	10.11	39.98	44.06	21.59
19	6.9550	2.7699	4.1863	76.55	101.55	97.00	10.37	39.83	44.82	22.41
Control	3.6459	1.5689	2.0770	0.00	0.00	52.86	5.20	24.33	24.91	10.97
General mean	6.6204	2.6518	3.9594	69.03	90.63	95.87	9.99	40.06	43.88	21.35
Correlation coefficient	0.7000	0.7300	0.6600	0.37	0.60	0.58	0.75	0.14	0.69	0.57
Minimum value	5.8800	2.3800	3.4600	51.98	66.67	92.70	9.10	39.60	41.50	18.90
Optimum combination	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[8:0:0:0]	[3:1:0:4] …	[8:0:0:0]	[8:0:0:0]
Maximum value	7.4400	3.0000	4.4600	91.01	113.00	98.80	10.90	40.54	46.40	24.20
Optimum combination	[1:3:3:1]	[2:2:2:2]	[1:3:3:1]	[2:2:2:2]	[2:2:2:2]	[1:3:3:1]	[1:3:3:1]	[8:0:0:0] …	[1:3:3:1]	[1:3:3:1]

Also, data in Fig. (10a) show wheat straw yield, ton/fed. in the second season as affected by FYM, SM, RM and PM, it can be noticed that the four single treatments (the four head of the tctrachedron) were 3.46, 3.52, 3.68 and 3.61 ton/fed. for FYM, SM, RM and PM., respectively. These mean that the RM single treatment was more effective on increasing wheat straw yield than other treatments, while FYM gave the lowest wheat straw yield, where the effect can be arranged on descending order: RM > PM > SM > FYM. The other intersecting points inside the tetrahedron (Fig 10b) show the highest value of wheat straw yield was 4.46 ton/fed located in the small tetrahedron corresponding to combination treatment of [1: 3: 3: 1] of (the 8 points score), or in other words, the actual composition can be detected as [1.25: 3.75: 3.75: 0.13] ton feddan^{-1} of FYM, SM, RM and PM, respectively. Moreover, Fig. (10c) show that, the central point of the tetrahedron has a wheat straw yield of 4.42 corresponds to a treatment of [2: 2: 2: 2], i.e, equivalent mixture of the four amendments used.

V- Economical analysis.

Data presented in Tables (10 and 11) show the total inputs costs, outputs, net income and the investment ratio for the tested treatments besides the control. The obtained results indicate that the highest net income value (14277.67 LE/fed.) was incorporated with the mixing of FYM, SM, RM and PM at the rate [2.5: 2.5: 2.5: 0.25] ton feddan^{-1}, respectively. While, the control (without any additions) gave always the lowest value (6342.57 LE/fed.).

From these Tables, it could be seen that although addition of FYM, SM, RM and PM at the rate [2.5: 2.5: 2.5: 0.25] ton feddan^{-1}, respectively gave the highest yield than the other treatments but the investment ratio was not the best one, this is due to its high inputs of PM which reflect on their high prices and costs.

On the other hand, most of the investment ratio values were incorporated with the highest net income besides the lowest inputs which were resulted from mixing the different rates of FYM, SM and RM with half of the recommended dose of mineral fertilizers.

NUMBER OF TREATMENTS = 19; NUMBER OF REPLICATES= 3
EXPRIMENTAL DATA AND (MEAN)

1. 2.40 2.48 3.13 (2.67)	8. 2.77 2.82 3.39 (2.99)	15. 2.66 2.74 3.36 (2.92)
2. 2.42 2.50 3.20 (2.71)	9. 3.36 3.42 3.34 (3.37)	16. 3.06 3.07 3.51 (3.21)
3. 2.48 2.58 3.29 (2.78)	10. 2.83 2.87 3.37 (3.03)	17. 2.63 2.71 3.32 (2.89)
4. 2.46 2.55 3.23 (2.75)	11. 2.71 2.78 3.36 (2.95)	18. 2.86 2.90 3.46 (3.07)
5. 3.44 3.51 3.34 (3.43)	12. 2.62 2.69 3.30 (2.87)	19. 2.95 3.02 3.49 (3.15)
6. 2.94 2.99 3.43 (3.12)	13. 2.98 3.03 3.54 (3.18)	
7. 2.90 2.95 3.43 (3.09)	14. 3.09 3.13 3.51 (3.24)	

GENERAL MEAN = 3.022511
MEAN ERROR = .1555964

CORRELATION COEFFICIENT= .6177353
KERETRIO FISHER F(18 38)= 1.3027

REALITY ADEQUATE TEST OF THE MODEL THROUGH THE LAST FOUR TREATMENTS

EXPRIMENTAL TREATMENT - TABULAR =DIFFERENCE KER.STUDENT
16 3.21 -3.27 = -0.06 -0.30
17 2.89 -3.08 = -0.20 -1.05
18 3.07 -3.06 = 0.01 0.05
19 3.15 -3.21 = -0.06 -0.33
THE SIGNIFICANT ADEQUATE SECTOR OF THE SQUARE TEST FOR THE CALCULATED VALUE , MULTIPLY BY 100

Maximum combination (fon) -0 ; MAXIMUM -1

X1
X4 X4
275 286 294 299 299 297 290 280 267 280 290 297 299 299 294 286 275
287 298 305 308 308 304 297 286 284 295 302 305 305 301 294 283
296 306 312 314 313 308 300 303 297 305 309 309 306 300 290
301 310 315 316 314 309 315 314 305 310 311 309 303 293
303 310 314 315 312 323 326 322 309 311 309 304 295
300 307 310 310 325 333 332 324 308 307 303 294
294 300 302 322 334 338 334 322 303 299 291
284 289 313 330 338 338 331 316 293 286
X2 271 299 320 332 337 334 323 305 278 X3
284 308 324 332 332 325 309 286 Fig. (9a)
294 313 325 328 324 311 291
300 315 321 320 311 294
303 312 314 309 295
301 306 304 293
296 297 290
287 283
275
X4

Maximum combination (fon) -.125 ; MAXIMUM -.625

X1
X4 X4
292 296 297 293 287 293 297 296 292
304 307 307 303 303 307 307 303
312 315 313 318 315 316 313
317 318 327 329 322 320
X2 318 332 337 335 324 X3
317 326 327 320 Fig. (9b)
312 317 313
304 303
292
X4

Maximum combination (fon) -.25 ; MAXIMUM -.25

X1
X4 X4
343 Fig. (9c)
X2 X3
X4

MAXIMUM VALUE YR = 3.43
OPTIMUM COMBINATION: (2: 2: 2: 2)

Fig. (9): Computer output of maize grain yield, ton/fed at the first season in response to all the possible combination of farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM).

NUMBER OF TREATMENTS = 19; NUMBER OF REPLICATES= 3
EXPRIMENTAL DATA AND (MEAN)

1. 3.20 3.05 4.13 (3.46)	8. 3.79 3.60 4.39 (3.92)	15. 3.60 3.46 4.37 (3.81)
2. 3.29 3.16 4.12 (3.52)	9. 4.30 4.22 4.52 (4.35)	16. 4.23 4.13 4.48 (4.28)
3. 3.46 3.30 4.28 (3.68)	10. 3.82 3.66 4.40 (3.96)	17. 3.55 3.40 4.37 (3.77)
4. 3.37 3.24 4.21 (3.61)	11. 3.66 3.51 4.34 (3.84)	18. 3.87 3.71 4.40 (3.99)
5. 4.43 4.35 4.49 (4.42)	12. 3.51 3.36 4.27 (3.71)	19. 4.12 4.00 4.44 (4.19)
6. 4.00 3.83 4.52 (4.11)	13. 4.18 4.06 4.49 (4.24)	
7. 3.96 3.77 4.41 (4.05)	14. 4.27 4.18 4.48 (4.31)	

GENERAL MEAN = 3.959442	CORRELATION COEFFICIENT= .6585718
MEAN ERROR = .1871036	KERETRIO FISHER F(18 38)= 1.616903

REALITY ADEQUATE TEST OF THE MODEL THROUGH THE LAST FOUR TREATMENTS

EXPRIMENTAL TREATMENT - TABULAR =DIFFERENCE KER.STUDENT
16 4.28 -4.31 = -0.03 -0.12
17 3.77 -4.06 = -0.29 -1.30
18 3.99 -4.01 = -0.02 -0.10
19 4.19 -4.22 = -0.04 -0.16
THE SIGNIFICANT ADEQUATE SECTOR OF THE SQUARE TEST FOR THE CALCULATED VALUE , MULTIPLY BY 100

Maximum combination (fon) -0 ; MAXIMUM -1

X1
X4 X4
361 376 386 392 392 388 379 365 346 365 379 388 392 392 386 376 361
377 391 400 405 404 399 389 374 370 384 394 399 399 394 385 370
388 402 410 413 412 405 394 396 387 398 403 404 400 391 377
395 407 414 416 414 407 414 411 399 405 406 403 395 381
396 407 413 415 411 424 427 420 405 407 404 396 384
392 403 408 408 426 435 434 424 404 402 395 383
384 393 397 421 435 440 435 421 398 392 380
371 379 408 427 438 439 431 413 386 375
X2 352 387 412 428 435 432 420 399 368 X3
371 399 419 429 429 421 403 375
384 407 420 424 419 404 380
392 409 417 415 404 383
396 407 408 401 384
395 400 395 381
388 387 377
377 370
361
X4

Fig. (10a)

Maximum combination (fon) -.125 ; MAXIMUM -.625

X1
X4 X4
381 386 386 381 371 381 386 386 381
399 403 402 396 395 401 401 397
413 415 413 418 413 414 411
421 423 433 433 425 422
X2 424 440 446 443 431 X3
421 431 431 422
413 416 411
399 397
381
X4

Fig. (10b)

Maximum combination (fon) -.25 ; MAXIMUM -.25

X1
X4 X4
442
X2 X3
X4

Fig. (10c)

MAXIMUM VALUE YR = 4.46
OPTIMUM COMBINATION: (1: 3: 3: 1)

Fig. (10): Computer output of wheat straw yield, ton/fed at the second season in response to all the possible combination of farmyard manure (FYM), sheep manure (SM), rabbit manure (RM) and pigeon manure (PM).

Table (10): Input production items and output of the experiments through the two growing seasons under study (summer season 2012 and winter season 2012/2013).

Items	Treatment		Unit	Unit price (LE)
Input				
Mineral fertilizer				
Nitrogen fertilizer	1/2 recommended dose only in both seasons		Kg N	4.18
Phosphorus fertilizer			Kg P_2O_5	6.19
Potassium fertilizer			Kg K_2O	8.33
Soil conditioners				
Farmyard manure	10 ton/fed	and all possible combination of these parameter	Ton	40
Sheep manure	10 ton/fed		Ton	30
Rabbit manure	10 ton/fed		Ton	40
Pigeon manure	1 ton/fed		Ton	1000
Seeds of maize	15 kg fed^{-1}		Kg	10
Seeds of wheat	60 kg fed^{-1}		Kg	4.17
labor			per fed	550
Land preparation			per fed	90
pesticides			per fed	500
Other costs			per fed	200
Output				
Maize grain			Ton	1500
Wheat grain			Ton	2500
Wheat straw			Ton	1000

Table (11): Economical assessment for the tested variables (natural soil conditioners) for the two growing seasons under study (summer season 2012 and winter season 2012/2013).

Treatment No.	Total yield Ton/fed.			Total yield price, LE/fed			Inputs (LE/fed)	Outputs (LE/fed)	Net income LE/fed	Investment ratio
	Maize grain	Wheat grain	Wheat straw	Maize grain	Wheat grain	Wheat straw				
1	2.6679	2.3843	3.4617	4001.85	5960.75	3461.70	2657.83	13424.30	10766.47	5.05
2	2.7084	2.4155	3.5211	4062.60	6038.75	3521.10	2557.83	13622.45	11064.62	5.33
3	2.7809	2.4710	3.6778	4171.35	6177.50	3677.80	2657.83	14026.65	11368.82	5.28
4	2.7473	2.4615	3.6102	4120.95	6153.75	3610.20	3257.83	13884.90	10627.07	4.26
5	3.4303	2.9967	4.4233	5145.45	7491.75	4423.30	2782.83	17060.50	**14277.67**	**6.13**
6	3.1191	2.7333	4.1142	4678.65	6833.25	4114.20	2607.83	15626.10	13018.27	5.99
7	3.0921	2.6955	4.0463	4638.15	6738.75	4046.30	2657.83	15423.20	12765.37	5.80
8	2.9935	2.5869	3.9226	4490.25	6467.25	3922.60	2957.83	14880.10	11922.27	5.03
9	3.3733	2.9373	4.3472	5059.95	7343.25	4347.20	2607.83	16750.40	**14142.57**	**6.42**
10	3.0251	2.6139	3.9608	4537.65	6534.75	3960.80	2907.83	15033.20	12125.37	5.17
11	2.9504	2.5492	3.8352	4425.60	6373.00	3835.20	2957.83	14633.80	11675.97	4.95
12	2.8685	2.4960	3.7145	4302.75	6240.00	3714.50	2720.33	14257.25	11536.92	5.24
13	3.1824	2.7981	4.2409	4773.60	6995.25	4240.90	2670.33	16009.75	**13339.42**	**6.00**
14	3.2432	2.9129	4.3083	4864.80	7282.25	4308.30	2720.33	16455.35	**13735.02**	**6.05**
15	2.9186	2.5332	3.8135	4377.90	6333.00	3813.50	3020.33	14524.40	11504.07	4.81
16	3.2143	2.8457	4.2814	4821.45	7114.25	4281.40	2664.08	16217.10	**13553.02**	**6.09**
17	2.8870	2.5191	3.7725	4330.50	6297.75	3772.50	2814.08	14400.75	11586.67	5.12
18	3.0724	2.6639	3.9916	4608.60	6659.75	3991.60	2839.08	15259.95	12420.87	5.37
19	3.1530	2.7699	4.1863	4729.50	6924.75	4186.30	2814.08	15840.55	13026.47	5.63
Control	1.7341	1.5689	2.0770	2601.20	3922.17	2077.02	2257.83	8600.40	**6342.57**	**3.81**

The results in Table (11) indicate that the net income values of SM and RM treatments generally were higher than those of the other treatments. Thus, the single added treatments can be arranged according to their high net income as follows: RM > SM > FYM > PM, while according to their high investment ratio were as follows: SM > RM > FYM > PM. Also, it can be noticed that the net income values were increased by increasing addition rates of SM and RM with half of the recommended dose of mineral fertilizers. Similar results had been obtained by [33, 35].

From the aforementioned results, it can be observed that its better economy to use these amendments (FYM, SM, RM and PM) in the presence of half recommended dose of mineral fertilizers to get a markedly higher net income.

Finally, it can be concluded that under clay loam soil conditions, the addition of FYM, SM, RM and PM with mineral fertilizers markedly improved soil chemical properties such as a decrease in soil pH and SAR. As well those organic residues caused a substantial increase in soil macronutrients which reflect on increasing the yield and its components incorporated with high net income and investment ratio, besides substitute a part of chemical fertilizers with natural soil conditioners to minimize the pollution caused from the intensive use of it.

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